Educational Technology & Society
An International Journal

Aims and Scope
Educational Technology & Society is a quarterly journal published in January, April, July and October. Educational Technology & Society seeks academic articles on the issues affecting the developers of educational systems and educators who implement and manage such systems. The articles should discuss the perspectives of both communities and their relation to each other:

- Educators aim to use technology to enhance individual learning as well as to achieve widespread education and expect the technology to blend with their individual approach to instruction. However, most educators are not fully aware of the benefits that may be obtained by proactively harnessing the available technologies and how they might be able to influence further developments through systematic feedback and suggestions.
- Educational system developers and artificial intelligence (AI) researchers are sometimes unaware of the needs and requirements of typical teachers, with a possible exception of those in the computer science domain. In transferring the notion of a “user” from the human-computer interaction studies and assigning it to the “student,” the educator’s role as the “implementer/manager/user” of the technology has been forgotten.

The aim of the journal is to help them better understand each other’s role in the overall process of education and how they may support each other. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to Educational Technology & Society and three months thereafter.

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Attitudes, Openness to Multiculturalism, and Integration of Online Collaborative Learning

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ABSTRACT

The current study examined the influence of students’ openness to multiculturalism on the frequency of integrating Online Collaborative Learning (OCL). The mediating variables were attitudes toward: benefits of OCL, negative aspects of OCL and challenges of OCL. The participants were 315 ICT coordinators who are also subject teachers. 139 coordinators had participated in at least one OCL training program (44%) and 176 coordinators had not (56%). The questionnaire was based on previous ones and comprised 33 items. Path analysis findings indicate that the negative aspects of OCL were a very significant mediating factor in the model, affecting the paths between openness to multiculturalism and experiencing the challenges of OCL, and the frequency of the integration of OCL. Furthermore, for ICT coordinators who had taken part in the OCL programs and saw openness toward multiculturalism among their students, there was little impact when there were complex challenges in the OCL. It may be that educating toward multiculturalism leads to an atmosphere of openness and egalitarianism, to better interpersonal relations and social skills in the class, and so they summon fewer frustrating situations in OCL. This is an atmosphere that assures collaboration and attainment of positive learning results.

Keywords

Online collaborative learning, Openness to multiculturalism, Attitudes, ICT coordinators

Introduction

Since 2010, a national ICT program has been operating in Israel known as “Adapting the education system to the 21st century.” It encompasses hundreds of elementary and junior high schools. The program focuses on applying the output in schools from both the organizational and pedagogical aspects, one of which is communications and collaboration (Ministry of Education, 2016), which affords one of the changes in 21st century learning (Resta & Carroll, 2010). Teachers are expected to apply a constructivist collaborative approach in an ICT environment in which students are actively involved in the learning process. According to this approach, students construct new knowledge through shared peer discussion in the learning, social, and cultural context, and the technological abilities of gathering, managing, creating, and sharing information indeed make it possible to realize many opportunities for innovative learning (Mikropoulos & Natsis, 2011). As part of the national program, in each school a teacher was appointed as the ICT coordinator to help introduce the technological changes to the school and instruct the teachers in their successful application. The teachers were chosen for their considerable and successful experience in the field and for their technological-pedagogical-content knowledge (TPACK) (Ministry of Education, 2016), which allowed them to integrate technology intelligently into their own teaching (Magen-Nagar & Avidov-Ungar, 2014).

In the framework of the national ICT program, some 30 diverse ICT collaborative programs serving the schools exist at national and district levels. Online collaborative learning in schools has the defined structure of an educational intervention program that occurs in one or more of the following study settings: Collaborative learning within the school (in small groups in a class or crossing grade levels and disciplines); Collaborative learning between schools in the town / district / country; and collaborative learning between students in Israel and students in other countries around different or common topics around a certain theme (Ministry of Education, 2016). The most common digital means used for collaborative learning are the following: forums or social media, collaborative thinking maps, collaborative documents, a shared gallery and a shared digital book (Magen-Nagar & Shamir-Inbal, 2014). Each collaborative learning program is accompanied by the professional development and training of the teachers. These programs are also budgeted by the Ministry of Education’s national ICT program.

The current study examined the variables that predict the integration of Online Collaborative Learning (OCL) among ICT coordinators. The variables in this study were: attitudes toward students’ openness to multiculturalism, attitudes regarding the benefits and negative aspects of OCL, and experiencing challenges in
OCL. Various characteristics may influence the teachers’ motivation to use OCL. Much research shows that the main obstacle to integrating ICT is the teachers’ attitudes towards its role in teaching and their ability to integrate it successfully (e.g., Kusano et al., 2013). The current study examines the attitudes of ICT coordinators towards OCL (benefits, negative aspects, and challenges) as factors affecting the frequency of its use. This learning, which is constantly on the rise following technological changes, is considered a dynamic teaching practice, but with a low level of application (Kaendler, Wiedmann, Rummel, & Spada, 2014; Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2016). These findings show a need to distinguish between different attitudes and identify which of them influence behavior. Moreover, this study adds a new dimension – the teachers’ estimation of their students’ attitudes toward the universal value of openness to multiculturalism. For OCL, the interaction between different learners is of critical significance, and one of the factors that affect this interaction is openness to diversity. Israel is defined as a multicultural country, and so openness to multiculturalism is a very relevant value in education. It is reasonable to assume that the students’ openness to multiculturalism will affect the nature of their learning as well as the teachers’ attitudes and behaviors regarding online collaborative learning and teaching.

In the current study, a path analysis model was used, as it enabled concurrent investigation of the direct and indirect influences of the variables on the dependent variable. The construction of the proposed model was based on a review of the literature and on prior research, and the research hypotheses were developed accordingly.

**Literature review and hypotheses development**

**Openness to multiculturalism**

The term “cultural” refers to a wide variety of groups, specifically, various ethnic minorities, immigrants, resident aliens, women, men, and homosexuals, as well as a range of political and religious orientations (Narvaez & Hill, 2010). Multicultural education is based on the principle of dialogue and respect between different groups in society and the mutual enrichment of openness to others. Openness to multiculturalism is defined as a basic value that is a component of human nature in every culture. It represents the value of universality relating to concern for the individual and the wellbeing of the collective, i.e., the desire to understand and accept other people, with an emphasis on intellectual and emotional openness to the environment and other cultures (Schwartz et al., 2012). Educational multiculturalism strives to offer equal education, which means providing equal educational opportunities to all students, whatever their ethnic, racial, cultural and social background (Banks & Banks, 2010). Such education is characterized by a commitment to social justice, critical approaches to learning and openness to multiculturalism.

Culturally, Israel is a highly diverse society. Its three main cultural segments are: secular Jews, religious Jews and Arabs. However, each of these three segments contains further subdivisions of diverse cultures and ethnic groups. There is no official national policy regarding intercultural education in Israel. However, projects and initiatives promoting it have regularly been supported and financed by the country’s various governments. Moreover, inherent in Israel’s Declaration of Independence (1948) is the commitment to extend equal rights to “all inhabitants.” Israel’s education system demonstrates such a commitment by allowing the opening of schools according to religious and cultural affiliation. These schools enhance the mandatory educational curriculum with particular national/religious/cultural content. As a result, the majority of schools have a specific religious and cultural orientation, with little or no interaction with other cultures. These differences between cultures tend to create tensions in Israeli society and hence, schools play a vital role in education for tolerance and openness to multiculturalism, a pluralistic approach (Schmida & Yosifon, 2006). As a consequence, educators must seek to create conditions that allow and encourage students to move beyond their narrow personal and social worlds and provide them with opportunities to experience the worlds of those different from them. A teacher who educates his or her students is familiar with their behavior and attitudes, and so it is feasible to assume that the ICT coordinator, who is a teacher, may know to what extent his or her students are open to multiculturalism. One of the most innovative strategies that can provide a solution is cooperative learning (Slavin, 2013). Group learning encourages positive social interactions between students from different cultures. This strategy reduces racial stereotyping and prejudices (McLemore & Romo, 1998). The effectiveness of collaborative learning depends on many conditions, such as the composition of the group (heterogeneity, number, and age), the nature of the task and the medium of communication. These conditions are interconnected and we cannot know what affects the outcomes of the learning (Kusano et al., 2013).

Over the last 40 years, there have been numerous initiatives in Israel to bring together diverse groups in a variety of educational settings. From the start of this century, the integration of ICT in these projects has gained
momentum, as it enables asynchronous meetings from different locations while at the same time concealing external appearances and thus allowing for an unprejudiced first impression (Shonfeld, Hoter, & Ganayem, 2013). This is very relevant when different ethnic/religious groups are easily recognizable by their external appearance (e.g., skin color, length of clothing, type of head covering or absence thereof). In classrooms where teachers educate toward openness to multiculturalism, cooperative learning will be more successful because of students’ social skills and values that afford them high quality interactions (Gillies, 2008; Johnson & Johnson, 2009).

In light of the above, the following hypotheses were proposed:

**H1:** ICT coordinators’ attitudes toward their students’ openness to multiculturalism has a positive effect on their perception of the benefits of OCL.

**H2:** ICT coordinators’ attitudes toward their students’ openness to multiculturalism has a negative effect on their perception of the negative aspects of OCL.

**H3:** ICT coordinators’ attitudes toward their students’ openness to multiculturalism has a positive effect on their challenging experiences in OCL.

**H4:** ICT coordinators’ attitudes toward their students’ openness to multiculturalism has a positive effect on their frequency of integrating OCL.

### Online collaborative learning

Collaboration is one of the accepted methods of distance learning that developed with the spread of online learning in the education system (Harasim, 2012). This learning is based on face-to-face collaborative learning, which contains five interrelated components: (1) Positive mutual dependency; (2) Personal accountability; (3) Fostering interaction; (4) Social skills; (5) Group process (Johnson & Johnson, 1999). When these components are well executed, the learners’ academic achievements, involvement, responsibility, and intrinsic motivation improve (Hanze & Berger, 2007). “OCL theory provides a model of learning in which students are encouraged and supported to work together to create knowledge: to invent, to explore ways to innovate, and, by so doing, to seek the conceptual knowledge needed to solve problems...” (Harasim, 2012, p. 90). Online collaboration is similar to face-to-face collaborative learning, but the meetings of group members are conducted synchronously and/or asynchronously via the internet. Siemens (2005) claims that learning in the digital age is no longer dependent on individual knowledge acquisition, storage, and retrieval; rather, it relies on the connected learning that occurs through interaction with various sources of knowledge (including the Internet and learning management systems) and participation in communities of common interest, social networks, and group tasks.

According to Ajzen’s (1991) Planned Behavior Theory, attitude affects behavior through a process of planned decision-making. The theory assumes that behavior is an indirect result of information or relevant behavioral beliefs toward the behavior, so that each of the influential factors is derived from behavioral beliefs; in our case, this would be the teachers’ beliefs about including OCL in teaching. This study examined the attitudes of ICT coordinators, which reflect the benefits, negative aspects and challenges of OCL, since these beliefs have a decisive impact on any change in behavior and on choosing the practice of OCL (Ertmer & Ottenbreit-Leftwich, 2010). Studies show that teachers’ attitudes have a greater impact on their actions than knowledge, and they are better predictors of teacher behavior (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Prestridge, 2012). The strategy of integrating collaborative technologies and the extent of their inclusion are affected by teacher’s beliefs, because the use of these technologies will help improve teaching and professional development (Kale & Goh, 2014).

OCL has great potential to promote meaningful interactions and empathy between students and teachers and among the students themselves. Collaborative learning is not only active, but also interactive. Each student interacts with other learners, and while exchanging ideas and knowledge, each student builds his/her own world of knowledge (Harasim, 2012). It was found that collaborative projects increased student engagement and motivation to learn (Kaendler et al., 2014). A link was also found between collaborative projects, student involvement in learning, and knowledge construction (Brett, 2004; Stahl, 2006). Researchers found that collaborative learning provides learners with skills needed in the work world, where much activity takes place in working groups (Palloff & Pratt, 2005). A meta-analysis of 629 studies found that with positive mutual dependency, students’ achievements, and motivation were higher than among those who experienced negative dependency or non-dependency (Johnson, Johnson, Roseth, & Shin, 2014).

Despite the benefits of OCL documented here, group collaborative work can scare learners. They often refrain from participating and even have reservations about taking part in group activities. There are some who refuse to
participate because of previous negative experiences due to an unfair amount of effort needed and assessment that did not reflect the level of their contribution to the group work (Harasim, 2012). Sometimes ethical questions arise regarding the sense of ownership of the knowledge and agreements about sharing the knowledge with others in order to improve the results of the group (Stahl, 2006). Cultural diversity among group members might be a challenge also, as it might lead to empathy toward the other, alongside confrontations and controversies among group members. Confrontations might arise regarding how collaborative tasks are to be completed or how decisions are made. Such disagreements might diminish the effectiveness of the learning if they are not dealt with properly, on the one hand. On the other hand, negotiation, discussion of solutions and brainstorming might advance the collaborative learning toward innovation and creativity (Johnson & Johnson, 2013). Moreover, sometimes a different mother tongue among learners (as is the case between Jews and Arabs in Israel) is a hindrance that can lead to misunderstanding (Shonfeld et al., 2013). Another issue that emerges in collaborative learning is coordinating schedules. Delays in studies due to lack of scheduling coordination might lead to diminished motivation and reciprocal blaming (Chiong, Jovanovic, & Gill, 2012).

Because of the challenges, the teacher plays a crucial role in fostering student interaction that is beneficial for learning (Gillies et al., 2008). Teachers’ professional knowledge and competence influence the success of collaborative learning. Teachers’ beliefs about their role might play a crucial role in the process of OCL in class (Kaendler et al., 2014). However, it was found that teachers are not always so enthusiastic about learning and implementing new theories (Tondeur et al., 2016) and that the collaborative learning experience changed their behavior (Van Leeuwen, Janssen, Erkens, & Brekelmans, 2013). In this research we suggest involving teachers in organized collaborative projects in order to increase their knowledge, and promote positive attitudes and willingness to integrate collaborative learning in their teaching.

In light of the above findings, the following additional hypotheses were proposed:

H5: ICT coordinators’ attitudes toward the benefits of OCL have a positive effect on their experience of challenges in OCL.
H6: ICT coordinators’ attitudes toward the benefits of OCL have a positive effect on the frequency with which they choose to integrate OCL into their work.
H7: ICT coordinators’ attitudes toward the negative aspects of OCL have a negative effect on their perception of the benefits of OCL.
H8: ICT coordinators’ attitudes toward negative aspects of OCL have a negative effect on their experience of challenges in OCL.
H9: ICT coordinators’ attitudes toward the negative aspects of OCL have a negative effect on the frequency with which they choose to integrate OCL into their work.
H10: ICT coordinators’ challenging experiences in OCL have a negative effect on the frequency with which they choose to integrate OCL into their work.
H11: ICT coordinators’ attitudes toward their students’ openness to multiculturalism has a positive effect on their frequency of integrating OCL via the attitudes toward the benefits of OCL, and attitudes toward the negative effect and challenging experiences in OCL.

It could be assumed that all variables in path analysis are stronger among ICT coordinators who participate in such programs compared to ICT coordinators who do not participate. This is because those who receive guidance, preparation, and training to integrate OCL should be better at it than those who are not prepared (Gillies, 2008; Johnson & Johnson, 2009).

Methodology

The participants

The study comprised 315 school ICT coordinators who participated in the national ICT program, and in addition, are also teachers of various disciplines (e.g., mother tongue, math, English). Prior to the study, 139 coordinators had participated in OCL programs (44%) and 176 coordinators had not participated (56%) in any such course. Most of the participants taught in elementary schools (70.6%); about half had held that position for up to three years (52.2%) and the rest for longer (47.8%). Similarly, about half of the coordinators had a Master’s degree (52.2%), others had a Bachelor’s degree (42.1%), and 0.9% held a PhD. Most had 11 years or more of teaching seniority (66.5%) and the rest had less (33.5%).
The research tools

The research hypotheses were examined using a self-reporting questionnaire developed for this study that was based on several questionnaires and on the literature. It included 33 items divided into five indices. The items were measured using a 5-point Likert scale with responses ranging from "not at all" (1) to "greatly" (5). Furthermore, background data such as age, education, teaching seniority and subject coordination were gathered. Table 1 presents the descriptive information about the research questionnaire.

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<td>Attitudes toward the benefits of OCL (adapted from Brown, 2008)</td>
<td>Attitudes toward the benefits of OCL</td>
<td>1. A better understanding of the contents</td>
<td>1-8</td>
<td>.90</td>
</tr>
<tr>
<td>Attitudes toward the negative aspects of OCL (adapted from Brown, 2008 and Capdeferro &amp; Romero, 2012)</td>
<td>Attitudes toward the negative aspects of OCL</td>
<td>13. Does not suit all types of students</td>
<td>9-16</td>
<td>.84</td>
</tr>
<tr>
<td>Challenging experiences in OCL (adapted from Capdeferro &amp; Romero, 2012)</td>
<td>Challenging experiences in OCL</td>
<td>21. Online discourse among students leads to misunderstandings</td>
<td>17-23</td>
<td>.80</td>
</tr>
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<td>Attitudes toward students’ openness to multiculturalism (adapted from Narvaez, Endicott, &amp; Hill, 2009)</td>
<td>Student’s experiences of, or efforts to increase their multicultural experiences</td>
<td>27. My students try to listen to opinions that differ from their own</td>
<td>24-32</td>
<td>.86</td>
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<tr>
<td>The frequency of integrating OCL</td>
<td>Frequency of integrating OCL</td>
<td>33. How frequently do you integrate OCL in your lessons?</td>
<td>33</td>
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In Table 1, the internal consistencies of the scales, which can be used to claim convergent validity, were assessed using Cronbach’s alpha. The alpha value of four scales ranged from 0.80 to 0.90.

The research process

In the middle of the semester of 2016, while schools were following the annual ICT curriculum, the ICT coordinators were asked to complete the online self-reporting questionnaire. Anonymity and confidentiality were assured since the questionnaires were completed without the inclusion of any identifying details.

Results

In order to examine the research hypotheses via path analysis, the correlations between the research variables were examined with a Pearson correlation matrix. The results of these analyses are presented in Table 2.

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</table>

Note. N = 315; * p < .01.
Table 2 shows significant Pearson correlations between the five research variables. The strongest positive relationship was between attitudes toward the negative aspects of OCL and the experiences of challenges in OCL (.605), and between attitudes toward the students’ openness to multiculturalism and attitudes toward the benefits of OCL (.434), while the weakest positive relationship was between attitudes toward the benefits of OCL and the frequency of integrating OCL (.244). Additionally, the weakest negative relationship was between attitudes toward the benefits of OCL and challenging experiences in OCL (-.174). The mean values of research variables were medium when positive attitudes toward the benefits of OCL were higher.

In order to examine the variables that predict the integration of OCL during lessons among ICT coordinators who participated in the collaborative ICT programs, compared to ICT coordinators who did not participate, a path analysis was conducted using the statistical AMOS 22.0 software for SEM (Arbuckle, 2013). This is a multi-variable data analysis in a graphic environment, used when testing a complex model that includes a range of variables or diverse dependency connections between them (Byrne, 2009). The first stage in SEM is evaluating the measurement model. The results of this model show that the value of $\chi^2$ is 0.42 ($df = 1$) which is statistically not significant ($p = .515$). The RMSEA index was lower than .06 (.000), thus reflecting a good fit; the NFI index was very high, approaching 1 (.999), the CFI index was 1.000 and the GFI index was .98. These results demonstrate that the measure achieved a satisfactory model fit.

The second stage involved evaluating the structural model that classifies the inter-variable effects. Figure 1 presents the path analysis of the ICT coordinators who participated in the OCL program, and Figure 2 presents that of the non-participating ICT coordinators. Each figure presents the standardized coefficients of effect ($\beta$).

*Figure 1. Path analysis for ICT coordinators after an OCL program (Note. *$p < .05$; **$p < .01$; ***$p < .001$.)

*Figure 2. Path analysis for ICT coordinators not in any OCL program (Note. *$p < .05$; **$p < .01$; ***$p < .001$.)
Examination of the structural model and confirmation of the research hypotheses

Figures 1 and 2 show that openness to multiculturalism is the independent variable and integrating OCL is the dependent variable. The model’s intermediary variables are benefits of OCL, negative aspects of OCL and challenging experience in OCL.

Examination of the first four research hypotheses (H1, H2, H3, H4) indicate that regarding attitudes toward their students’ openness to multiculturalism, among ICT coordinators who participated in OCL programs there is a significantly strong effect on the attitudes toward the benefits and negative aspects of OCL ($\beta = .46, \beta = -.38, p < .001$ respectively), and of a low, negative intensity on the experience of challenges in OCL ($\beta = -.17, p < .05$), but there is no significant effect on the frequency of integrating OCL ($\beta = -.13, p > .05$). In other words, in the group of ICT coordinators who had participated in OCL programs, the more open the coordinators believed their students were to multiculturalism, the more familiar the coordinators were with the benefits and negative aspects of OCL, and the more they agreed with the experience of challenges in OCL.

Among ICT coordinators who had not participated in any OCL training, for attitudes regarding their students’ openness to multiculturalism, there is a significant effect of medium, positive intensity on the attitudes regarding the benefits of OCL ($\beta = .32, p < .001$), but there is no significant effect on the negative aspects ($\beta = -.09, p > .05$), on the challenging experience in OCL ($\beta = -.15, p > .05$) and on the frequency of integrating OCL ($\beta = .13, p > .05$). In other words, in the group of coordinators that had not participated in an OCL program, the more open the coordinators believed their students were to multiculturalism, the more significantly they recognized the benefits of OCL.

Examination of the remaining five research hypotheses (H5, H6, H7, H8, H9) indicate that among ICT coordinators who participated in the OCL program regarding the benefits of OCL, there is no significant effect on the challenging experiences in OCL ($\beta = .00, p > .05$), nor any significant effect on the frequency of integrating OCL ($\beta = .14, p > .05$). However, attitudes toward the negative aspects of OCL have a significant effect of a strong, positive intensity on the challenging experiences in OCL ($\beta = .61, p < .001$) and of a low, negative intensity on the attitudes toward the benefits of OCL ($\beta = -.25, p < .001$), as well as of a low, negative intensity on the frequency of integrating OCL ($\beta = -.26, p < .01$). In other words, in the group of ICT coordinators who had taken part in OCL programs, it was found that the greater the extent to which they agreed with the negative aspects of OCL, the less they agreed with the benefits of OCL, the more they agreed about challenging situations in OCL and the more frequently they integrated OCL in lessons.

Among ICT non-participating coordinators, regarding attitudes toward the benefits of OCL, there is no significant effect on the challenging experiences in OCL ($\beta = .07, p > .05$), nor any significant effect on the frequency of integrating OCL ($\beta = .08, p > .05$). However, attitudes toward the negative aspects of OCL have a significantly strong, positive effect on the challenging experiences in OCL ($\beta = .57, p < .001$), and a low, negative intensity on the attitudes toward the benefits of OCL ($\beta = -.30, p < .001$), but there is no a significant effect on the frequency of integrating OCL ($\beta = -.05, p > .05$). In other words, in the group of ICT coordinators who had not participated in any OCL program, the greater the extent to which they agreed with the negative aspects of OCL, the less they agreed with the benefits of OCL, and the more they agreed about challenging situations in OCL.

Table 3. The significance of mediator effect - Sobel test (Z)

<table>
<thead>
<tr>
<th></th>
<th>Benefits of OCL</th>
<th>Negative aspects of OCL</th>
<th>Challenging experiences in OCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>For ICT coordinators after OCL programs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sobel test (Z) - integrating OCL</td>
<td>2.71**</td>
<td>3.42***</td>
<td>3.25***</td>
</tr>
<tr>
<td>Sobel test (Z) - challenging experiences in OCL</td>
<td>-3.70**</td>
<td>-4.42***</td>
<td></td>
</tr>
</tbody>
</table>

| For ICT coordinators not in OCL programs |                |                         |                                |
| Sobel test (Z) - integrating OCL | 2.23*          | 1.17                    | 2.11*                          |
| Sobel test (Z) - challenging experiences in OCL | -2.08*         | -1.25                   |                                 |

Note. *p < .05; **p < .01; ***p < .001.

Examination of hypothesis H10, indicates that among ICT coordinators who had participated in OCL programs, with regard to challenging experiences in OCL, there is a no significant effect on the frequency of integrating OCL ($\beta = -.17, p > .05$), but among ICT coordinators who had not participated in OCL programs there is a significant effect on the frequency of integrating OCL ($\beta = -.25, p < .01$). In other words, for the group of ICT coordinators who had not taken part in OCL programs, the greater the extent they agreed with the challenging
experiences in OCL, the more frequently they integrated OCL in their lessons. To examine hypothesis H11, the indirect effects for each mediator were tested with Sobel and the results are shown in Table 3.

Table 3 shows that among coordinators participating in the OCL program, there is significantly mediate between openness to multiculturalism and integrating OCL and challenging experiences in OCL. Among coordinators who had not participated in an OCL program, only the benefits mediator was significant between them.

A summary of the hypotheses testing results is shown in Table 4.

### Table 4. Results of hypothesis tests

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Causal path</th>
<th>Path coefficient</th>
<th>Supported</th>
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</thead>
<tbody>
<tr>
<td>H1</td>
<td>OM → BE</td>
<td>.46***</td>
<td>.32***</td>
</tr>
<tr>
<td>H2</td>
<td>OM → NA</td>
<td>-.38***</td>
<td>-.09</td>
</tr>
<tr>
<td>H3</td>
<td>OM → CE</td>
<td>-.17</td>
<td>-.15</td>
</tr>
<tr>
<td>H4</td>
<td>OM → integrating of OCL</td>
<td>-.13</td>
<td>.13</td>
</tr>
<tr>
<td>H5</td>
<td>BE → CE</td>
<td>.00</td>
<td>.07</td>
</tr>
<tr>
<td>H6</td>
<td>BE → integrating of OCL</td>
<td>.14</td>
<td>.08</td>
</tr>
<tr>
<td>H7</td>
<td>NA → BE</td>
<td>-.25***</td>
<td>-.30***</td>
</tr>
<tr>
<td>H8</td>
<td>NA → CE</td>
<td>.61***</td>
<td>.57***</td>
</tr>
<tr>
<td>H9</td>
<td>NA → Integrating of OCL</td>
<td>-.26</td>
<td>-.05</td>
</tr>
<tr>
<td>H10</td>
<td>CE → Integrating of OCL</td>
<td>-.17</td>
<td>-.25**</td>
</tr>
<tr>
<td>H11</td>
<td>OM→NE→BE→CE Integrating of OCL</td>
<td>.17</td>
<td>.34**</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01; ***p < .001. BE= Attitudes toward the benefits of OCL; NA= Attitudes toward the negative aspects of OCL; CE= Challenging experiences in OCL; OM= Attitudes toward the students' openness to multiculturalism.

Finally, different images were obtained in the percentage of explained variance of the endogenous variables for each group, wherein the variables are endogenous in the model for ICT coordinators who had participated in an OCL program. Attitudes toward the benefits of OCL (36% and 21% respectively) and the negative aspects of OCL (15% and 1% respectively) and the challenging experiences in such learning (47% and 33% respectively) are explained at a higher level than that in the model for the ICT coordinators who had not participated. However, integrating OCL is explained to a similar, relatively lesser, extent by the five research variables among the ICT coordinators in the program and among the non-participatory ICT coordinators (17% and 13% respectively).

### Discussion and conclusions

The current study used a path analysis model to examine the influence of openness to multiculturalism on the frequency of integrating OCL in lessons among school ICT coordinators. The mediating variables were attitudes toward: benefits of OCL, negative aspects of OCL and challenges of OCL. The path analysis model, which provided satisfactory correlating indices, explained only to a relatively small extent the frequency of integration of OCL in both research groups, as opposed to the explained variance of the experience of the challenges of OCL. This finding could strengthen the claim that teaching with OCL is hard, not simple and infrequent for any teacher (Magen-Nagar & Shamir-Inbal, 2014) but it is challenging (Slavin, 2013). The two groups consisted of school ICT coordinators, who, besides their role as managers of ICT in the school, are also teachers who usually have TPACK knowledge that sensibly integrates technological tools and services, constructivist teaching practices and study content. They teach using advanced, rich, and up-to-date technological means more than other teachers at school. Thanks to their technological skill, techno-pedagogical experience, technology orientation, and ongoing training, they guide students through collaborative research assignments and problem solving in technology-based learning environments (Mishra, Koehler, & Henriksen, 2011).
The division into two groups was according to their participation in specific OCL programs, in order to identify the significant variables affecting the frequency of the integration of OCL in teaching. The current study found that the more the ICT coordinators saw their students’ behaviors as being open to children from a different culture, the more positive their attitudes were toward OCL. It seems that in a class in which students learn in an open and respectful atmosphere, the teacher leading ICT recognizes the benefits of OCL. The benefits are directed mainly at the learner as an individual, i.e., better understanding of the material and developing higher-order thinking. In high-quality collaborative learning, each student is active and interacts with the other learners, and when there is negotiation and the exchange of opinions and knowledge, each student constructs his or her own world of knowledge and thus develops (Harasim, 2012). However, only the ICT coordinators who had taken part in the programs also recognized the negative aspects of OCL, which relate to the class as a social unit, e.g., OCL creates tensions among the children. This is because OCL is based on the friendships and mutual dependency among group members (Siemens, 2005). Constructing collaborative knowledge in an online environment requires discussion and the exchange of opinions, while maintaining ongoing contact and reciprocal communication among the group members (Gillies, 2008). Furthermore, for ICT coordinators who took part in the OCL programs and saw openness toward multiculturalism among their students, there was little impact when there were complex challenges in the OCL. It may be that educating toward multiculturalism leads to an atmosphere of openness and egalitarianism, to better interpersonal relations and social skills in the class, and so they summon fewer frustrating situations in OCL. This is an atmosphere that assures collaboration and attainment of positive learning results in the 21st century (Harasim, 2012).

The attitudes toward negative aspects of OCL were a very significant mediating factor in the model, affecting the paths between openness to multiculturalism and experiencing the challenges of OCL, and the frequency of the integration of OCL. All the negative aspects examined in this study focus on the interaction between the students, which might harm the class as a social group. For example, it may be hard for students to maintain proper ongoing communication with all members of the group. This finding supports earlier studies that emphasize the importance of interaction in collaborative learning (Johnson et al., 2014), where the students are either unable to create high-quality shared knowledge or are unable to communicate with each other, or the online discourse leads to misunderstandings and formation of ideas, and the mutual dependency is negative. In such a process, the interaction between the students is impaired and this leads to ineffective learning, lack of motivation, dissatisfaction, and to a decline in achievements (Hanze & Berger, 2007). For the teachers’ part, these attitudes toward negative aspects generate a poor experience of OCL, especially in the more complex and challenging part of this kind of learning. In addition, these negative aspects affect the frequency with which they will integrate OCL activities into their teaching plans. In other words, seeing attitudes toward the negative aspects of OCL has very negative implications for the teacher, especially among ICT coordinators who did not participate in a specific OCL program. Thus it is important to prepare the ICT coordinators not only for the benefits of OCL, but also for its negative aspects, and to provide them with the knowledge and strategies to cope with the challenges of OCL. At the same time the students in the class as a social unit should be equipped with the necessary social skills, while being educated toward openness to multiculturalism.

The research findings may offer a conceptual framework that distinguishes three dimensions that teachers and school ICT coordinators must attend to in order to be ready for OCL in their lessons:

- The systemic dimension – cultivating a positive, egalitarian school climate that is open to multiculturalism and supportive of reciprocal social and interpersonal relations in class and in the school.
- The professional dimension – developing pedagogical knowledge for OCL, including the formation of attitudes and understandings regarding the benefits and negative aspects of OCL.
- The practical dimension – experience in OCL accompanied by training to cope with the challenges.

The most important of these is the practical dimension.

This study was original since it took into account a number of significant variables and examined their simultaneous influence on the choice to integrate use of OCL. However, the study has certain limitations: the variable of the frequency of integration of OCL was examined by only a single item ranked on a scale of 1-5, so that it was not possible to check the validity and reliability of the variable. In other words, it did not take into account other situations that might indicate the frequency of OCL integration. Consequently, future research should add items for this variable, such as – to what extent do you guide your students to use collaborative technology (a forum, social media, a shared document). Likewise, an ICT coordinator who is a homeroom teacher or a subject teacher reported reporting on the openness of students to multiculturalism is a general impression based on the interpersonal relations between the students. In order to reinforce the findings, there should be a further study, administering a multiculturalism questionnaire to students, with a two-phase analysis teacher level and student level (such as in SEM). Also, attitudes toward OCL and experience of its challenges...
might change as a function of contextual situations or factors. The study should be expanded and repeated in a year’s time to examine differences between the findings, and the parameter of the coordinator’s TPACK knowledge should be added.

In practical terms, these findings suggest clues to help the ICT coordinators and teachers in general plan collaborative teaching and learning, so that the objectives and performance are more directed at the class level and less at the level of the individual learner. The class is a natural experimental field for social processes supporting both openness to multiculturalism and collaborative learning, and so it should be perceived as a social unit that aspires to achieve shared social and scholastic goals. The findings provide useful information for writing OCL intervention programs, particularly for ICT leaders, the agents of change for learning adapted to the 21st century.

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Gamification from Player Type Perspective: A Case Study

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ABSTRACT
Studies highlight the need to consider different player types during gamification design. The aim of the present study was to determine the elements that affect learners showing different player type characteristics in a gamified learning environment. Accordingly, the study examined which game elements trigger which mechanics. The design of the study’s gamified learning environment used the game elements of leaderboard, achievements, point, badge, content unlocking, level, gifting, team, and story which were thought to motivate different player types. A total of 41 undergraduate students participated in the study for 7 weeks. Using the “Player Type Scale” developed by the researchers, player types were determined as killer, achiever, explorer, and socializer. One learner showing the dominant characteristics of each player type were interviewed to determine which elements each learner liked, disliked, or was indifferent to and which mechanics these elements served. Results indicated that: (a) players may show characteristics different than their player type depending on the design features of the gamified learning environment, (b) the mechanics that attract learners in a gamified learning environment differ with regard to player type, (c) the elements that trigger a mechanic differ in with regard to player type, (d) an element may serve different mechanics for different player types, and (e) the selection of elements and the context in which they are used in the design affects the mechanic it serves and therefore the whole process.

Keywords
Gamification, Player type, Game mechanics, Game elements

Introduction
The needs of modern learners have changed in accordance with the development of technology and the evolution of the learning environment. Educators often use games and game-like environments to attract learner attention during the instructional process. Although interest in gamification has only recently become widespread, the term “gamifying” can be seen as early as the 1980s. Bartle described the act of “gamifying” an online system as “turning something not a game into a game” (Werbach & Hunter, 2012). A variety of definitions for this term have subsequently appeared in the literature, including:

- “The process of game-thinking and game mechanics to engage users and solve problems” (Zichermann & Cunningham, 2011),
- “A simple concept of making non-gaming systems more engaging through applying gaming principles to them” (Bishop, 2014), and

In the educational context, gamification can be described as an educational approach using game design principles in the learning environment to engender interest and motivation in learners.

Several studies on gamification in the educational context have reported that it increases participation in online learning environments (Hew, Huang, Chu, & Chiu, 2016; Barata, Gama, Jorge, & Gonçalves, 2013; Caton & Greenhill, 2014), motivates learners during difficult assignments (Hew et al., 2016), and produces more qualified learning products (Buckley & Doyle, 2014). In addition, the game mechanics and elements used during gamification of the learning environment lead to a greater level of entertainment (Hew et al., 2016; De-Marcos, Domínguez, Saenz-de-Navarrete, & Pagés, 2014), engagement (Akpolat & Slany, 2014), motivation, and flow (Kocadere & Çağlar, 2015). Additional positive results include increased voluntary participation in activities in the learning environment (Josip & Epema, 2014). However, to avoid clouding the potential positive effects of gamification, gamified learning environments must be designed correctly and the differences in learners’ individual differences and motivations must be taken into consideration (Ferro, Walz, & Greuter, 2013; Ibanez, Di-Serio, & Delgado-Kloos, 2014). For this reason, Werbach & Hunter (2012) reported that the characteristics of different subgroups such as player types must be kept in mind during the design of gamified learning environments.
Several studies have categorized players into types. Studies by Bartle (1996), Ferro et al. (2013), Fullerton (2014), and many others have been conducted to determine the ways in which players behave and to categorize them accordingly. Bartle’s (1996) “Multi-User Dungeon” study examined players’ expectations and produced the first effort at player categorization, classifying players using their act/interact preferences and orientation (world/player). He visualized this classification on a coordinate plane, with “world/player oriented” on the x-axis and “act/interact” on the y-axis, producing the four categories of killer, achiever, explorer, and socializer. Similarly, Ferro et al. (2013) described five different player types, dominant, objectivist, humanist, inquisitive, and creative, basically adding the creative type to Bartle’s classification. Later, Fullerton (2014) defined nine different player types: competitor, explorer, collector, achiever, joker, artist, storyteller, performer, and director. With this categorization, it can be said that Fullerton (2014) separated and assigned Ferro et al.’s types (2013) into more than one category. In the current study, we chose Bartle’s (1996) player type categorization as our basis, Bartle’s classification is considered the most fundamental method of categorization (Ferro et al., 2013) and has been recommended by Werbach and Hunter (2012) for use in gamification. Additionally, these types were developed for use in multiplayer video games which is also used in gamification (Nicholson, 2014).

In Bartle’s classification (1996), killers try to dominate other players by “acting on the people” in the environment. This type of player is not interested in completing assignments well or scoring high points but instead aims to achieve scores that are sufficient to dominate and beat others. Killers explore the game to learn new ways to harm other players. They tend to communicate with others only to humiliate them.

Achievers “act in the world” and care about the assignments in the environment in order to win. This kind of player determines goals and put active effort into reaching those goals and increasing their scores as much as possible. Achievers only socialize to learn what other players know about earning points. The possibility of earning points most induces this type of player to explore the learning environment. Achievers only care about their own scores and assignments in the environment and are usually not interested in other players or in harming them. However, achievers may want to harm players that earn a high score or prevent them from earning rewards. The achiever type tends to brag about the levels they have reached and how quickly they have reached them.

The explorer “interacts with the world”. They want to explore the environment and discover as many new things as possible. Explorers usually look for bugs and facilitators in the game. Earning points is a boring activity that is only useful for exploring the next level. This type of player only wants to socialize if it will lead to new exploration and may want to harm others if they are prevented from exploring in the environment.

The final type, socializers, “interact with the people” in an environment and usually take advantage of the communication function to socialize. This type of player explores the game with the aim of discovering what other players are talking about and only feel the need to earn points to be able to reach new communities. Socializers tend to only harm those who harm their friends. In other words, socializers’ only aim is to foster good communication and meet new people and develop good friendships.

Individuals may show different player type characteristics depending on context and environment (Ferro et al., 2013). The most obvious example of this would be that a socializer, whose primary goal is to make new friends and to communicate, may turn into a killer when their friend is harmed. Moreover, it is possible that individuals can show characteristics of another player type in addition to their dominant primary style (Bartle, 2005). Indeed, studies determining player types have indicated that individuals may exhibit not only one dominant player type characteristic but instead show more than one type of player type characteristics (Herbert, Charles, Moore, & Charles, 2014).

While research emphasizes the importance of keeping player types in consideration in gamification design (Werbach & Hunter, 2012), only a few studies in the literature focus on these different player types. Ferro et al. (2013) categorized players into player types determined by researchers such as Bartle (1996), Caillios & Barash (1961), and Fullerton (2014) and examined their personality traits based on these types. Ferro et al. (2013) tabulated game elements and mechanics that can be used in a gamified learning environment with regards to the player types they determined in the theoretical analysis. The authors suggested the following mechanics for each player type: (a) leaderboards, progress bars, statuses, achievements, combos, and points for the killers; (b) badges, bonuses, combos, levels, progress bars, and reward schedule for achievers; (c) quest, rewards, and story elements for explorers, and (d) quest, customization, and story for socializers.

While not focusing on player types directly, Kocadere and Samur (2016), like Ferro et al. (2013), suggested the use of elements in gamified learning environment design based on Bartle’s player types. The authors suggested...
the use of leaderboards, points, and challenges for the killer player type; achievements, badges, social graphs, and progress bars for achievers; content unlocking, stories, collections, and unexpected elements and events for explorers; and gifting and teams for socializers.

Studies performed by Herbert et al. (2014) and Barata et al. (2013) clustered participants in the gamified learning environment and conducted a review based on combined player types. Çağlar and Kocadere (2016) examined the motivation levels of combined player type participants in a gamified learning environment. We were unable to find a study in the literature specifically examining the elements that attract individuals who show characteristics of a dominant player type. Although Ferro et al. (2013), and Kocadere and Samur (2016) touched on this subject with their theoretical analyses, they emphasized that their suggestions needed validation with applied studies. In this context, the current study on player types in gamified learning environments aims to determine which elements are attractive to each dominant player type during the 7-week use of a gamified learning environment developed by the researchers. In addition, the study aims to analyse the relationship between mechanics and elements for each player type. Research questions are given below:

- Which mechanics attract each of the four player types in the environment and which elements serve these mechanics?
- Which mechanics do the four types dislike and which elements serve these mechanics?

Our study ultimately aims to fill the gaps in the literature on choice and the role of elements in the design of a gamified learning environment.

**Method**

The study was designed as a case study based on interviews with participants. Participants used the gamified learning environment for seven weeks. The research process consisted of four phases: (1) the design of the gamified environment, (2) the development of the player type scale, (3) the use of the gamified environment and the determination of the participants’ player types, and (4) the review of cases that show dominant player type by interview.

**Design of gamified online learning environment**

A gamified online learning environment was designed for use in this study. In the design of this environment, emphasis was made to include elements not generally present in the literature beyond just those of badge and leaderboard (Kapp, 2012). Based on previous theoretical studies, a variety of gamification mechanics and elements thought to attract different player types were used. Game elements serve mechanics and directly affect the game design. Mechanics are more general structures. In gamified learning environments, there may be one or more elements that trigger every mechanic (Werbach & Hunter, 2012).

Game mechanics thought to attract different player types were determined as follows: competition, status, progression, resource acquisition, reward, cooperation, transaction, and narrative. Elements expected to trigger these mechanics in the gamified learning environment were determined as: achievement, badge, content unlocking, gifting, leaderboard, level, point, team, and story. These mechanics and the elements thought to serve those mechanics are shown in Table 1.

<table>
<thead>
<tr>
<th>Element/Mechanic</th>
<th>Leaderb.</th>
<th>Point</th>
<th>Content Unlock. &amp; Level</th>
<th>Badge</th>
<th>Achiev.</th>
<th>Gifting</th>
<th>Team</th>
<th>Story</th>
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<tbody>
<tr>
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*Table 1. Mechanics and the elements used to trigger them*
Selected elements were incorporated into the environment. The online learning environment was arranged so that each week corresponded to one level. Each level included assignments suitable to that week’s subject. Assignments were varied, such as discussing in forums, reading an article, or putting together a presentation. Some assignments were individual and others required teamwork. In the realization process of this design, learners were awarded points for completing assignments. In the scoring phase, student work was reviewed for quality. Learners were placed on a leaderboard with the points they earned. Badges were used as a sign of status and given to the top three scorers and those who reviewed additional content. Only those with a certain score were able to pass onto the next level and those learners without a score sufficient to unlock the content could receive points from their peers using a gifting element. Players who unlocked the next level by obtaining the required score by themselves were rewarded with achievements that benefited them in the next levels. Levels, badges, and achievements were used in accordance with the story as suggested by Çağlar and Kocadere (2015).

Participants

For the development of the Player Type Scale, data were obtained from 197 undergraduate students enrolled in the Department of Computer Education and Instructional Technology at 7 universities in different cities. A total of 41 undergraduate students from the same department completed the designed scale and participated in the gamified learning environment in the context of a course. In the final phase of the study, 4 of the 41 participants were selected considering their primary player types and 1 participant representing each player type was interviewed in depth.

Data collecting tools

Researchers developed the “Player Type Scale” to determine player type. Keeping in line with the literature, our scale was based on the 4-type theoretical structure proposed by Bartle (1996) and players were categorized as killer, achiever, explorer, and socializer. A total of 19 items on the 4 factors were developed. Two experts were consulted to review the items. Those items appearing to refer to more than one factor were corrected so that each item corresponded to one factor only. A total of 12 items, 3 per factor, were finalized. Two students reviewed the items for clarity and no changes were made. Items were compiled into a 9-point Likert-type scale.

Suitability of the data for the factor analysis was tested using the Bartlett’s Sphericity Test and the Kaiser–Meyer–Olkin (KMO) measure. The Bartlett’s Sphericity Test was meaningful and the KMO value was .866. A KMO higher than .50 indicates an appropriate data structure for factor analysis in terms of sample size (Çokluk, Şekerçioğlu, & Büyükoztürk, 2010). Confirmatory factor analysis tests a pre-defined structure to determine whether it is confirmed as a model (Çokluk et al., 2010). Since scale items were made on the grounds of theoretical infrastructure, factor analysis was applied.

The Chi-square (105.98) / Degree of freedom (47) ratio was 2.25, below the threshold of 3 and indicating perfect fit (Çokluk et al., 2010). RMSEA value was .075, also indicating good fit according to Jöreskog and Sörbom (1993) (Çokluk et al, 2010). Fit indices values were NFI .96, NNFI .97, CFI .98, IFI .98, and GFI .92. The item-total correlation, a test of the relationship between the item values and total values, was between .441 and .806. Item-total score correlations above .30 show good differentiation of individuals (Büyüköztürk, 2009). The credibility coefficients, demonstrating questions’ similarity or proximity, was .84 for the killer factor, .813 for the achiever, .801 for the socializer, and .911 for the explorer. Coefficients over .60 are considered credible (Kalaycı, 2006). In addition to the scale, a semi-structured interview form was used to understand what gamification elements were sought in the environment by each dominant player type.

Data analysis and trustworthiness

In the analysis of data obtained in the interviews, elements were grouped depending on whether participants viewed them in a positive or negative way. Elements deemed to be neither negative nor positive or that did not affect the players were placed in the neutral group. Mechanics triggered by these elements were reviewed. Data were analysed independently by two researchers. Participants were interviewed again for analyses that did not match until the two researchers reached a common conclusion. Findings were then confirmed by the participants. To increase trustworthiness, the research process was described thoroughly, data obtained from interviews was reported with quotes, the limits of the study were defined, and all findings were compared to the studies in the literature.
**Findings**

Data was taken from interviews with participants showing dominant characteristics on the scale. The views of each learner are supported with their own words. For each player type, mechanics that positively or negatively affected the player and the elements that trigger those mechanics were determined. Elements that did not affect the players were also defined. As these elements had no effect on participants, they did not trigger any mechanics to record.

**Case 1: Killer Kate**

Kate was determined to be a “killer” using the scale and was most attracted by the mechanics of competition and status. For Kate, the leaderboard and point elements served as competition mechanic:

**Leaderboard:** “Every day I open the system and check out who did what (...) on the leaderboard (instead of top 10 etc.) I check the classroom ranking and calculate how to surpass people.”

**Point:** “If there were no points, I would not have done any assignments. (...) Without the leaderboard, there would be no competition. For example, I, for one, look at my friend’s point and plan accordingly. If they have 100 points and I have 92, I plan to read an article to surpass him.”

Status also attracted Kate and she was triggered by the leaderboard and level elements:

**Leaderboard:** “Right now, I like the system because I am in the top 5. I like that people see that I am in top 5 too.”

**Level:** “If I am doing two assignments, I should have a priority; that is why those levels are very important.”

The badge, achievement, and story elements were neutral and did not affect Kate:

**Badge & Achievement:** “It does not even occur to me look at the badge and achievement on my profile. I only look at the leaderboard and the badges do not affect me much. I only viewed badges in the first week. I am not interested in achievements at all.”

**Story:** “There is a goal and order because of the story. (...) It may be used to attract those who are not interested in the system but it does not affect me much.”

Kate was negatively affected by the gifting and team elements and did not like the team element because she thought it would curtail her personal status:

**Team:** “I do not want to do teamwork. When I work individually, my performance is more apparent. When it is with a group, it gets curtailed.”

Kate did not like the gifting element because it indirectly served the competition:

**Gifting:** “I do not want to give my friends any points. I want to show up on the leaderboard.”

**Case 2: Achiever Arnold**

Arnold showed characteristics of the “achiever” and was positively affected by the elements of progression, competition, and resource acquisition. According to Arnold, the level and point elements triggered the progression mechanic:

**Level:** “When I advance, it feels like the former subject is closed. If we stay in the same level constantly, there would be a lot of accumulation in terms of work load. But logic for progression is like that in games, that is why I like the concept of levels.”

**Point:** “I believe there should be points for every activity in the environment because that is how you advance. What is determining (the progression) are the points.”

For the achiever, the leaderboard triggered the competition mechanic:
Leaderboard: “(If there were no leaderboard), no one would have competed then, including myself. For instance; you share things on the forum and I would not have done it on my own. The leaderboard encourages me. (...) In a competitive environment, you consider your counterpart; for example, if I had not seen their point, I would not put an effort into catching up with them. Because I might think maybe there is a lot of gap. Points motivate me too.”

In addition, the achiever believed that the achievement element served as resource acquisition and was therefore interested in obtaining them:

Achievement: “As long as achievements have a purpose... I mean, there was a pair of binoculars for example, the ones who had taken it would have been exempted from the quiz. It feels better if you feel like you are using it after collecting, as long as it has a purpose. It is not for nothing, or just an icon. It has a purpose. Binoculars (an achievement) for example, made sense to me. I am putting an effort into obtaining them. That is why I view them positively. Because they motivate me. That is why taking them feels like you are using it, because it has a logic.”

The badge and story elements did not affect or motivate Arnold the Achiever. He explained that the story was part of the overall narration and therefore neither bothered nor attracted him:

Story: “(I like) competition more than the story’s content. That pulls me into it. Of course, the story must be in accordance with the general structure. It does not bother me, so it is alright.”

Arnold reported that he had no desire to earn badges that did not advance his status and did not view them as a resource acquisition but only as a collection:

Badges: “(Badges) are like a decoration, an icon. I do not have such a desire (to collect badges). Honestly, I did not check it out thoroughly. I usually check the leaderboard. If (the badges) had a purpose or anything, of course I would have wanted them. I mean, had it made me feel special, I would have wanted them.”

Arnold had negative associations with the gifting and team elements due to a dislike of giving or taking points and difficulties during work sharing:

Gifting: “I would not like to give points to a friend. Because it is an assignment and it is up to him to do it or not. It should be themselves making up for it, not anyone else. I would not like receiving or giving points.”

Team: “I believe the majority of assignments must be individual. Because everyone does not contribute the same in team work. There are difficulties with work sharing and contributing at the same level.”

Case 3: Explorer Emma

The mechanics that attracted Emma, who exhibited characteristics of the “explorer”, were narrative, progression, and reward. Emma reported that the narrative mechanic was triggered by the story element:

Story: “(Thanks to the story) we do our homework, yes, but we also feel like we are right in an adventure. The creativity of the environment forces people to be like that. (...) (Without the story) my activity would have decreased. Like I said, there is an inaction.”

The progression mechanic was triggered by the level element:

Level: “This way (because of levels) it is more disciplined and planned. (...) It goes on step by step, because it carries on from easier to difficult or in an increasing way, it always contributes.”

The reward mechanic was triggered by the badge and achievement elements:

Badge: “Let’s say I have done this homework, when I see (the badges I earned) I say; “I shall work harder, be the first, get that badge...” It is gamified when you say it like that. (Badges) like I said increases activity. (...) The badges are a reinforcer. They affect the student. (...) They affect me. I was really happy when I became the first in one week, honestly, there is a desire to earn badges.”
Achievement: “I missed (an achievement) by three points last week. I get sad (when I miss them). I say let me take a look at the online environment, check it out, what happened. There was no such thing in the beginning, it became more frequent later. We keep collecting these tools (achievements, collection items). It also ensures participation. When I think about it as a reward, it pushes me towards the next step.”

The elements of points, leaderboard, and gifting were described as neutral:

Point: “I would have participated (even if there had not been any points for completion of assignments). In the end, we are using the environment even if there are no points.”

Leaderboard: “(If I rank my priorities) being in the leaderboard is at the end. It does not mean much. In the end, my goal is to understand whatever is taught in this class. That is why I can put it at the bottom.”

Gifting: “If (my friend) did not reach to that point because of a very very unfortunate, very very serious situation, I would share my points.”

Finally, Emma did not like the team element:

Team: “I prefer individual assignments. In a general sense, team work causes problems in every way. Both in terms of individual responsibility and the progress and completion of the assignment. In terms of time. In terms of individuals’ own personal characteristics.”

Case 4: Socializer Sarah

Sarah showed “socializer” characteristics on the scale and was attracted by the mechanics of narrative, cooperation, and transaction. According to Sarah, the narrative mechanic was triggered by the story, badge, and achievement elements:

Story & Achievement: “Had there been no story, none of the things earned (achievements) would not have existed. Like binoculars, boats. One feels really nice after earning them. They say “Oh, how nice, now I have binoculars”. Like, they feel that they are in the game. It is good in that sense.”

Badge: “Badges are nice too. They are, like, complementing the story. This is gamified because this is why people get caught up in the game.”

The cooperation mechanic was triggered by the team element:

Team: “I put in an effort for team work in the environment. We do the homework together, so I feel like I’m responsible for them.”

In addition, Sarah reported that the gifting element triggered the transaction mechanic:

Gifting: “Even if I do not get back the points I give, I would like to give points to my friends. What was good about this system was allowing them to unlock things with points I gave them.”

There were no elements that Sarah did not like in the environment. However, the socializer was not affected by the leaderboard, point, and level elements:

Leaderboard: “(The leaderboard) does not cause much problem. It does not mean much to me that everyone shows up on the leaderboard. Being in the top three or five comes last for me.”

Points: “I earned as many points as the class required but the points did not affect me much.”

Level: “It is good that there are levels. I can see where I am but it does not really affect me.”
Discussion and conclusion

The gamification approach has received significant recent attention and positive results have been observed (Hew et al., 2016; Buckley & Doyle, 2014; De-Marcos et al., 2014) in terms of improving the learning process. In this approach, however, a qualified design is necessary to achieve these positive effects. While various studies (Werbach & Hunter, 2012; Ferro et al., 2013) have stated that player types must be taken into account in gamification design, further applied studies focusing on gamification design and player types are needed. The aim of the current study was to analyze the relationship between mechanics and elements in a gamified learning environment and which gamification items attract or do not attract the player types.

In this study, findings were evaluated in terms of the elements that (a) affected the player in a positive way and the mechanics those elements served, (b) affected the players in a negative way and the mechanics those elements served, and (c) did not affect the players in any way. Findings related to (a) and (b) are summarized in Table 2. Elements viewed as neutral (c) were not placed in the table as they did not trigger any of the mechanics.

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As can be seen in Table 2, the killer type was positively affected by the competition mechanic that allowed her to dominate other players and by the status mechanic that increased her reputation. The achiever was attracted to the competition mechanic, which provided the competitive environment, and to the progression and resource acquisition mechanics, which provided a sense of progression and facilitated movement, respectively, through the environment. The explorer type was positively affected as well by the progression mechanic, which allowed them to explore while progressing, the narrative mechanic for creating a feeling of being immersed in the environment, and the reward mechanic, which was perceived as part of the narrative. The socializer type was attracted by the cooperation and transaction mechanics to interact with others in the learning environment. In addition, the socializer was positively affected by the narrative mechanic, which allowed her to feel part of the environment. It can be concluded, the mechanics that attract learners in a gamified learning environment differ depending on the player type.

In terms of elements, the killer type liked the leaderboard, points, and levels; the achiever the leaderboard, points, levels, and achievements; the explorer the levels, story, badges, and achievements; and the socializer the story, badges, achievements, team, and gifting elements (Table 2). In the literature, it has been reported that players classified under the killer type tend to be interested in the leaderboard and point elements; while those classified as achiever are interested in the level and achievement elements; the explorer the level, story, and badge elements; and the socializer the team, gifting, and story elements (Ferro et al., 2013; Kocadere & Samur, 2016). Differently from these studies, in the current study, players classified as the killer type reported positive associations with the level element; the achiever with the point and leaderboard elements; the explorer with the achievement element; and the socializer with the badge and achievement elements. On the other hand, the killer and achiever types did not like the gifting and team elements and the explorer did not like the team element.

In the design of a gamified learning environment one or more elements are used to trigger certain mechanics. The elements of points, achievements, badges, gifting, and levels were understood by different player types to trigger different mechanics. The point element was thought to trigger the competition mechanic for the killer
type and the progression mechanic for the achiever. The achievements element was considered a reward by the explorer while the achiever interpreted it as resource acquisition and the socializer as part of the narrative. The badge element was a reward for the explorer but an element serving the narrative for the socializer. Additionally, for the killer type, gifting was a negative element triggering competition as it could allow other players to move ahead of them on the leaderboard, while conversely it attracted the socializer as a method to trigger transaction. The level element served as a status mechanic for the killer but a progression mechanic for the achiever and explorer. The mechanics that the elements serve differ by player type. In other words, an element might serve different mechanics depending on player types. This is thought to be related directly to the use of elements in the design. For example, as achievements are selected to support the narrative, the achievement element triggered the socializer in this context. If the design had not been created in this manner, the achievement element would not have affected the socializer to the same degree. Such an observation reveals the importance of the way each selected element is used, in addition to its simple selection. On the other hand, elements that trigger a mechanic differed by player type. As an example, the progression mechanic was triggered by the point element for the achiever but by the level element for the explorer. Another example, the competition mechanic was triggered by the point element for the killer but by the leaderboard element for the achiever.

The mechanics and elements with a positive effect on player types are given in Figure 1. The 8 mechanics used in the design and their triggering elements according to player types were located based on Bartle’s (1996) coordinate plane. Mechanics were placed onto the coordinate plane in the inner circle and the corresponding elements that served these mechanics were placed as a second, external ring. The elements that trigger player types are shown on the coordinate plane with arcs.

![Figure 1. The elements and mechanics that positively affect different player types](image)

Although only users with dominant player types were selected for further evaluation, player types extended into different quadrants in Bartle’s original determinations (Figure 1). In Figure 1 it can be seen that, while the killer acted within the limit of its original quadrant, “acting on other players,” the arcs of the achiever, explorer, and socializer extended into other quadrants. Theoretically, the achiever should be in the act-world quadrant, the explorer in the world-interact quadrant, the socializer in the player-interact, and the killer in the player-act quadrant (Bartle, 1996). Indeed, Bartle (2005) reported that individuals have primary types but might also show characteristics of different player types, depending on environment features and circumstances. In our study, these variants may be due to the way the elements were used in our gamified environment. The achiever, in addition to “acting on the world”, also unexpectedly “acted with the people” through the leaderboard element. The fact that scores were given for the quality performed assignments and that players were ranked on the leaderboard might have encouraged the achiever, who aims to complete assignment as well as possible. The explorer type, who likes to “interact with the world,” also seemed to enjoy “acting on the world” and was
attracted by the level element, likely related to how the progression mechanic allowed the explorer to further explore the environment. The locked levels made exploring only possible through progressing to the next level and might have triggered the explorer’s desire to move forward from level to level. Another player who showed different characteristics than expected was the socializer, who crept into the explorer’s quadrant and was positively affected by the narrative mechanic of the world-interact quadrant. The socializer reported that the story allowed them to feel as if they were part of the environment and that earning achievements and badge elements attracted them to the narrative.

In addition to the mechanics and elements that attracted different players, the team element was established as the one element disliked by all player types, with the exception of the socializer. While the killer believed that the team element curtailed the reputation they earned from the status mechanic, the explorer and achiever disliked this element because qualified cooperation was either difficult or impossible. The killer reported that the gifting element served as a competition mechanic while the achiever thought it negatively affected the transaction mechanic. Like the team mechanic, the transaction mechanic was only seen in a positive light by the socializer. This is thought to be caused by the way in which the gifting element, which triggers this mechanic, was used. Had the gifting element not been based solely on gifting points, this element might have attracted more players.

We found that the team element only appealed to the socializer type and can thus be an optional element in gamification design. On the other hand, cooperation is an educational goal, making the team element more important to discourage more competition. Further studies on how to balance competition and cooperation for optimal learning would be useful. In addition, clustering studies that focus on player type and gamification elements are necessary.

The current study could not explain the role of the narrative mechanic in attracting the socializer player type. Further studies on the effect of the narrative mechanic and its role relative to the other mechanics would contribute to the understanding of this mechanic’s attraction. Considering its nature, instead of being a mechanic, narrative might be considered a framework. In addition, further studies on how to design a narrative that can motivate all player types in a gamified learning environment may be recommended. Finally, due to the limited number of participants, conducing additional studies with a greater number of participants to allow for generalization is warranted.

In conclusion, the current study is thought to provide further clarity about the relationship between mechanics and elements for the different player types. The findings of this study can be summarized in 5 main points:

- Players may show characteristics different from their player type depending on the design features of the gamified learning environment.
- The mechanics that attract learners in a gamified learning environment differ depending on the player type.
- The elements that trigger a mechanic might differ depending on the player types.
- An element might serve different mechanics depending on player types.
- The selection of elements and the context they are used in the design affects the mechanic they serve and therefore the entire process.

The ability of a gamified learning environment to attract all player types is directly related to the way the elements are used in the design. For this reason, learning environments should be designed to incorporate a variety of elements so that each player type is able to encounter those that attract them. In addition, it is recommended that designers should be careful when choosing elements because those viewed as neutral do not increase participation and those that are disliked negatively affect mechanics and participation. In particular, the team and gifting elements negatively affected some player types and might be made optional.

References


Ontology Informed Design to Advance Developers’ Informal Online Learning

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ABSTRACT

Software developers rely on the abundance of online resources to meet their informal learning needs. Designing systems to effectively support this relies on a sound understanding of the informal learning process. In this paper, we show how the development and implementation of an ontological model can be used to increase understanding of informal learning needs and enhance system design. We interviewed developers about their informal online learning behaviors, and created a novel ontological model, LILO (Learning Informally Online), to represent user interaction with online learning resources by incorporating the resulting concepts, typologies, and relationships. From this ontology, we derive five main design requirements for an informal learning system for developers: keyword support, search support, resource genre utilization, reliability cues, and objective support. We then demonstrate how the ontology can be applied to advance system design using as an example CAN (Composable Accessibility Infrastructure), a system capable of supporting web developers’ informal online learning.

Keywords

Design, Ontology, Informal learning, Web development

Introduction

Web users are increasingly turning to online resources for educational needs, in both formal and informal learning environments (McLoughlin & Lee, 2008). Not only do web and software developers play an important role in making such resources available, they themselves frequently depend on the online resources for their own learning needs (Vasilescu, Serebrenik, Devanbu, & Filkov, 2014). Their online learning processes are typically self-directed, project motivated, more distributed, incorporate more disparate material, and take place outside of formal learning environments (Dorn & Guzdial, 2010). Even though the sheer amount of educational resources on the web provides many new learning opportunities, it can also be overwhelming for learners to navigate (Foley, 1995). Designing systems to facilitate this learning effectively is challenging and requires a good understanding of the informal learning process.

To address these challenges, we utilize an ontology driven design approach. In computer and information sciences, ontologies serve as explicit representations of the concepts and relationships relevant to some area of interest (Gruber, 1995), and are one means of capturing and representing an understanding of a particular domain. Ontologies serve as solid conceptual models, and can offer a strong foundation to system design (Fonseca, 2007). The use of ontology in the information systems design process offers several unique advantages. Guarino (1998) suggests that ontology-driven design can make important concepts and relationships more explicit to designers at the time of design or deployment. Ontologies also offer deeper understanding of particular tasks, applications, and domains (Guarino, 1998), and can guide the production of data compatible with Semantic Web architecture (Doan, Madhavan, Domingos, & Halevy, 2002).

The online learning process has been previously ontologically modeled; however, most prior models have been constructed from the perspective of formal learning processes and systems (Jovanovi, Knight, Gaevi, & Richards, 2006). Though previous work has shown how subject ontologies can be used to support more informal learning online (Miranda, Orciuoli, & Sampson, 2016), fewer works have attempted to model the actual informal learning process itself. Though informal learning online is a pervasive activity, developers show a particular reliance on such learning (Dorn & Guzdial, 2010), suggesting them to be a worthwhile population to work from. However, general knowledge about developers’ informal online learning environment is also lacking. While research has examined their interactions with specific informational resources (Dabish, Stuart, Tsay, & Herbsleb, 2012; Vasilescu et al., 2014), less is known about developers’ general behaviors across a range of online learning resources. Before designing effective systems for supporting developers’ informal learning, we need to better understand what elements are critical in the informal learning process. The ontology-driven design approach allows us to construct a model to first better understand developers’ informal online learning process, and then to utilize that model to advance the design of an informal learning system.
More specifically, our work makes the following contributions. First, we present the development of LILO (Learning Informally Online), a novel ontological model representing developers’ informal online learning process. The model provides an interpretation of the interactions between learners and learning materials in an informal environment, and adds to the greater body of knowledge concerning informal learning. It captures the unique features of the informal learning process while integrating them with existing models of web interaction. Second, the model elicits design requirements to advance the design of systems that are created to support informal online learning. The design requirements include guidance of user interactions and dictation of the general metadata needs of such a system. Finally, we demonstrate the incorporation of LILO using a case study with CAN (Composable Accessibility Infrastructure), a real and multifunctional system designed to assist web developers in learning how to develop accessible web products, and show how its design can be improved through findings from LILO.

Related works

In preparing for the present study, we looked to three main areas of literature for inspiration as well as opportunities: developers’ learning, relevant theories of informal learning, and ontologies for learning and annotation.

Developers’ learning

Engineering fields have been traditionally taught in a deductive manner, with theory presented before illustrative scenarios or practical examples, but recent focus has turned to more inductive manners of learning, including problem-based learning, discovery learning, and just-in-time learning (Prince & Felder, 2006). Example exercises, evaluations, projects, and interaction among developers have been shown to be an effective way for students to learn about web development topics such as accessibility (Fong Boh, Slaughter, & Espinosa, 2007).

Many professionals rely on informal learning in work environments (Yanchar & Hawkley, 2015), though little research has examined independent, informal learning for web developers. However, online environments afford many opportunities for informal learning for developers. Code hosting and Q&A sites have been found to be popular and valuable online learning and communication resources for software engineers (Vasilescu, Filkov, & Serebrenik, 2013; Dabbish et al., 2012).

Theories of informal learning

Informal learning can be examined through a number of theoretical lenses and models (Cheetham & Chivers, 2001). To gain further insight into the processes by which developers in particular engage with resources in informal learning environments, we focused on three specific theories and models of learning, including constructivism, connectivism, and self-directed learning.

Constructivism is one of the main learning theories utilized in the creation and understanding of instructional environments (Ertmer & Newby, 1993). Constructivism focuses on the learner creating knowledge through the process of understanding their experiences. Subsequent theories have attempted to make sense of how constructivist learning has adapted to online environments. For example, connectivism is an alternative, proposed theory that includes technology and knowledge creation into meaning making. Connectivism focuses on deriving knowledge through the connections that we make, both physical and digital (Siemens, 2005).

While constructivism and connectivism reveal insight into the online learning environment in which many web developers are participating, neither focus specifically on informal learning. A more applied model of informal learning can be found in works on self-directed learning. This has been described as a style of learning in which learners take initiative for their education, with or without assistance (Knowles, 1975). Various models have been proposed to represent the important entities and processes present in a self-directed learning environment. Knowles (1975) describes important elements of self-directed learning, particularly apparent in the concept of the learning contract, in which learners are asked to think independently about learning objectives, learning resources, evidence of accomplishment, and means of evaluating the learning process. Though most literature on self-directed learning models recognizes the importance of the learner, the goal, and the process, later models sought to add more interactivity and complexity. For example, Danis (1992) proposed a framework of self-
Ontologies for learning and annotation

A number of ontologies have been designed to support learning, though they tend to focus more on formal, classroom based learning, connecting the learner to learning resources though curricula or formal learning design. For example, the Learning Object Context Ontologies (LOCO) (Jovanović et al., 2006) presents a framework for capturing learning objects, learning designs, and context. A project to convert the Gateway to Educational Materials (GEM) vocabulary into an educational ontology also resulted in a model focused on formalized learning environments (Qin & Paling, 2001). Relatively little attention has been devoted to developing an ontology of informal learning, particularly for developers. The inFormal Learning Support System (iFLSS) supported discovery of learning materials concerning web development through the use of existing domain ontologies, but did not ontologically model the actual learning process used by web developers (Westerhout, Monachesi, Markus, & Poesa, 2010).

Ontological work examining the practice of online annotations may also inform part of developers’ interactions with online learning resources. The annotation of online material offers users an interactive way to contribute to and benefit from the wealth of resources available, but is often contained within specific systems; an ontologically driven system of content annotation can therefore be beneficial (Yang, Chen, & Shao, 2004). Recently, the Open Annotation Collaboration, a joint project supported by the W3C, has set forth a new data model for annotation interoperability (Haslhofer, Simon, Sanderson, & Van de Sompel, 2011). At its core, the Open Annotation Data Model is a lightweight model comprising an Annotation, a Body, and a Target resource, but through additional classes and relationships, is also capable of accommodating complex situations (Bradshaw et al., 2013). Such models of annotation may be useful in understanding and representing how developers interact with resources during their informal learning processes.

Modeling developers’ online learning and ontology informed design

A number of different ontology engineering processes are available, all of which seek to guide the formation of ontologies through a series of different tasks; specific processes include TOVE, ENTERPRISE, NeOn, and METHONTOLOGY. Reviewing these processes, the authors chose to utilize METHONTOLOGY due to its established nature, previous usage, and general applicability to the current research design.

METHONTOLOGY is a structured methodology designed to create ontologies, and divides the process into several tasks, including setting a goal and plan, knowledge elicitation, conceptualization, formalization, integration, implementation, evaluation, documentation, and maintenance (Fernández-López, Gómez-Pérez, & Juristo, 1997).

Following METHONTOLOGY, below we organize and present our specific methods and results during the ontology engineering process according to three major stages: specification and knowledge acquisition, conceptualization and integration, and implementation and evaluation.

Specification and knowledge acquisition

During the specification task, ontology engineers focus on creating a formal specification document outlining the scope and goals of the work (Fernández-López et al., 1997). Prior to any data elicitation, conversations among the researchers yielded an internal specification designed to guide the present project. The scope includes the informal learning process carried out by developers in online settings. The goal is a high-level model of this process, capable of integration into developer software, and with potential applicability in a wider range of online learning environments.

Knowledge acquisition for this study relied on two major sources of data: previous literature and models as discussed in the above literature review, as well as interviews with web and software developers.

We conducted semi-structured interviews with 17 student developers. Several methods for recruitment were employed. Students working in relevant labs on campus were invited to take part in the study. In addition,
Interview results

Overall, interview results suggest three main areas of interest and interaction concerning developer learning online: learning strategies, learning resources, and learning objectives.

When asked how they would proceed with finding resources for their learning needs, all 17 participants responded that they would use the search engine Google. When asked if they would ever go directly to a specific site, three participants responded they might go to an official documentation site such as W3C, while four participants responded that they might go to Stack Overflow while learning to solve a very specific problem. When asked about difficulties encountered in the learning process, all participants reported some difficulty in determining appropriate keywords for an initial search. As one participant stated, “the most difficult part is knowing how to form your query properly.” Terminology related to development or programming can be very specific to a particular language, and when learners had difficulty describing their learning objective with the most appropriate terms, the searching process could be time-consuming, or even unsuccessful. In fact, the most common type of assistance sought by the participants at any stage of the learning process was help determining keywords or a description of their objectives. When asked to describe sample searches, participants’ responses fell into three main types: error messages, keywords, and natural language questions.

Participants were also asked to provide information about the online resources they used during their learning process. Close attention was paid to the categories or genres of learning resources the participants mentioned, and their personal descriptions of these. Participants named and described their resources fairly consistently. As a result, through the response coding process we were able to arrive at eight main genres of learning resources consulted by participants (see Table 1). The genres appear to vary along several dimensions, including formality, time commitment, and specificity. Q&A sites such as Stack Overflow were regularly mentioned by all interview participants. According to one participant, “I will check Stack Overflow because it’s more focused on what I ask.” Other participants described Q&A sites as quick to consult. Thus, Q&A sites feature greater specificity with less time commitment, and were preferred by participants describing work or class related settings. Other genres appear to be associated with other learning settings. For example, online courses (non-school) feature less specificity, but greater formality and time commitment. Participants who described these resources in the interviews did so while discussing learning for personal reasons, or learning broad topics like a new language. Overall, resource genre was reported among the top criteria in selecting specific learning resources.

Beyond genre, participants indicated several other considerations when selecting a resource, which centered on resource reliability. Official documentation or publicly available course materials from a university were regularly described as among the most reliable resources. As such, name or visual recognition, and site creator are strong reliability indicators to these learners. Within a specific resource like a Q&A site, participants reported using up-votes and comments to determine the reliability of a given piece of information. Given the importance of annotations like votes and comments in the selection process, participants were asked how they contribute to
such practices with learning resources. Surprisingly, 12 of the 17 participants responded that they do not contribute such annotations at all, mostly due to feeling too unskilled or uncertain. The participants who did contribute would leave comments thanking the author, or occasionally post their own questions in response to being unsuccessful at finding their desired learning resources.

<table>
<thead>
<tr>
<th>Resource genre</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blog</td>
<td>expert authors post tips, generally written out text</td>
</tr>
<tr>
<td>Code storage</td>
<td>site to post and share code solutions</td>
</tr>
<tr>
<td>eBook</td>
<td>formally published books online</td>
</tr>
<tr>
<td>Official</td>
<td>documentation from body responsible for a standard</td>
</tr>
<tr>
<td>Online course</td>
<td>formal courses generally covering a broader topic, not undertaken as part of school program</td>
</tr>
<tr>
<td>Q&amp;A site</td>
<td>users post and answer questions, with answers getting annotated with votes and comments</td>
</tr>
<tr>
<td>Tutorial</td>
<td>step by step instructions covering a specific function or topic</td>
</tr>
<tr>
<td>Video</td>
<td>audio/visual content through sites like YouTube, or as part of a course</td>
</tr>
</tbody>
</table>

Finally, we examined the results to draw conclusions about the learning objectives drawing developers to learning resources. In attempting to understand the impetus connecting informal learners to their resources, we identified four main learning objective settings. In the work setting, learners were responsible for independently learning something needed to complete a task or project as part of a job. The class setting was defined as learning conducted alongside of a class, but independently of material or tasks prescribed by the teacher. Closely related, the class assignment setting entailed learning conducted as part of a specific project for a class, in which the student heavily relied on learning resources outside the scope of class to complete. Finally, the personal setting represents learning conducted solely for the personal enrichment or continuing education of the learner. Independent from setting but closely related, several learning objective types were also indicated by the data. The most commonly described type was “complete a specific task,” particularly when participants were discussing what we identified as the work or class assignment settings. Other types included “learn general skills,” “learn a new language,” “find examples,” and “find reference information.” Thus, the learning objective itself begins to emerge as the connection between a developer and learning resources, described by properties including setting and type.

Conceptualization and integration

In the next major stage of work, results of the knowledge acquisition task are used to conceptualize an initial model while attempting to integrate classes, properties, and definitions from existing ontologies and models where possible (Fernández-López et al., 1997).

Conceptualization frequently requires the construction of vocabularies designed to identify and define the important concepts, properties, and vocabulary within the domain of interest. During the analysis of the developer interviews, a number of useful vocabularies emerged, including resource genres, learning objective settings, learning objective types, and search types. Reviewing these vocabularies, a list of essential entities began to emerge that would form the core of the new ontology. These included Objectives, Resources, Annotations, and Users.

At the same time, emerging results were checked against a number of existing ontologies, schemas, and vocabularies, satisfying the integration task of the METHONTOLOGY workflow. For example, learners’ interactions with online comments and votes have been previously modeled with the Open Annotation Data Model (Bradshaw et al., 2013). Tagging interactions in particular have been modeled by ontologies including SCOT (Scerri, Decker, Kim, & Yang, 2012) and MOAT (Passant & Laublet, 2008). Simple information about the users themselves can be captured with properties from the popular FOAF ontology, which describes people, their connections, and their activities (Brickley & Miller, 2014). Finally, the Dublin Core schema offers a number of useful, general properties that are applicable, including title, author, and subject. Efforts were made to incorporate existing classes and properties from these ontologies and vocabularies.
Through several drafting processes, the authors incorporated findings into an initial, conceptual model. The model, dubbed LILO (Learning Informally Online) (Figure 1), serves the purposes of illustrating our understanding of developers’ online learning experiences.

![LILO ontology with select attributes](image)

**Figure 1.** LILO ontology with select attributes

LILO depicts the interaction among four main classes: User, Objective, Resource, and Annotation. In a departure from the previously examined educational ontologies (Jovanović et al., 2006; Qin & Paling, 2001), we chose to connect the User to learning resources through a conceptual Objective class. In more formal settings, this role is served by curricula, learning design, or instructor intervention. Here, in a more informal setting, Objective serves as a high-level representation of a learning need. Interview results indicated several important properties of the Objective class, including the setting, and the objective type. Objective may also be further expressed through the optional Search class, representing the common scenario where learners use a search engine to connect with learning resources through one of the previously identified search types common to developers. Resource represents any online source that Users may find informative and may help satisfy their learning objective. Adopting the role of a target from the Open Annotation Data Model, Resource bears several important properties including title and author, and, specific to LILO, a genre. Finally, the Annotation and Body concepts from the Open Annotation Data Model are incorporated to represent resource annotations such as comments or up-votes that developers described creating or utilizing.

**Implementation and evaluation**

Next, work focused on implementing the conceptualized model into a formal ontology. To achieve this, the authors used the Protégé software, an open-source editor for ontology construction. Through the use of Protégé, an initial, formal ontology was codified using OWL/XML.

Following implementation, METHONTOLOGY specifies that ontologies must be evaluated. Ontology evaluation includes verification, focused on the technical correctness of the ontology, as well as validation, focused on the semantic correctness and appropriateness (Fernández-López et al., 1997). Though METHONTOLOGY prescribes no specific evaluation strategy, the authors chose to utilize an online ontology scanner, OOPS!. A tool for detecting pitfalls in ontology development, OOPS! is currently capable of detecting over 40 common ontology errors, ranging from minor to critical (Poveda-Villalón, Gómez-Pérez, & Suárez-Figueroa, 2014). The authors uploaded an OWL/XML file of the LILO ontology into OOPS!, resulting in the identification of several minor errors. These errors were corrected, and a subsequent scan revealed no remaining errors. Further validation of the ontology is addressed below through its implementation in the provided case study.
New design requirements informed by LILO

Reviewing the resulting ontology, we focused on classes and properties unique to LILO and determined five major design requirements specific to an informal learning system for developers.

Keyword support

Development and programming terminology is specific and varies among different computing languages. Interview participants described difficulty in determining appropriate keywords for a specific task they needed to learn about. The user’s initial words for a problem are modeled within LILO as the tag property of the Objective class. Allowing users to tag a learning need or development issue with their initial keywords will help a system capture terminology among less experienced developers, and associate this terminology with a specific development problem. In collaborative or crowdsourced settings, user tags would enable the system to accommodate for variance in terminology for specific topics and guide users to more commonly used terms.

Search support

Closely related to keyword support, search support represents the ability for a system to suggest or provide relevant searches for a particular problem faced by a developer. In the interviews we found that developers struggling to arrive at the best search terms often need assistance in this stage of the learning process. Therefore, an informal learning system should be able to serve this role, supporting users in determining the most relevant terms to use in a search for learning resources. Systems capable of detecting specific development issues should be able to provide suggested searches for relevant informative sources.

Resource genre utilization

Interviewees relied heavily on resource genres to select a specific learning resource from the multitude of search results. Genres varied along the dimensions of formality, specificity, and time commitment, with faster, more specific genres (e.g., Q&A sites) preferred by those learning to complete a specific task. A system offering search support would be strengthened by the addition of genre labels to suggested resources, and by promoting different genres of resource depending on the developer’s setting and objective type.

Reliability cues

In addition to genre, interviews showed that developers notice and respond to certain indicators of reliability when selecting among various learning resources. Utilizing such reliability cues such as up-votes is one way that a system can help direct developers to the resources that they are most likely to trust. Additionally, when suggesting resources to a developer, clearly displaying site titles and, where relevant, author names, can provide additional reliability cues that are useful in resource selection.

Objective support

In describing their learning objectives, developers identified various work, school, and personal settings for their learning needs. Closely related are learning objective types, with developers demonstrating a range between specific task-based objectives to learning an entire language. LILO’s Objective class contains properties that represent these aspects of learning objectives. Incorporation of this metadata could allow a system to better anticipate appropriate resources for any specific learning activity. Over time, the system could also better adapt to the learning style and needs of a particular user.

Case study

In the following section, we present a case study using a real system to demonstrate how design requirements derived from LILO can be used to advance system design. The system, CAN (Composable Accessibility
Infrastructure), represents an extent system with pre-existing conceptual decisions. Applying ontology to improve an existing design is referred to by Guarino (1998) as re-engineering.

**Background**

CAN is a software system that supports web developers in learning how to build accessible web products using online materials (Huang et al., 2015). The system collects a variety of web accessibility issues on real websites and their software fixes, dynamically composes solutions on the fly, and delivers this content as learning material to web developers for learning how to fix accessibility issues on a webpage. Web developers interact with CAN through a Chrome browser plugin application.

Previous user studies focused on developers’ use of CAN to understand and fix accessibility issues (Huang et al., 2015), while beginning to reveal the educational potentials for the platform (Huang & Dobreski, 2017). Results of this study showed that developers enjoyed using CAN to deal with accessibility issues, however further support for the learning process was needed. Less experienced developers still needed assistance in understanding basic elements or concepts involved. Also, findings showed that web developers feel most comfortable checking online resources for this assistance in learning. Facilitating search, quickly connecting users to known and trusted sources, and allowing them to discern between resources emerged as important considerations in the continued development of CAN’s educational aspects. Overall, findings suggest CAN to be an interesting and suitable environment for incorporating design features inspired by LILO.

**New design informed by LILO**

In updating CAN’s design based on requirements derived from LILO, we focused specifically on keyword support, search support, and the implementation of resource genres. In CAN’s previously existing design, solution source code was viewable in the developer console. In the new design, we added explanatory comments into the solution code, including keywords to provide assistance in understanding and articulating the problem (see Figure 2).

![Figure 2. Solution source code with keywords](image)

We implemented a new search function, CAN.search, to allow an assisted search process using these supplied keywords. The results of the search are displayed in a float out layer containing a list of learning resources annotated with genre labels, and optional refining filters based on these resource genres (see Figure 3). Ultimately, the CAN.search function is intended to lead users to a result screen of learning resources labeled with genre terms via CAN’s crowdsourcing model. In the new design, genre labels for a list of online learning resources were bootstrapped into the system according to the typology presented in Table 1. In this design, each learning resource is labeled with one genre term.
Other design requirements are supported, though less explicitly, by the new design of CAN. The use of the CAN.search function facilitates simple searches using the previously identified keywords. The resulting list of suggested learning resources contains article title, page title, and some descriptive text from the resource, offering some of the reliability cues developers are used to relying on when evaluating potential learning resources (see Figure 3). We were faced with several problems concerning objective support. Though useful as an abstraction in understanding the connection between learners and learning resources, the objective class posed problems in direct implementation into a system. Forcing users to declare objective settings or types would be logistically challenging without interrupting or formalizing the learning process. Additionally, the CAN system is focused on correcting accessibility problems, making certain aspects of the learning objective already implicit in system design. Therefore, for the purposes of this case study, the objective class was not implemented.

![Figure 3. CAN developer console with search results screen.](image)

**Discussion**

The process of implementing LILO in design revealed some of the issues associated with reconciling an abstract conceptual model with concrete system architecture. One area of friction between LILO and CAN was the Objective class. While useful at a conceptual level, the Objective class exists as a purely abstract entity. Though LILO predicts the importance of Objective attributes like setting and type, recording and utilizing metadata associated with it presented logistical and functional challenges to system design in CAN. In practice, systems like CAN may better represent the functional connecting entity between Users and Resources.

Though attempts have been made at determining a general set of genres for web documents, genre terminology is often better understood and agreed upon with specific communities (Rosso, 2008). The specific set of genre terms implemented in CAN in this study was derived from interview data during ontological modeling, though shows similarity to frameworks of online learning resources presented in previous research (Dabbagh & Kitsantas, 2012). Current resource genres were pre-applied in the CAN case study. It is hoped that users themselves would apply genre terminology to recommend resources through additional functionality in the future design of the system. Additionally, interviews revealed that developers found certain resource genres more useful for certain learning situations. While this requires further exploration, CAN’s crowdsourced model could reveal connections between certain genres and learning situations over time, and allow for further customization of resource recommendation and increased objective support.

Importantly, the LILO model was able to successfully incorporate existing standards like Dublin Core, FOAF, and the Open Annotation Data Model. However, opportunities exist for further integration with other online ontologies that could provide increased support for LILO’s design implications. For example, the MOAT ontology allows content users to apply semantically backed tags, allowing for increased terminology disambiguation within the context of specific online groups (Passant & Laublet, 2008). Applying semantics to the tags LILO prescribes for Objectives could allow for further keyword and objective support, and potential exists to incorporate tagging of other entities such as Resources. Though LILO models the online learning process of developers, the topical content of learning resources may be modeled by specific subject ontologies.
The use of a domain specific ontology allows for further disambiguation of terminology and concepts within a given domain, and could be used to supplement LILO’s implications for keyword support; previous work has already shown the potentials for SKOS-based subject ontologies in supporting online learning in this manner (Miranda et al., 2016). Furthermore, integration with subject specific ontologies may offer the improved search support indicated by LILO. Gaeta et al. (2014) proposed a social, semantic approach to learning online through the use of classification and descriptive ontologies that capitalizes on the Semantic Web’s ability to enhance search and serendipitous discovery. Systems utilizing LILO could be compatible with such an approach, offering the ability to provide related concepts during the search process, and enabling increased personalization and serendipity during search.

**Limitations and future work**

The present work is limited by the specificity of the population examined. Study of other developer populations, such as those in purely professional environments, is needed to refine understandings of the informal online learning activities and the LILO ontology. Utilization of interviews allowed us to access developers’ own thoughts on the covert processes involved in informal learning, though incorporation of observations and further content analysis of relevant resources could also provide further sources of development for LILO. Though METHONTOLOGY identifies stages of the ontology development lifecycle, this process is not strictly linear, allowing for ongoing work in any of the stages (Fernández-López et al., 1997). Further knowledge acquisition could help refine LILO while making it more widely applicable.

Though LILO itself was evaluated during the study, formal evaluation of the new LILO inspired CAN design must also be undertaken. Doing so will also allow evaluative conclusions to be drawn concerning both the system and the ontology itself. Of the four main types of ontology evaluation laid out by Brank, Grobelnik, and Mladenic (2005), application implementation is particularly suited for ontology-driven system design; according to this evaluative viewpoint, a good ontology is one that helps an application produce good results on a given task. Formal user study with the new CAN design is needed to evaluate learner performance and satisfaction; findings will hold implications for both system performance and ontology performance.

Future work is also needed to understand how to further implement LILO into the design of systems with informal learning components, and to evaluate this implementation. Though LILO was designed to model online learning by developers, it has potential applicability to a wider group of online users. Just as CAN’s design was enhanced through the incorporation of LILO, other online learning support systems could be modified. Guarino (1998) refers to this process as re-engineering, and indicates its benefits for system reuse and maintainability. Design implications given in this study could be used to guide the re-design of other online learning systems, and full incorporation of LILO through re-engineering would offer the opportunity to evaluate other LILO enhanced designs while revealing the applicability of the ontology to other learners.

**Conclusion**

Online resources have opened new avenues for informal, self-directed learning activities. Web and software developers often rely on informal online learning to accomplish tasks and keep their skills up to date. Understanding and supporting the learning needs of this population is therefore of particular importance. In our work, we sought to enhance informal learning system design through the development and incorporation of ontology. LILO provides a unique illustration of this domain, offering insight into the learning objectives driving the connection between developers and learning resources while suggesting important design considerations. Initial design work with CAN reveals the potentials for ontology informed requirements to improve design for an informal learning system.

Incorporation of ontologies such as LILO offers the opportunity for increased integration into the Semantic Web, an important setting offering useful strategies for informal learning. Further integration with online ontologies such as MOAT or subject domain ontologies hold the potential for further search and learning support. At the same time, further work is needed to compare LILO with the learning activities of a wider array of developers. Similarly, LILO may hold potential in supporting the design of informal online learning systems for other topics and populations, but additional research and incorporation into system design is required. On a broader level, our work with LILO reveals the issues implicit in reconciling an abstract conceptual model with actual system architecture, issues which merit continuing exploration within the work of ontology informed design.
Acknowledgments

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References


The Impact of Motivation and Personality on Academic Performance in Online and Blended Learning Environments

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ABSTRACT

This study investigates the impact of students’ motivation and personality traits on their academic performance in online and blended learning environments. It was conducted with students attending a mandatory introductory information technology course given in a university in Turkey. The Big Five Inventory and Motivated Strategies for Learning Questionnaire were completed by a total of 316 students. A learning management system (LMS) was used for online collaboration and accessing course materials. At the end of the course, information on the accessibility of LMS and students’ academic performance including their exam results was obtained. The Bayesian Structural Equation Modeling was used to examine academic performance in terms of its relationship with motivation and personality. In the online learning environment, the results showed that the conscientiousness trait was significantly related to LMS use whereas in blended learning, there were no significant relations between personality traits and LMS use. Self-efficacy was found to be the predictor of LMS use in the online environment while task value and test anxiety were the predictors in the blended learning environment. Conscientiousness and LMS use were significantly related to course grades in both learning environments. Finally, self-efficacy for learning performance was also associated with course grades in the online learning environment.

Keywords

LMS Use, Personality, Big five, Motivation, Bayesian estimation, Academic performance

Introduction

Online instruction provides learners with the opportunity of gaining learning experience any time anywhere and thus students can control their learning path, pace and contingencies of instruction (Graham, 2006; Hannafin, 1984). On the other hand, blended learning combines the conveniences of both online and face-to-face instruction. In both learning environments, many factors affect academic performance. For example, personality traits (Nofile & Robins, 2007; O’Connor & Paunonen, 2007) and academic motivation (Brackney & Karabenick, 1995; Credé & Phillips, 2011) have a significant role in the success of students.

Training materials, delivery medium of instruction and learning styles are among other significant predictors of academic performance (Akkoyunlu & Soylu, 2008; Kim, 2013). Educational materials can be provided in a variety of technological media. For example, tools facilitating real-time online collaboration through video calls and mobile phones increase social presence thus positively affecting students’ engagement and learning experience (Graham, 2006; Lim, Morris, & Kupritz, 2007; López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011). In the literature, the value of online support materials has been investigated in both online and blended courses (Baugher, Varanelli, & Weisbord, 2003; Biktimirov & Klassen, 2008; Wilson, 2003). The authors suggested that having a higher access to lecture notes increases the course grades of the students. Educational materials can be also provided in learning management systems (LMS). These systems additionally play a facilitator role in communication between the instructor and students. LMS may influence students’ confidence and motivation for learning positively (Coates, James, & Baldwin, 2005). There is also a positive correlation between the achievements of course objectives/learning outcomes and students’ online activities in LMS (Huang, Lin, & Huang, 2012).

In recent years, the role of motivation in online learning has received considerable attention due to the high attrition rates of students in online classes (Chen & Jang, 2010). It was argued that high attrition rates are negative indicators of motivation. In addition, since the interaction between students and instructors are different in both online and blended learning environments, students may have different motivators which affect their academic performance. For example, motivation created by face-to-face activities positively predicts final grades (López-Pérez et al., 2011). In a blended learning context, a significant positive correlation was found between self-efficacy and course grades (Lynch & Dembo, 2004). Rovai and Jordan (2004) stated that online learning is not suitable for all students, thus their academic performance could change according to the type of the learning...
environment. The study conducted by Ginns and Ellis (2007) revealed that students opposed to the idea that teaching in an e-learning context was supportive of learning.

The aim of this study was to identify and compare the impact of personality and motivation in online and blended environments on the academic performance of students. Although a number of studies have partially investigated some of these factors in specific learning environments, to our knowledge, no study has, so far, examined these factors together to compare the two environments in terms of their capability to predict the use of a learning management system (LMS) and course grade. Therefore, in the current study, we particularly focused on motivation and personality since these are significant predictors of students’ choice of these environments and achievement of high grades from a course. To this end, we used the same training materials and LMS in the online and blended environments with the sole difference being the weekly lectures organized with the participation of students and an instructor in the blended learning environment. Furthermore, blended learning, and in particular LMS use, has been reported to improve students’ final grades (López-Pérez et al., 2011) and thus in this study, we also determined whether LMS use can predict course grades in both online and blended learning environments. We used Bayesian Structural Equation models to investigate the causal relationships between the variables.

Big Five Personality and academic performance

Personality traits describe individual differences in behavior, cognitions and emotions. The Big Five Personality model contains five dimensions of personality. The characteristics of these traits are described below (Costa & McCrae, 1992; McCrae & Costa, 1987):

- Extraversion refers to being talkative, energetic, assertive and social.
- Agreeableness is characterized with being good-natured, cooperative and trustful.
- Conscientiousness covers the characteristics of being organized, disciplined, responsible and achievement-oriented.
- Neuroticism refers to being worried or insecure, and is related to the degree of emotional stability and anxiety.
- Openness demonstrates a high degree of intellectuality, imagination and independent-mindedness.

Of the Big Five traits, conscientiousness has been reported to be positively related to course grades and grade point average (GPA) in several studies (Chamorro-Premuzic & Furnham, 2003; Duff, Boyle, Dunleavy, & Ferguson, 2004; Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Nguyen, Allen, & Fraccastoro, 2005; Paunonen & Ashton, 2001; Poropat, 2009; Rosander, Bäckström, & Stenberg, 2011). Furthermore, the meta-analysis conducted by O’Connor and Paunonen (2007) and the literature review conducted by Noftle and Robins (2007) revealed that compared to other traits, conscientiousness has the strongest and most consistent association with academic success. However, in the literature, there are contradictory results in terms of the relationship between the remaining four personality traits and academic performance. For example, neuroticism was found to be negatively correlated to course grades or GPA (Chamorro-Premuzic & Furnham, 2003) but this relation was not reported as significant in certain studies (Duff et al., 2004). Furthermore, while Rosander et al. (2011) found a positive significant relation between neuroticism and academic performance, the extraversion trait was reported to have a negative relation with course grades or GPA (Nguyen et al., 2005; Noftle & Robins, 2007; O’Connor & Paunonen, 2007). A positive but weak relation between openness and course grades has been demonstrated (Lounsbury et al., 2003; Noftle & Robins, 2007; O’Connor & Paunonen, 2007; Paunonen & Ashton, 2001); however, the study by Rosander et al. (2011) reported that a significant relationship was only observed in language and practical disciplines which are associated with the characteristics of the openness trait related to being curious and imaginative. There is one study that found a significant positive correlation between agreeableness and GPA (Gray & Watson, 2002).

Academic motivation

Academic motivation is one of the important predictors of academic success and has a significant impact on student behavior and learning (Fairchild, Horst, Finney, & Barron, 2005). In educational studies, researchers have used different motivational theories to examine academic motivation (Fortier, Vallerand, & Guay, 1995) such as expectancy-value theory (Berndt & Miller, 1990); goal theory (Meece & Holt, 1993); self-efficacy theory (Zimmerman, Bandura, & Martinez-Pons, 1992) and intrinsic motivation (Deci & Ryan, 1985).
There are different motivational factors and scales to measure students’ motivation for a specific course; such as Achievement Motivation Inventory (Schuler, Thornton III, Frintrup, & Mueller-Hanson, 2004) and Motivated Strategies for Learning Questionnaire (MSLQ). In the current study, MSLQ was chosen since it covers a wide range of theories given above (Pintrich, 1991). MSQL was designed to measure college students’ motivation and self-regulated learning related to a specific course (Artino Jr, 2005). It measures six motivational factors under three constructs:

Value construct
- Intrinsic Goal Orientation refers to students’ perceptions of engaging in a learning task for challenge, curiosity or mastery. A high score of intrinsic goal orientation for an academic task indicates that the students participate in the task for themselves. Students with high intrinsic motivation have higher course grades (Brackney & Karabenick, 1995; Credé & Phillips, 2011) or a higher level of intrinsic value is correlated with a higher level of student achievement (Pintrich & De Groot, 1990).
- Extrinsic Goal Orientation represents the extrinsic reasons for participating in a task such as achieving good grade, rewards or gaining competitive advantage over peers. Students with high extrinsic goal orientation do not participate in academic tasks for the task itself. This is supported by the research of Lin, McKeachie and Kim (2001) reporting that students with medium or high extrinsic motivation achieved higher course grades.
- Task Value refers to students’ perception of to what extent the task is important and useful. A positive correlation between task value and course grades has been reported by Brackney and Karabenick (1995).

Expectancy construct
- Control of Learning Beliefs refers to the extent to which the students believe that they can manage their efforts to learn and this process will result in positive outcomes. It has been found to be positively correlated with course grades (Lin et al., 2001).
- Self-Efficacy for Learning and Performance refers to the expectancies of the ability to accomplish a task. Self-efficacy positively predicts students’ course grades (Brackney & Karabenick, 1995; Credé & Phillips, 2011).

Affect construct
- Test Anxiety is related to students’ negative thoughts that prevent their performance. Test anxiety was found to be negatively associated with course grade (Brackney & Karabenick, 1995; Credé & Phillips, 2011).

The current study

The originality of the current study is to show the impact of motivation and personality traits of students on their course grades and LMS use. Furthermore, online and blended learning environments were compared in an introductory information technology (IT) course in terms of predicting academic performance. Considering the previous studies in the literature, five main hypotheses were proposed.

The literature review showed that the conscientiousness trait has the most significant relation to academic performance and the relations between the remaining four personality traits and academic performance vary. We expected to obtain similar results to the literature in terms of the association between the conscientiousness traits and academic performance. Furthermore, due to the conflicting results obtained from earlier studies in relation to the remaining four personality traits, we proposed the following hypothesis regarding only the conscientiousness trait:

**Hypothesis 1a:** The conscientiousness trait predicts course grades in both online and blended learning environments.

**Hypothesis 1b:** The conscientiousness trait predicts LMS use in both online and blended learning environments.

Various studies have shown that students’ motivation is an important predictor of their academic success and it is related to the individuals. Among the six motivation factors measured by MSLQ, the one that is most significantly related to academic performance is intrinsic motivation. Other significant factors include self-
efficacy and test anxiety. Most of the earlier studies have been conducted in traditional learning environments. Therefore, we used the results from both online and blended environments to fill the gap in the literature. To this end, the following hypotheses were proposed:

**Hypothesis 2a:** Intrinsic goal orientation predicts course grades in both online and blended learning environments.

**Hypothesis 2b:** Intrinsic goal orientation predicts LMS use in both online and blended learning environments.

**Hypothesis 3:** Self-efficacy predicts course grades and LMS use in both online and blended learning environments.

**Hypothesis 4:** Test anxiety predicts course grades in both online and blended learning environments.

No other hypotheses were proposed for the remaining three motivation factors. However, all the relations were tested during the analysis. Furthermore, this study also investigated whether there is a relationship between LMS use and course grades based on the following hypothesis:

**Hypothesis 5:** LMS use predicts course grades in both online and blended courses.

All hypotheses are represented in the proposed research model in Figure 1. This proposed structural model was tested separately for online and blended course participants' data.

![Proposed research model](image)

**Method**

**Participants**

The participants of this study were a total of 316 undergraduate students who enrolled in an introductory IT course in the Middle East Technical University (METU). Of these participants, 189 (109 female, 80 male) attended the online class and 127 (76 female, 51 male) attended the blended class. The average ages of the participants in the online and blended classes were 22.27 (SD = 2.17) and 22.03 (SD = 1.78), respectively. The subject area of students was diverse ranging from social sciences to engineering. In the online course setting, students do not attend face-to-face lectures but use LMS to access the lecture notes, upload assignments and follow the announcements. In the blended course setting, students attend face-to-face lectures conducted in computer laboratories. The classes last 12 weeks each semester and each week, students in the blended class attend two-hour laboratory sessions carried out by the instructors. Therefore, they access the materials at least once a week. Blended and online class students take the same exams in a laboratory at the same time. The exams comprise multiple choice and true false questions. This course has been given to all university students more than sixteen years each semester. The lecture notes are updated as technology develops. The exam questions are revised carefully each year by a committee.
Procedure

To conduct the study with human participants, the ethics approval was obtained from the METU Research Center for Applied Ethics. The online class participants were sent a link to the online survey using their school e-mail addresses. The blended class participants completed the survey in the classroom environment. A total of 658 students were reached, but 381 students participated in the study (59% response rate). 65 entries were excluded from the analysis due to incomplete or invalid responses. The participation in the study was totally voluntary and it took 20 minutes to complete the survey.

Instruments and measures

Personality traits

The Big Five Inventory (BFI) of 44 items (John & Srivastava, 1999) was used to measure the personality traits since it has been reported to be highly reliable despite having fewer items than the NEO Personality Inventory-Revised and NEO-Five Factor Inventory (Gosling, Rentfrow, & Swann Jr, 2003). Furthermore, BFI is more established and validated than Ten Item Personality Inventory (Gosling et al., 2003; John, Naumann, & Soto, 2008). The items were rated on a 5-point Likert scale from 1-Strongly disagree to 5-Strongly agree.

Motivated Strategies for Learning Questionnaire (MSLQ)

MSLQ prepared by Pintrich (1991) can be broken down into two main parts: motivation and learning strategies. However, in this study, only the motivation part was used. There were 29 items rated in a seven point scale from 1-not all true of me to 7-very true of me.

Measures on grades and LMS use

The average grade of participants was computed using the scores from their midterm and final exams and assignments. The students used NetClassR LMS which had been developed by METU to provide the instructors with a platform to distribute lecture notes, give assignments, make announcements, send e-mail to students, announce students’ grades and conduct exams. During the semester when the study was conducted, the LMS logs of the participants of the study were recorded. At the end of the semester, an aggregated LMS use score was computed based on the total number of LMS accesses. It was assumed that the students used the system every time they accessed it. In addition, the system automatically logged the students out when they were not active for a certain period; therefore, the number of access indicated the level of system use. However, the exact duration of the LMS access use was not available in the system.

Analysis approach

Bayesian Structural Equation Modeling (BSEM) was used to analyze the casual relationship between personality traits, motivation, LMS use and course grades. BSEM is an alternative to the general applications of Structural Equation Modeling (SEM) to handle the assumptions of them like normality, sample size and missing data (Lee, 2007). Different from the two forms of traditional SEM, BSEM depends on Markov Chain Monte Carlo algorithm (Muthén & Asparouhov, 2012) and has many advantages over SEM (Dunson, Palomo, & Bollen, 2005). It allows nonlinearity, interactions, missing data, mixed categorical variables and can be implemented with a smaller sample size. One of the distinguishing features of BSEM is using priors which are the specifications of prior distribution for model parameters (Kaplan & Depaoli, 2013). Prior information is important since the inference of the model is based on the posterior distributions of model parameters, which rely on prior distributions.

Model Convergence in BSEM can be checked with the Gelman-Rubin convergence diagnostics, convergence statistics (CS) in Amos (Arbuckle, 2012; Gelman, Carlin, Stern, & Rubin, 2004). Model fit in BSEM is simply assessed with a posterior predictive p value (Kaplan & Depaoli, 2013). Having a p value around 0.5 indicates a very good fit of the model to data (Dunson et al., 2005). However, models are acceptable when the p is between 0.3 and 0.7 (Song & Lee, 2006). A zero value of p indicates that the model does not represent the data (model misfit).
Data analysis and results

Preliminary analysis

To examine the internal consistency of the questionnaire, the Cronbach’s alpha (coefficient alpha) was checked. The Cronbach’s alpha was computed for each subscale under BFI and MSLQ for online and blended classes separately (Table 1). Extrinsic goal orientation under the motivation scale was excluded from the analysis since it got a low alpha score for both online and blended class participants. This could be caused by the extrinsic goal orientation items being related to getting good grades or higher grades than their peers and thus referring to the students’ concern about their total grade. Since the participants of this study were from a noncredit course, these items were not applicable. After the reliability analysis, a composite score was computed by taking the average of the corresponding items in each personality trait and motivation factor. Table 2 presents the descriptive statistics of the scores.

<table>
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<tr>
<th>Sub scale</th>
<th>Number of items</th>
<th>Coefficient alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Online class</td>
</tr>
<tr>
<td>Extraversion (E)</td>
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<td>0.836</td>
</tr>
<tr>
<td>Agreeableness (A)</td>
<td>9</td>
<td>0.597</td>
</tr>
<tr>
<td>Conscientiousness (C)</td>
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<td>0.763</td>
</tr>
<tr>
<td>Neuroticism (N)</td>
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<td>0.806</td>
</tr>
<tr>
<td>Openness (O)</td>
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</tr>
<tr>
<td>Intrinsic Goal Orientation (IGO)</td>
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</tr>
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<td>Test Anxiety (TA)</td>
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<td>Task Value (TV)</td>
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<td>Extrinsic Goal Orientation (EGO)</td>
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</tr>
<tr>
<td>Control of Learning Beliefs (CLB)</td>
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</tr>
<tr>
<td>Self-efficacy for Learning Performance (SELP)</td>
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<td>0.872</td>
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Table 2. Descriptive statistics of all variables of BFI and MSLQ

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<th>Max</th>
<th>Mean</th>
<th>SD</th>
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<td></td>
</tr>
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<td>0.51</td>
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<tr>
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<td>3.11</td>
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<td>3.00</td>
</tr>
<tr>
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<td>5.00</td>
<td>3.69</td>
<td>0.61</td>
<td>3.70</td>
</tr>
<tr>
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<td>6.67</td>
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<td>1.33</td>
<td>3.00</td>
</tr>
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<td>7.00</td>
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<td>7.00</td>
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<td>25.16</td>
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<td>87.60</td>
<td>55.72</td>
<td>23.10</td>
<td>61.30</td>
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<td>Blended class</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>1.25</td>
<td>3.50</td>
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<td>3.58</td>
<td>2.44</td>
<td>3.60</td>
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<td>1.00</td>
<td>4.00</td>
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<td>6.40</td>
<td>3.52</td>
<td>1.00</td>
<td>3.60</td>
</tr>
<tr>
<td>TV</td>
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<td>89.70</td>
<td>59.39</td>
<td>23.76</td>
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</table>
Correlation analysis

In order to examine the interrelatedness of the variables in the dataset, correlation coefficients were computed. The effect sizes (r) were evaluated by following the rule of thumb interpretation of Cohen (1992): r = 0.1-small, r = 0.3-medium and r = 0.5-large. Table 3 presents the correlations between personality traits, motivation factors, LMS use and course grades among the online participants. A weak to moderate correlation was found among the subscales of the personality traits. Of all the measured personality traits, conscientiousness was weakly correlated with both LMS use and course grades. Moreover, weak to high correlations were found among the subscales of MSLQ. Intrinsic goal orientation and task value were weakly correlated to course grades whereas self-efficacy was weakly correlated to both course grades and LMS use. Finally, LMS use was weakly correlated to course grades.

Table 4 illustrates the correlations between personality traits, motivation factors, LMS use and course grades among the blended course participants. There are weak to high correlations within the subscales of motivation. Task value and test anxiety were weakly correlated to LMS use. In addition, weak to moderate correlations were found within the subscales of personality traits. The conscientiousness trait was weakly correlated to course grades. A moderate correlation was found between LMS use and course grades.

Table 3. Correlation among all variables for online class participants

<table>
<thead>
<tr>
<th></th>
<th>TA</th>
<th>TV</th>
<th>CLB</th>
<th>SELP</th>
<th>E</th>
<th>A</th>
<th>C</th>
<th>N</th>
<th>O</th>
<th>Grade</th>
<th>LMS</th>
</tr>
</thead>
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<tr>
<td>IGO</td>
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<td>.668**</td>
<td>.337**</td>
<td>.372**</td>
<td>.039</td>
<td>.171*</td>
<td>.197</td>
<td>-.180*</td>
<td>.028</td>
<td>.169</td>
<td>.134</td>
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<td>-.038</td>
<td>.019</td>
<td>.177</td>
<td>.158</td>
<td>.018</td>
<td>.124</td>
<td>.015</td>
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<td>.208**</td>
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<td>.067</td>
<td>.178</td>
<td>.104</td>
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<tr>
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<td>.217**</td>
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<td>.205**</td>
<td>.163*</td>
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<tr>
<td>Grade</td>
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<td></td>
<td></td>
<td></td>
<td>.160*</td>
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</table>

Note. *p < .05; **p < .01.

Table 4. Correlation among all variables for blended class participants

<table>
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<tr>
<th></th>
<th>TA</th>
<th>TV</th>
<th>CLB</th>
<th>SELP</th>
<th>E</th>
<th>A</th>
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<th>N</th>
<th>O</th>
<th>Grade</th>
<th>LMS</th>
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<td>.038</td>
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<tr>
<td>E</td>
<td>.018</td>
<td>.292**</td>
<td>-.331**</td>
<td>.362**</td>
<td>.004</td>
<td>-.06</td>
<td></td>
<td></td>
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<tr>
<td>A</td>
<td>.205*</td>
<td>-.142</td>
<td>.230**</td>
<td>.024</td>
<td>.032</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-.289**</td>
<td>.227*</td>
<td>.244**</td>
<td>.082</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>N</td>
<td>-.067</td>
<td>-.005</td>
<td>.095</td>
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<td></td>
<td>.082</td>
<td>.036</td>
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<td>Grade</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>.383**</td>
<td></td>
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</tr>
</tbody>
</table>

Note. *p < .05; **p < .01.

Course grade prediction: BSEM

To identify the casual relations between all the variables and test the hypotheses, two structural models were created in Amos Graphics 21 and analyzed with BSEM; one for online course and one for blended course. In BSEM, a CS value smaller than 1.002 indicates model convergence (Gelman et al., 2004). Therefore, during the analysis, when CS was below 1.002, the model was considered acceptable. Table 5 presents the CS of both models. During analysis, weakly informative priors were used and the means of model parameters were set to a bounded uniform distribution (Dunson et al., 2005; Hoyle, 2012). In this study, means of the coefficients of the observed variables were set to a uniform distribution having lower bound 1 and upper bound 5 or 7, since it was suggested that defining priors with upper and lower bounds for Likert type scales is appropriate when informative priors are lacking (Arbuckle, 2012). Since uniform priors could result in improper posterior, the
admissibility test was used to prevent them. Model fit was tested based on the posterior predictive p value. A p value around 0.5 gives the best model fit (Dunson et al., 2005) and models are acceptable when p is between 0.3 and 0.7 (Song & Lee, 2006). In this study, online and blended course models were considered acceptable since they had a predictive p value of 0.29 and 0.48, respectively (Table 5). The graphical representations of the models are given in Figure 2 and 3. All significant paths are represented in the figures with the standardized direct effects of predictor variables over the dependent variables. Table 6 presents the parameter estimates obtained from BSEM.

Table 5. Model statistics

<table>
<thead>
<tr>
<th></th>
<th>Online course</th>
<th>Blended course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior predictive p</td>
<td>0.29</td>
<td>0.48</td>
</tr>
<tr>
<td>Convergence statistics</td>
<td>1.0018</td>
<td>1.0018</td>
</tr>
<tr>
<td>R²</td>
<td>0.100</td>
<td>0.200</td>
</tr>
</tbody>
</table>

In the online course model (Figure 2), the predictors of course grades are LMS use, self-efficacy and conscientiousness ($R^2 = 0.100$). The conscientiousness trait has a positive path to LMS use and course grades, which supports Hypothesis 1a and Hypothesis 1b. Hypotheses 2a and 2b are not supported since there is no significant path from intrinsic goal orientation to course grades or LMS use. There is a positive path from self-efficacy to course grades and LMS use supporting Hypothesis 3. Hypothesis 4 is not supported, since there is no significant path between test anxiety and course grades. Finally, the significant path between LMS use and course grades supports Hypothesis 5.

Table 6. Parameter estimates of course grade

<table>
<thead>
<tr>
<th>Parameter estimates (Estimation of course grade)</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Credibility interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower bound</td>
<td>Upper bound</td>
<td></td>
</tr>
<tr>
<td>Online course (a)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade ← LMSUse</td>
<td>0.095</td>
<td>0.003</td>
<td>-0.037</td>
</tr>
<tr>
<td>LMSUse ← SELP</td>
<td>3.835</td>
<td>0.058</td>
<td>0.840</td>
</tr>
<tr>
<td>Grade ← SELP</td>
<td>3.401</td>
<td>0.059</td>
<td>0.519</td>
</tr>
<tr>
<td>Grade ← C</td>
<td>6.190</td>
<td>0.162</td>
<td>0.537</td>
</tr>
<tr>
<td>LMSUse ← C</td>
<td>5.544</td>
<td>0.151</td>
<td>0.031</td>
</tr>
<tr>
<td>Blended Course (b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade ← LMSUse</td>
<td>0.189</td>
<td>0.002</td>
<td>0.108</td>
</tr>
<tr>
<td>LMSUse ← TA</td>
<td>7.399</td>
<td>0.128</td>
<td>0.876</td>
</tr>
<tr>
<td>LMSUse ← TV</td>
<td>5.188</td>
<td>0.112</td>
<td>-0.599</td>
</tr>
<tr>
<td>Grade ← C</td>
<td>8.630</td>
<td>0.144</td>
<td>2.426</td>
</tr>
</tbody>
</table>

When the blended class model is examined (Figure 3), test anxiety, task value, conscientiousness trait and LMS use are found to be the predictors of course grades ($R^2 = 0.200$). The conscientiousness trait has a positive path to course grades supporting Hypothesis 1a. Hypothesis 1b is not supported since there is no significant path from conscientiousness to LMS use. Hypotheses 2a and 2b are also not supported due to the lack of a significant path from intrinsic goal orientation to course grades or LMS use. Similarly, Hypotheses 2 to 4 are not supported since...
there is no significant path between the parameters. However, a significant path is observed between text anxiety and LMS use, which was not hypothesized. Finally, the significant path between LMS use and course grade supports Hypothesis 5.

![Figure 3. Structural model - Blended class](image)

**Conclusion and discussion**

This study contributes to the literature by providing a comparative analysis with respect to the relationship between individual differences and academic performance in online and blended environments using BSEM analysis. More specifically, we examined the effects of personality and motivation over academic performance in both online and blended learning settings. Many of the previous studies analyzed these constructs only partially and in one environment. The participants of this study were also from different subject areas from social sciences to engineering unlike other studies. Another important contribution of this study was to investigate the impact of motivation and personality factors on the frequency of access to lecture notes.

The results indicate that personality is a predictor of academic performance in both online and blended course settings. A significant positive relation was found between the conscientiousness trait and course grades in both settings. This implies that students with the characteristics of the conscientiousness trait are more successful in exams. This is not surprising considering that conscientious individuals are considered to be organized, disciplined and responsible (McCrae & Costa, 1987). This result confirms the results of previous studies by Nofie and Robins (2007), Poropat (2009) and Nguyen et al. (2005). Moreover, the conscientiousness trait was found to be positively and significantly related to LMS use in the online course setting. Online environment has a limited capacity to engage learners in learning events unless the learners are self-motivated and active learners (Daniels & Moore, 2000). Conscientious individuals exhibit these characteristics. However, this relation was not observed in the blended course setting. This may be due to the nature of the course as the students in the blended course regularly used online materials in laboratory sessions. Hence, LMS access does not directly show how active a particular student is in a face-to-face class.

Self-efficacy was found significantly related to both LMS use and course grades in the online course setting. Students with higher self-efficacy are more likely to work harder and achieve more tasks than their peers (Linnenbrink & Pintrich, 2002). In the online course setting, students do not attend face-to-face lectures and activities and therefore they usually study by themselves, which requires higher self-efficacy and discipline. Furthermore, studies have shown that self-efficacy positively predicts students’ course grades (Brackney & Karabenick, 1995; Credé & Phillips, 2011). The findings of the current study are in parallel with these studies. Although self-efficacy was found significantly related to LMS use and course grades in the online environment, no significant relation was found in the blended course setting. The reason could be attributed to regular support provided to these students. This reduced the need for individual studying without solely relying on online materials. This finding is in agreement with the results reported by Lynch and Dembo (2004).

Previous studies have reported a negative relation between test anxiety and course grades (Brackney & Karabenick, 1995; Credé & Phillips, 2011). However, in the current study, we did not find any direct relation between the two in both settings. This could have resulted from the context of our study, in which the
participants attended a course that did not contribute to their GPA. This may have reduced their level of anxiety concerning the exams. On the other hand, we found a positive significant relation between test anxiety and LMS use in the blended course. This may be due to these students feeling the need to study lecture notes more than their peers, which can also explain their higher use of LMS compared to others. Although test anxiety was found related to LMS use in the blended course setting, no significant relation was found between the two parameters in the online course setting. It may be due to the students who have a familiarity with the course content preferring to register for the online course.

A significant positive relation was found between task value and LMS use in the blended course setting. This implies that if students found the course content useful, they studied the lecture notes more. Similarly, in the study by Brackney and Karabenick (1995), a positive correlation was found between course grades and task value. In the current study, task value has indirectly affected course grades through its effect on LMS use in the blended course setting. It can be concluded that students are more successful when they find the course content useful and important.

LMS use was found to positively affect course grades in both online and blended class settings. This result implies that students, who study lecture notes more, are more likely to receive higher grades in a course. Similarly, in a self-reported survey, Swan (2002) found that students who had higher levels of interaction with the content had higher reported levels of satisfaction and learning. However, contradicting results were revealed by Baktimirov and Klassen (2008), who reported no correlation between content hits and course grades, and Grandzol and Grandzol (2010), who showed that student participation was a significant inverse predictor of course completion. Grandzol and Grandzol (2010) explained this with the fact that they could not be sure whether the students were actively engaged with the materials or just left the web page open. Since the course materials are well established meaning that they have been regularly revised according to instructors and students’ feedbacks, this argument does not prevail for our study.

The implications of this study can be summarized as follows: in the online course setting, students who are conscientious and have higher self-efficacy are more likely to succeed in a course. However, others may require support from their instructors. Test anxiety and task value constructs are only observed in the blended course setting. Providing students with sample exams and previous years’ questions or organizing a mock up exam may decrease their anxiety about the course. Furthermore, students can be provided with the choice of taking the online or blended version of the class if the course supports both settings. Those with lower self-efficacy or conscientiousness can be encouraged to take the blended rather than the online course since they may struggle more in the latter. Furthermore, instructors can observe the access patterns of their students to the lecture notes to have an idea about how they will perform at the end of the course.

Future work

This study contributed to the literature by investigating the relationship between the individual differences, LMS use and course grades in the online and blended course settings. One limitation of this study is that the results cannot be generalized across different disciplines and cultures since the data was collected from an introductory IT course given in a university in Turkey. In the future, different courses can be evaluated to observe the differences in different disciplines. In the context of this study, LMS use was represented as a total score of students’ access to the LMS lecture materials. It was assumed that students used the lecture notes in LMS during their access. However, since the system does not provide details regarding actual use, the students may have only logged into the system but left without reading or giving their full attention to the materials. The duration of LMS use, the number of forum accesses to read and leave messages, and access details with respect to individual files may affect the results.

References


Factors Influencing Preservice Teachers’ Intention to Use Technology: TPACK, Teacher Self-efficacy, and Technology Acceptance Model

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ABSTRACT

This study aimed to investigate structural relationships between TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness for preservice teachers who intend to use technology, based on the Technology Acceptance Model (TAM). A total of 296 responses from the College of Education from three Korean universities were analyzed by employing the structural equation modeling methods. The results indicated that preservice teachers’ TPACK significantly affected teacher self-efficacy and perceived ease of using technology. The teachers’ TPACK also positively influenced their perceived ease of using technology and perceived usefulness of technology in the classroom. Finally, teacher self-efficacy, perceived ease of use, and perceived usefulness of using technology affected teachers’ intention to use technology. However, TPACK did not directly affect their intention to use technology. Based on the findings, we discuss implications and suggest future research directions for preservice teachers’ intention to use technology.

Keywords

Intention to use technology, Preservice teacher, TPACK, Teacher self-efficacy, Technology Acceptance Model (TAM)

Introduction

As information communication technology has developed, technology-integrated learning has also evolved, and the demand for technology in education has increased. In response to technical changes in educational settings, teachers, as experts, must both address the challenges of teaching with technology and maintain a good grasp of subject-matter content. In an era of highly valued technological knowledge, it is important that teachers develop an integrated knowledge of teaching, content, and technology, called Technology Pedagogy and Content Knowledge (TPACK), as suggested by Mishra and Koehler (2006). TPACK is becoming a required area of expertise for teachers in new learning environments in the 21st century.

In South Korea (hereafter Korea), technology-integrated learning and teaching has become increasingly prevalent, with high-tech learning environments, such as mobile technology, social media, smart classrooms, flipped learning, and live webcasts (Lee & Park, 2016). Flipped learning allows teachers to invert their classes. The benefit to students is that they have more time to digest material, rather than listen to lectures; teachers upload videos and lecture on a new platform which students can access both online and on mobile devices before class. Students can thus review the contents and materials in advance and actively participate in a discussion during class. In addition, the Korean government has encouraged schools and teachers to use and apply the flipped learning method (Korean Ministry of Education, 2016), based on scholarly evidence on the positive effect of the flipped learning approach on students’ achievement (Chao, Chen, & Chuang, 2015; Zainuddin & Hallili, 2016). To create such a technology-friendly learning environment, teachers’ positive experiences with use of technology and their intention to use technology are critical (Baek, Jong, & Kim, 2008).

Scholars have discussed how to improve users’ positive perception of technology and intention to use technology by adopting the Technology Acceptance Model (TAM) (Cheung & Vogel, 2013; Teo, Su Luan, & Sing, 2008). Davis (1989) first defined TAM as a theory that explains the factors influencing the intention to use information technology in order to improve performance in organizations. Perceived ease of use and perceived usefulness of technology are the most critical concepts that influence the intention to use technology; thus, external variables that affect these two concepts should be considered (Davis, 1989). More recent research emphasizes external variables that influence perceived ease of use and perceived usefulness in TAM (Venkatesh, Thong, & Xu, 2012). In addition to the intention to use technology, TAM further applies the intention to various learning technologies and diverse media-based learning environments, including online and mobile learning (Huang, Lin,
Therefore, we applied the concept of TAM to teaching contexts and educational settings from a teacher’s perspective.

The affective aspect of teachers is important when they use new technology, because it can influence their decision-making and behavior (Kramarski & Michalsky, 2010). Various complicated tasks are needed to match appropriate technology to teaching methods (Kramarski & Michalsky, 2010; Shin, 2013). Therefore, when looking at the factors influencing technology adoption, not only the cognitive aspect but also the affective aspect should be considered.

Self-efficacy can be defined as an individual’s belief in one’s ability to organize and implement actions to carry out designated types of performance and tasks (Bandura, 1977). Teacher self-efficacy refers to “the teacher’s personal belief in ability to plan instruction and accomplish instructional objectives” (Gavora, 2010, p. 18). Researchers have actively discussed teacher self-efficacy as they have paid more attention to the influence of self-efficacy on teacher behavior since the 1970s (Henson, 2001). In particular, self-efficacy is the most powerful factor affecting teacher behavior (Henson, 2001; Tschanmen-Moran & Hoy, 2001). Those with higher teacher self-efficacy were more likely to use more advanced instructional methods closely related to their students’ learning (Henson, 2001).

However, little empirical research has focused on the relationships between TPACK, teacher self-efficacy, and TAM (Alsofyani, Aris, Eynon, & Majid, 2012; Hsu, 2016). Further, few scholars have paid much attention to the significant influence of TPACK on both preservice teachers’ self-efficacy and their intention to use technology. More research on understanding preservice teachers and supporting them to apply TPACK in their future schools needs to be conducted. In this study, we regarded four factors (TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness) as the antecedents of the intention to use technology. Based on TAM, this study explores the predictors of preservice teachers’ intentions to use technology by connecting preservice teachers’ cognitive (TPACK) and affective (teacher self-efficacy) characteristics. That is, the purpose of this study is to investigate the structural relationships between the four factors and preservice teachers’ intentions to use technology.

The significance of this study is that it identifies factors that affect intention to use technology, including TPACK and teacher self-efficacy, for preservice teachers who need to become able to integrate knowledge of teaching, content, and technology in new learning environments in the Korean context. Additionally, by examining the relationships between factors, this study emphasizes that teacher self-efficacy and TPACK are core formative factors for increasing intention to use technology. The current study implies that developing and improving TPACK plays a critical role in helping preservice teachers use and integrate technology into educational contexts appropriately.

**Literature review**

**TPACK**

TPACK is a theoretical framework for describing the interaction and integration of technology, pedagogy, and content knowledge needed to successfully integrate technology use into teaching (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). Shulman (1986) first claimed that teachers needed content knowledge (CK), pedagogy knowledge (PK), and pedagogical content knowledge (PCK). Mishra and Koehler (2006) extended Shulman’s (1986) work by adding technological knowledge (TK) and used the term TPACK. The TPACK framework consists of seven domains: CK, PK, TK, PCK, technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPCK) (Mishra & Koehler, 2006).

Based on the three main knowledge categories for teachers (i.e., content, pedagogy, and technology), TPACK emphasizes the dynamic interaction and integration of knowledge with the use of technology (Schmidt et al., 2009; Thompson & Mishra, 2007). It describes the use of technology to support specific pedagogies within a particular content area. Additionally, TPACK describes the use of technology as an instructional technique. Finally, it describes the use of technology to help teachers improve student learning (Schmidt et al., 2009; Thompson & Mishra, 2007).

Scholars have found that TPACK is positively related to teacher self-efficacy, perceived ease of use, perceived usefulness of technology, and intention to use technology (Abbitt, 2011; Alsofyani et al., 2012;
Horzum & Gungoren, 2012; Liu, 2011; Sahin, Celik, Akturk, & Aydin, 2013; Semiz & Ince, 2012). Preservice teachers demonstrated a high level of teacher self-efficacy when using TPACK in different contexts, including math education, early childhood education, college education, and physical education (Abbitt, 2011; Semiz & Ince, 2012). In addition, TPACK significantly and positively influenced perceived ease of use and perceived usefulness (Alsofyani et al., 2012; Horzum & Gungoren, 2012). In technology-based learning environments, preservice teachers are more likely to perceive the easy use and usefulness of technology when they learn how to use and apply TPACK in the classroom (Horzum & Gungoren, 2012). Moreover, TPACK positively influenced teachers’ and preservice teachers’ intention to use technology in technology-integrated learning and teaching settings (Alsofyani et al., 2012; Liu, 2011). Teachers who developed TPACK were more likely to be confident and to intend to select and use a technology in an appropriate way in their instruction (Maeng, Mulvey, Smetana, & Bell, 2013).

Teacher self-efficacy

Teacher self-efficacy relates to teachers’ personal beliefs about their abilities and skills as educators. It includes both their beliefs about their ability to plan instruction and to accomplish instructional objectives (Gavora, 2010) and their confidence in their ability to promote student learning (Hoy, 2000).

Many studies have also reported that teacher self-efficacy has a positive influence on student achievement (Denham & Michael, 1981; Moore & Esselman, 1992). According to these studies, teachers with high self-efficacy ask their students open-ended questions, use inquiry methods, and prefer small-group learning activities more than their counterparts with low self-efficacy do (Brouwers & Tomic, 2003; Henson, 2001). Teachers who have high self-efficacy are more likely to use innovative components in instructional activities and are more willing to try creative and untested teaching methods (Gavora, 2010). In addition, highly self-efficacious teachers are more open to new ideas, have a greater commitment to teaching, and are more willing to adopt better teaching methods (Tschannen-Moran & Hoy, 2001). As previous studies have discussed (Brouwers & Tomic, 2003; Henson, 2001), teacher self-efficacy can significantly motivate adoption of new technologies in the classroom.

Several researchers have confirmed the relationships between teacher self-efficacy and intention to use technology (Anderson, Groulx, & Maninger, 2011; Jeung, 2014; Baker-Eveleth & Stone, 2008; Banas & York, 2014; Valtonen, Kukkonen, Kontkanen, Dillon, & Sointu, 2015). Preservice teachers’ beliefs about the value of classroom technology integration were significant predictors of their intentions to use technology in classrooms (Anderson et al., 2011). Valtonen et al. (2015) also reported that preservice teachers’ self-efficacy positively affected their intention to use information and communication technology.

Perceived ease of use and perceived usefulness

Perceived ease of use is the degree to which users believe they will use new technology without particular difficulty. Perceived usefulness means how much individual users recognize that new technology will help improve performance (Davis, 1989).

Based on TAM, researchers have explored the influence of perceived ease of use on perceived usefulness (Chow, Herold, Choo, & Chan, 2012; Joo, Lee, & Ham, 2014; Lee & Lehto, 2013). Data from 350 students who used mobile learning services at a leading online university in Korea confirmed that perceived ease of use significantly influenced perceived usefulness for integrating a user interface and personal innovativeness into TAM for mobile learning (Joo et al., 2014). In Second Life, a 3D virtual environment, 206 nursing students perceived the new system as being useful when they were able to use it easily (Chow et al., 2012).

Research has confirmed that perceived ease of use and perceived usefulness significantly affect teachers’ intention to use technology (Jeung, 2014; Davis, Bagoozi & Warshaw, 1989; Suki & Suki, 2011; Teo, 2011; Wangpipatwong, Chutimaskul, & Papasratorn, 2008). For instance, Wangpipatwong et al. (2008) found that perceived ease of use and perceived usefulness were positive predictors of intention to use an e-government website.
Intention to use technology

Intention to use technology can be defined as the degree to which the user would like to use technology in the future. Scholars have proposed that intention to use technology is a form of technology acceptance behavior relevant to perceived ease of use and perceived usefulness (Chow et al., 2012; Lee & Lehto, 2013; Teo, 2011). Teachers are more likely to intend to use technology when they perceive the easy use and usefulness of technology in learning and teaching (Teo, 2011). In addition, teacher self-efficacy has been regarded as critical for explaining teachers’ use of technology in the classroom (Albion, 2001). Furthermore, preservice teachers with developed TPACK tend to be confident and to intend to use technology in their instruction (Alsofyani et al., 2012; Liu, 2011; Maeng et al., 2013). In this study, we regarded intention to use technology as a final dependent variable to support previous studies on the relationships between the variables mentioned above.

Theoretical framework: Technology Acceptance Model (TAM)

The relationships between TPACK, perceived ease of use, perceived usefulness, and intention to use technology can be discussed in the context of the technology acceptance model (TAM). TAM, developed by Davis (1989), has been used to explain factors affecting individual acceptance of technology, based on Fishbein and Ajzen’s (1975) theory of reasoned action. In TAM, perceived usefulness and perceived ease of use directly influence the intention to use technology; moreover, perceived usefulness is directly affected by perceived ease of use (Davis, 1989).

In the original version, TAM included only perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention to use (Davis, 1989). To respond to criticism of the original TAM’s parsimony, Venkatesh and Davis, (2000) extended TAM by including external variables that affect perceived usefulness, perceived ease to use, and, ultimately, intention to use technology. As Figure 1 shows, external variables influence perceived usefulness and perceived ease of use; perceived ease of use affects perceived usefulness; both perceived usefulness and perceived ease of use affect intention to use; and ultimately the intention to use influences actual usage. This study considers TPACK and teacher self-efficacy as cognitive and affective factors that influence preservice teachers’ intention to use technology for their instruction.

![Figure 1. Technology acceptance model (TAM) (Davis, Bagozzi, &Warshaw, 1989, p. 985)](image_url)

Based on the literature review and our theoretical framework, this study examined the structural relationships between factors influencing preservice teachers’ self-efficacy, perceived usefulness, perceived ease of use, and their intention to use technology for teaching. TPACK was considered a critical factor that influences other variables in this study. Figure 2 displays the research hypotheses for this study.

**Hypothesis 1:** Preservice teacher’s TPACK will positively affect teacher self-efficacy.

**Hypothesis 2:** Preservice teacher’s TPACK will positively affect perceived ease of using technology.

**Hypothesis 3:** Preservice teacher’s TPACK and perceived ease of use will positively affect perceived usefulness of technology.

**Hypothesis 4:** Preservice teacher’s TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness of technology will affect intention to use technology.
Methods

Participants and procedures

The survey participants were undergraduate students enrolled in a required 2-credit teacher certification course in the College of Education at three Korean universities (Table 1). These preservice teachers intended to work in middle and high schools after graduation. The teacher certification course opened in Fall 2014 and ran for two hours a week for 16 weeks. Each week, students studied teaching and learning theories, instructional design concepts, and multimedia. Assessments included midterm exams, microteaching skill practice, group activities, and presentations. A paper-and-pencil survey was conducted during the last two weeks of the semester. To conduct the survey, instructors introduced this study, explained the purpose of the study, and distributed the questionnaire to students. Data were collected from 300 students; four incomplete responses were removed. Among the 296 (98.6%) respondents, 189 (63.9%) were female and 105 (35.5%) were male. Their average age was 22.3 years (SD = 1.71). Most were in their sophomore and junior year (78%).

Table 1. Participants’ major programs

<table>
<thead>
<tr>
<th>Major programs / Subjects</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art, music, and physical education</td>
<td>68</td>
<td>23.0</td>
</tr>
<tr>
<td>Early childhood and elementary education</td>
<td>63</td>
<td>21.3</td>
</tr>
<tr>
<td>Foreign language (English, French, and German)</td>
<td>50</td>
<td>16.9</td>
</tr>
<tr>
<td>Social studies</td>
<td>42</td>
<td>14.2</td>
</tr>
<tr>
<td>Korean</td>
<td>30</td>
<td>10.1</td>
</tr>
<tr>
<td>Science (Physics and chemistry)</td>
<td>24</td>
<td>8.1</td>
</tr>
<tr>
<td>Mathematics</td>
<td>19</td>
<td>6.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>296</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Instruments

To examine the structural relationships between the variables, we used five measurement instruments that were based on existing instruments in English (see Table 2). The items were prepared for use in Korean by using appropriate translation-back-translation procedures. The questionnaire used a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree) in order to have a consistent scale for the instruments. Cronbach’s alpha was reviewed to consider internal consistency of the instruments. The questionnaire included 30 questions for participants, excluding demographics.
To measure TPACK, the scale developed by Schmidt et al. (2009) was adopted. Among the 47 TPACK instrument items, we selected eight items for TPKC, combined four repeated items (40–43) into one, and used the final five items. The original instrument was developed for preservice teachers in elementary and early childhood education, and included items to assess knowledge in all content areas. Since participants in this study were preservice teachers for middle and high schools, however, the subject matter for their courses had already been decided. Thus, we removed the expressions identifying specific subjects (such as mathematics, literacy, science, and social studies) in the four items and combined them into one item to assess content knowledge regardless of the subject. Experts in the field reviewed the modified and final instruments.

Teacher self-efficacy was also measured, using the instrument developed by Schwarzer and colleagues (1999) because the original instrument was targeted at preservice teachers and focused on assessing their subjective beliefs about their own capability and personal competence.

To measure perceived ease of use and perceived usefulness, 12 items were employed from the instrument developed by Davis (1989). Finally, intention to use technology was measured by using three items developed by Taylor and Todd (1995).

**Data analysis**

The collected data were analyzed using the following procedures. First, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to confirm the validity and reliability of the measurement scale. After an exploratory factor analysis of each variable in this study, TPACK, teacher self-efficacy, perceived ease of use, perceived usefulness, and intention to use technology were found to be one-dimensional factors, requiring the use of item parcels in order to avoid placing too much weight on a particular variable in the hypothesized model (Kishton & Widamn, 1994). Item parceling was employed to reduce measurement error by combining individual items and using these combined items.

Second, descriptive statistics and correlation analysis were performed using SPSS. Multivariate normality was checked using AMOS by examining the skewness and kurtosis of each variable. The maximum likelihood estimation was selected as an appropriate statistical estimation method, because the variables fit the normal distribution. The goodness of fit indices used for this study were the minimum sample discrepancy (CMIN), Tucker-Lewis index (TLI), comparative fit index (CFI), standardized root mean square residual (SRMR), and root-mean-square error of approximation (RMSEA).

Structural equation modeling (SEM) was conducted to examine the structural relationships between the five variables in this study. SEM can analyze the integrated relationship among all variables in this study, and to estimate the relations among the variables that have been corrected for biases attributable to random error and construct-irrelevant variance (Bollen, 1989; Tomarken & Waller, 2005). By using multiple indicators to estimate the effects of latent variables, SEM corrects for unreliability within the construct and provides more accurate estimates of the relationship between the latent variable and the criterion (McCoach, Black, & O’Connell, 2007).
Results

The means, standard deviations, skewness, and kurtosis for all the variables were analyzed to confirm the multivariate normal distribution (Table 3). After item parceling, teacher self-efficacy was categorized into teacher self-efficacy in teaching (items 1-7) and administration (items 8-10). The mean scores ranged from 3.33 to 3.82; the standard deviations ranged from 0.57 to 0.71. Considering the skewness (ranging from [0.90] to [0.93]) and kurtosis values (ranging from [0.46] to [1.69]), the collected data met the assumption of a multivariate normal distribution, in that the values of skewness were lower than 3 and the kurtosis values were lower than 10 (Kline, 2011). The VIF values were lower than 10, indicating that multicollinearity did not occur. The correlations in order to have discriminant validity (Kline, 2011). In this study, all factor-loading values (the correlations between observed variables and latent variables) were between .61 and .94 (p < .05) and AVE values (.53–.86) were larger than the square of the correlations between latent variables (.45–.85). The results indicated a good level of convergent and discriminant validity.

<table>
<thead>
<tr>
<th>Measurement variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 TPACK 1</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2 TPACK 2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 TSE (teaching)</td>
<td>.49*</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>4TSE (administration)</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8 P-Usefulness 2</td>
<td>.48*</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Intention to Use 1</td>
<td>.49*</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>10 Intention to Use 2</td>
<td>.46*</td>
<td></td>
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</tbody>
</table>

**Table 3. Descriptive statistics and correlations for the variables**

**Note.** p < .05.

Additionally, analysis of variance (ANOVA) was performed to see if there are significant differences in teacher self-efficacy, perceived ease of use, perceived usefulness, and intention to use technology according to participants’ seven major programs. The results showed that there were no significant differences (Table 4).

<table>
<thead>
<tr>
<th>Teacher self-efficacy</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-value</th>
<th>p</th>
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<td>.349</td>
<td>1.324</td>
<td>.246</td>
</tr>
<tr>
<td>Within groups</td>
<td>76.147</td>
<td>289</td>
<td>.263</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>78.240</td>
<td>295</td>
<td>.263</td>
<td>1.324</td>
<td>.246</td>
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<table>
<thead>
<tr>
<th>Perceived ease of use</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>3.585</td>
<td>6</td>
<td>.598</td>
<td>1.516</td>
<td>.173</td>
</tr>
<tr>
<td>Within groups</td>
<td>113.891</td>
<td>289</td>
<td>.394</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117.477</td>
<td>295</td>
<td>.394</td>
<td>1.516</td>
<td>.173</td>
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<table>
<thead>
<tr>
<th>Perceived usefulness</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-value</th>
<th>p</th>
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<tbody>
<tr>
<td>Between groups</td>
<td>2.599</td>
<td>6</td>
<td>.433</td>
<td>1.173</td>
<td>.321</td>
</tr>
<tr>
<td>Within groups</td>
<td>106.739</td>
<td>289</td>
<td>.369</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>109.337</td>
<td>295</td>
<td>.369</td>
<td>1.173</td>
<td>.321</td>
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</table>

<table>
<thead>
<tr>
<th>Intention to use technology</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean squares</th>
<th>F-value</th>
<th>p</th>
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<tbody>
<tr>
<td>Between groups</td>
<td>1.314</td>
<td>6</td>
<td>.219</td>
<td>.491</td>
<td>.815</td>
</tr>
<tr>
<td>Within groups</td>
<td>129.033</td>
<td>289</td>
<td>.446</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>130.347</td>
<td>295</td>
<td>.446</td>
<td>.491</td>
<td>.815</td>
</tr>
</tbody>
</table>

**Note.** *p < .05.

Construct validity

CFA provides evidence that the instruments have convergent and discriminant validity. Convergent validity can be confirmed when the correlations between observed variables and latent variables are more than .50; discriminant validity can be confirmed when the correlations between latent variables are less than .80 (Kline, 2011). In particular, average variance extracted (AVE) values should exceed .50 and be larger than the square of the correlations in order to have discriminant validity (Kline, 2011). In this study, all factor-loading values (the correlations between observed variables and latent variables) were between .61 and .94 (p < .05) and AVE values (.53–.86) were larger than the square of the correlations between latent variables (.45–.85). The results indicated a good level of convergent and discriminant validity.
Measurement model

Before examining the structural model, the fitness of the measurement model was evaluated by maximum likelihood. As seen in Table 5, all fitness indexes of the measurement model seemed desirable ($\chi^2 = 41.402; df = 25; \chi^2/df = 1.656; TLI = .986; SRMR = .021; CFI = .992; RMSEA = .047$). All factor-loading values of the items of each latent variable, ranging from .61 to .94, were acceptable.

| Table 5. Results of fitness examination of the measurement model |
|---------------------------------|-----|------|------|-----|-------|
| $\chi^2$                        | df  | TLI  | SRMR | CFI | RMSEA |
| Measurement model               | 41.402 | 25    | .986 | .021 | .992   |
|                                    |     |   |      |     |       |
| Fit criteria                     | -   | -   | > .90 | < .08 | > .90 |
|                                    |     |   |      |     |       |
| RMSEA (90% Confidence Interval)  | .047 (.019 ~ .072) |     |      |     |       |

Structural model and hypothesis testing

As the measurement model satisfied the fitness index criteria and structural model’s estimate possibility was theoretically confirmed, the study employed maximum likelihood estimations to estimate the initial research model’s fitness. As shown in Table 6, the initial structural model provided a good fit to the data ($\chi^2 = 76.556; df = 27; \chi^2/df = 2.835; TLI = .963; SRMR = .064; CFI = .977; RMSEA = .079$).

| Table 6. Results of examination of fitness of the structural model |
|---------------------------------|-----|------|------|-----|-------|
| $\chi^2$                        | df  | TLI  | SRMR | CFI | RMSEA |
| Structural model                | 76.556 | 27    | .961 | .064 | .977   |
|                                    |     |   |      |     |       |
| Fit criteria                     | -   | -   | > .90 | < .08 | > .90 |
|                                    |     |   |      |     |       |
| RMSEA (90% Confidence Interval)  | .079 (.058 ~ 1.00) |     |      |     |       |

To test the hypotheses, the statistical significance of the path coefficient between the variables was examined. First, the direct effects of preservice teachers’ TPACK ($\beta = .73, t = 10.75, p < .05$) on teacher self-efficacy was statistically significant. Second, the direct effects of preservice teachers’ TPACK ($\beta = .62, t = 10.59, p < .05$) on perceived ease of use was statistically significant. Third, preservice teachers’ TPACK ($\beta = .29, t = 4.21, p < .05$) and perceived ease of use ($\beta = .49, t = 7.05, p < .05$) had significant effects on perceived usefulness. Finally, teacher self-efficacy ($\beta = .17, t = 2.07, p < .05$), perceived ease of use ($\beta = .19, t = 3.01, p < .05$) and perceived usefulness ($\beta = .64, t = 10.16, p < .05$) also had significant effects on intention to use technology. However, the effect of preservice teachers’ TPACK on intention to use technology was not significant ($\beta = .00, t = .000, p > .05$). In sum, hypotheses 1 through 3 were all supported, and hypothesis 4 was partially supported (Table 7).

| Table 7. Hypothesis testing: Path coefficient estimates |
|---------------------------------|-----------------|-----------------|
| Paths                           | Path coefficient ($t$-value)      |
| H1 TPACK                         | Teacher self-efficacy               | .733 (10.75)    |
| H2 TPACK                         | Perceived ease of use               | .622 (10.59)    |
| H3 TPACK                         | Perceived usefulness                | .209 (4.21)     |
|                                | Perceived usefulness                | .494 (7.05)     |
| H4 TPACK                         | Intention to use technology         | .000 (0.00)     |
| Teacher self-efficacy            | Intention to use technology         | .174 (2.07)     |
| Perceived ease of use            | Intention to use technology         | .194 (3.01)     |
| Perceived usefulness             | Intention to use technology         | .644 (10.16)    |

Note: *p < .05; t-value > |1.96|.

Based on the results from testing the hypotheses, a modified model (Figure 3) was created after removing one path (TPACK → Intention to use technology) because the effect of TPACK on intention to use technology was not significant in the hypothesized model. A chi-square statistic was generated to examine the statistical differences between the initial hypothesized model and the modified model. The results revealed no significant differences between the two models in goodness of fit ($\Delta \chi^2 = 0.00, p = .99$), thus confirming the validity of the modified model as the final model used in this study. The modified model, as shown in Table 8, presented a good fit to the data ($\chi^2 = 76.556; df = 28; \chi^2/df = 2.734; TLI = .963; SRMR = .064; CFI = .977; RMSEA = .077$).
Table 8. Results of fitness examination of the hypothesized and modified models

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$</th>
<th>df</th>
<th>TLI</th>
<th>SRMR</th>
<th>CFI</th>
<th>RMSEA (90% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesized model</td>
<td>76.556</td>
<td>27</td>
<td>.961</td>
<td>.064</td>
<td>.977</td>
<td>.079(.058-.100)</td>
</tr>
<tr>
<td>Modified model</td>
<td>76.556</td>
<td>28</td>
<td>.963</td>
<td>.064</td>
<td>.977</td>
<td>.077(.056-.097)</td>
</tr>
<tr>
<td>Fit criteria</td>
<td></td>
<td></td>
<td>&gt;.90</td>
<td>&lt;.10</td>
<td>&gt;.90</td>
<td>&lt;.08</td>
</tr>
</tbody>
</table>

Discussion

This study examined the structural relationships between TPACK, teacher self-efficacy, perceived ease of use, perceived usefulness, and intention to use technology for preservice teachers. The findings supported the following implications. First, preservice teachers’ TPACK positively affected teacher self-efficacy. This finding is in accord with the findings of previous studies (Abbitt, 2011; Semiz & Ince, 2012). It implies that preservice teachers with high levels of TPACK are more likely to increase their self-efficacy in teaching. TPACK would significantly affect a teacher’s self-efficacy in learning environments with new learning technologies and media. Teachers and preservice teachers would benefit from the implementation of workshops and training programs to improve the level of TPACK.

In addition, preservice teachers’ TPACK positively influenced perceived ease of use and perceived usefulness of technology, which supports previous research (Alsofyani et al., 2012; Horzum & Gungoren, 2012). In other words, preservice teachers who have high levels of TPACK would probably find it easier to use technology and would perceive using technology as a helpful teaching tool. Broad technical training should be provided to teachers and preservice teachers to overcome reluctance to learn new digital media and enable them to perceive ease of use and usefulness of technology. By establishing TPACK competency criteria, a systematic TPACK training series can be offered. Then, teachers and preservice teachers can learn more (e.g., how to use diverse apps and new teaching techniques in technology-integrated classes) according to their individual abilities and levels.

The current study also confirmed that perceived ease of use significantly affected perceived usefulness in TAM, which is consistent with previous studies (Davis, 1989; Chow et al. 2012; Joo et al., 2014). When teachers and preservice teachers perceive ease of use of technology, they can also perceive usefulness of technology. Considering that teachers’ perceptions of usability (3.31 out of 5) and satisfaction (3.30 out of 5) were lower overall than students’ perceptions of usability (3.69) and satisfaction (3.61) (KERIS, 2011), it is important for teachers to have enough time and opportunities to practice new technologies until they feel comfortable enough to use the technology and perceive that technology is useful in teaching.

Finally, teacher self-efficacy, perceived ease of use, and perceived usefulness had a positive influence on their intention to use technology. That is, the level of intention to use technology was determined by levels of teacher self-efficacy, perceived ease of use, and perceived usefulness of technology. However, the findings of this study...
indicated that TPACK did not directly affect intention to use technology, although it did so indirectly. Perhaps TPACK indirectly influenced teachers’ intention to use technology because teachers with high levels of TPACK spent more time handling students’ unexpected behaviors than playing an anticipated role in a technology-integrated class; this might have influenced their intention to use technology (Joo et al., 2014).

In other words, TPACK affected teachers’ intention to use technology through teacher self-efficacy, perceived ease of use, and perceived usefulness of technology. Perceived usefulness of technology (β = .64) has a stronger influence on intention to use technology than does teacher self-efficacy (β = .17) and perceived ease of use (β = .19). Even though preservice teachers have high teacher self-efficacy and perceive the ease to use of technology in classrooms, they could not accept technology when they thought that the use of technology does not contribute to meaningful learning experiences. That is, preservice teachers do not blindly use new technology, and they critically accept the technology based on its benefits to teaching and learning. To encourage teachers to use new technology in practice, it is important to provide them a stable infrastructure/system, so they can easily use the technology without any problem, by offering technology that is based on subjects and learners’ characteristics.

Limitations and recommendations for future research

There are several limitations in this study. Above all, it focused on preservice teachers for only middle and high schools. In addition, the findings cannot be generalized, because the questionnaire was given only to undergraduate students in three Colleges of Education in Korea based on convenience sampling. Another limitation is that this cross-sectional study collected self-reported data, which could lead to common method bias. The relevance of the study could be limited by its focus, which is based upon self-report and perceptions of the ease of use and usefulness of technology rather than on the actual use of technology in classroom practice.

In future studies, preservice teachers in elementary schools could be recruited in order to compare those results with our current findings on student middle- and high-schoolteachers. Subsequent research could also examine how teachers use technology in practice. Further studies should include a variety of data sources to capture broader phenomena on similar topics. By comparing other teacher groups in different cultural contexts, future studies could explore how cultural differences affect teachers’ perceptions of the use of technology. Additionally, diverse factors influencing teachers’ intention to use technology could be examined. Experience related to technology, school support for using technology in classrooms, or teachers’ anxiety about technology use should be included to observe different dynamics in technology-oriented learning environments.

References


Shin, T. S. (2013). A Relation between pre-service teachers’ fixed mindsets regarding their abilities to teach with technology and their perceived TPACK. *Journal of Educational Studies, 44*(2), 21–45.


Knowledge Sharing Self-Efficacy, Motivation and Sense of Community as Predictors of Knowledge Receiving and Giving Behaviors

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ABSTRACT

This study examines the extent to which knowledge sharing self-efficacy, motivation and sense of community variables predict undergraduate students’ knowledge sharing behaviors (knowledge receiving and knowledge giving) in online learning environments. The participants included undergraduate students (N = 284) from two different universities in Turkey. Stepwise multiple regression analyses were carried out to identify the variables predicting knowledge sharing behaviors as knowledge giving and receiving behaviors. The results revealed that both knowledge giving and receiving behaviors were best predicted by knowledge sharing self-efficacy, followed by motivations and sense of community. External effects and growth of aim affected knowledge receiving, whereas only internal effects affected knowledge giving. The independence factor has a negative effect on knowledge receiving, yet has a positive effect on knowledge giving.

Keywords

Knowledge sharing, Knowledge receiving-giving, Self-efficacy, Motivation, Sense of community

Introduction

Information presents both complex and connected features. It can be freely disseminated within a community when appropriate conditions are provided. Knowledge sharing is a kind of exchange behavior that is performed consciously between two or more individuals (Bock, Zmud, Kim & Lee, 2005). Knowledge sharing refers to receiving knowledge from the source or giving knowledge to the source. The foundation of knowledge sharing is knowledge creation: the production of knowledge by the receiver. In this sense, knowledge sharing is an important process for the acquisition of knowledge and supporting people’s learning processes, creating new ideas through socialization, and developing new opportunities. It can be defined as activities that help people work together, facilitate knowledge changes, enhance organizational learning capacities, and raise people’s skills in achieving individual and organizational aims (Dyer & Nobeoka, 2000). The knowledge sharing process facilitates the creation of the relevant sense between the source, who can effectively convey what s/he knows, and the receiver, and ensures the development of a solution.

Online learning has grown significantly over the past few years. Students’ participation and interaction have become important in online learning environments. According to Avci Yücel and Usluel (2016), improvements in students in terms of knowledge building and sharing processes may be seen in the students’ interaction and participation. The success of online learning environments depends on the knowledge sharing process (Ma & Yuen, 2011). Knowledge is internalized when knowledge is created and shared through online learning environments. Knowledge sharing is the main activity that encourages people and increases their motivation to contribute in online learning environments. Individuals can respond to a problem in online learning environments through sharing their knowledge. Nevertheless, knowledge sharing is a complex and time consuming process. Therefore, it is important to understand how to create and organize knowledge before sharing. It may be problematic because of the human related or technical related factors. Some participants experience difficulty in this process due to other individuals within the community. There are certain reasons leading people not to share knowledge: not knowing why knowledge sharing is necessary; what you need to do to share knowledge and how to share knowledge, also; believing that there are more important things than knowledge sharing (Shaari, Abdul Rahman & Rajab, 2014). Moreover, knowledge sharing frequency can be considered as the main problem encountered in online knowledge sharing process (Lin, Hung, & Chen, 2009). Hence, there are many factors playing an important role in an individual’s willingness to share knowledge, such as the requisite information and communication technologies, organizational and technical infrastructure, benefits, trust, extrinsic and intrinsic motivation, performance expectation, self-efficacy, and sense of community (Ardichvili, Page & Wentling, 2003; Sharratt & Usoro, 2003; Bock et al., 2005; Tamjidyamcholo, Bin Baba & Tamjdi, 2013; Tseng & Kuo, 2014). Therefore, it is necessary to study how people’s awareness of sharing
knowledge can be raised and identifying the source of this problem seems important for the development of the learning process.

When the literature is reviewed, it is seen that some studies have examined the relationship between knowledge sharing behaviors (KSB) and certain variables such as motivation, sense of community, attitude and self-efficacy perceptions (Chen, Chen & Kinshuk, 2009; Chen & Hung, 2010; Chen, 2011; Yang & Lai, 2011; Liao, To, & Hsu, 2013; Tseng & Kuo, 2014; Lai & Chen, 2014; Hau & Kang, 2016; Yılmaz, 2016). However, very few of these studies examined KSB in terms of the two categories of knowledge receiving behavior (KRB) and knowledge giving behavior (KGB) (Chen & Hung, 2010; Tseng & Kuo, 2014). Moreover, most of these studies were carried out within organizational settings, in company or management sectors or in communities of professional development. Kwak and Park’s (2016) studied employees and they found that knowledge self-efficacy (KSE), and social interaction ties positively influence knowledge-sharing activities in social media contexts. A further study by Wang and Hou (2015) related the influence of various types of motivations to employees’ KSB; it was seen that intrinsic/soft rewards (e.g., personal reputation) and extrinsic/hard rewards (e.g., reciprocity, financial rewards/benefits) are significant influencing factors in KSB. Hau and Kang (2016) studied users’ innovation-related knowledge sharing in online user communities. They found that users’ lead userness has a positive relationship with their innovation-related knowledge sharing in an online user community. Self-efficacy and controllability of online community systems affect perceived behavioral control, and thus affect innovation-related knowledge sharing. Henttonen, Kianto and Ritala (2016) study was based on a public organization, and found that knowledge-sharing propensity (attitude, benefits and self-efficacy) leads to knowledge-sharing behavior, and this behavior leads to improved individual job performance. The studies in the literature mostly used forums, blogs, wikis and social environments as the virtual communities for examining knowledge sharing and its features. Eid and Al-Jabri (2016) aimed to examine the impact of ways of using social networking sites (SNS) (such as chatting and online discussion, creating knowledge and information content, file sharing, and enjoyment and entertainment) on knowledge sharing and learning among tertiary students. The results showed that there are significant positive relationships between both chatting and online discussion and file sharing and knowledge sharing, as well as enjoyment and enjoyment, with student learning. Additionally, certain studies in the literature investigated the teachers’ behaviors (Chen, 2011; Tseng & Kuo, 2014).

Nowadays, the use of online learning environments has been spreading rapidly and the number of university students who use these environments is increasing. In this study, KSB is divided into two categories: KRB and KGB, and is applied to those undergraduate students who have experience in using online learning environments. As noted, KSB has been regarded as being only one category in previous studies conducted with undergraduate students who are participated in virtual learning environments (Yılmaz, 2016). It is, however, necessary to examine knowledge giving and knowledge receiving separately, as they are significantly different from each other. Thus, it will be possible to better explain KSB and get more insights into KSB.

The purpose of study was to investigate the KSE, motivation and sense of community variables influencing the prediction of KSB which affect the interaction, participation and learning in online learning environments. In this context, the research question for this study is: “To what extent is undergraduate students’ KSB predicted by their KSE, motivation and sense of community?”

Knowledge Sharing Behavior (KSB)

KSB is defined as a behavior displayed by group members in online learning environments for receiving and giving resources, knowledge, experience, or emotional support to/from other members (Bock & Kim, 2002; Ridings, Gefen & Arinze, 2002; Wasko & Faraj, 2000, 2005; Tseng, & Kuo, 2014). KSB emerges with the expectation of external rewards and reciprocal relations (Bock et al., 2005). Knowledge sharing is steady and smooth when group members believe that sharing yields a reciprocal benefit, or the maintenance of reciprocal relations contributes to their work. Group members are generally interested in knowledge sharing to acquire new information, access more useful sources, increase interpersonal communication, enhance both working performance and problem-solving skills, and support professional skills (Tseng & Kuo, 2014). Group members particularly expect to benefit from the sharing process (Watson & Hewett, 2006).

Knowledge sharing activities are divided into two categories (Ridings et al., 2002; Tseng & Kuo, 2014): knowledge receiving and knowledge giving. Knowledge receiving, in its simplest definition, refers to reading message threads and conversations in an online environment. In addition, knowledge is actively demanded by the sending of questions and suggestions. On the other hand, knowledge giving in an online environment involves initiating a new subject, sending a message, responding to another person’s message directly, or just
ssending comments. Therefore, knowledge giving mostly involves active participation and exposure. In this regard, this study deals with these two different but associated modes within the scope of KSB.

Knowledge Sharing Self-Efficacy (KSE)

People’s perceptions of their own skills regarding the ability to complete complex tasks are referred to as self-efficacy (Bandura, 1982). Self-efficacy is one of the key factors affecting people’s expectations in relation to the future flow and possible outcomes of a transaction. It is an individual’s belief in his/her own skills which affects the strategies adopted by him/her to achieve certain aims. It is a kind of self-evaluation of decisions regarding our behaviors, the extent of our efforts, and our determination in the face of obstacles (Hsu, Ju, Yen, & Chang, 2007). Self-efficacy belief therefore plays an important role in motivation and behaviors (Bandura, 1997). Researchers stated that KSE also influences individuals’ knowledge sharing decisions in virtual and online learning environments and organizations (Bock et al., 2005; Hsu et al., 2007; Kankanhalli, Tan & Wei, 2005). KSE refers to a person’s belief in his/her own skills to be able to share knowledge in either online or face-to-face environments. In addition, KSE is also known as a behavioral control variable that helps people overcome the problems they encounter regarding knowledge exchange in virtual environments (Hsu et al., 2007).

In addition to the willingness to share knowledge, we need to have positive perceptions regarding our skills in creating knowledge. The possibility of open exhibition of a specific behavior by a person with high self-efficacy is higher in comparison to the possibility of exhibition of such behavior by a person with lower self-efficacy. Basically, high-level KSE may improve interpersonal collaboration, reduce “free-riding (taking without giving)” behaviors, and increase the participants’ knowledge contribution. The literature indicates that self-efficacy regarding a particular field influences a person’s attitudes and behaviors regarding said field. Recently, studies have been conducted on whether people’s self-efficacy have an effect on knowledge sharing (Tamjidyamcholo, Bin Baba & Tamjid, 2013; Shaari et al., 2014; Van Acker, Vermeulen, Kreijns, Luigterink & Van Buuren, 2014). When people believe that they are either not connected to the subject, it is not important, or there is a lack of time, they might refrain from receiving or giving knowledge.

Motivation

Motivation can be defined as an internal force determining the direction of the motivating act and rousing the appropriate behavior (Mohd, Goh & Fathi, 2012). Researchers explain the role of motivation as directing behaviors, setting an aim, allowing the continuation of, as well as leading to a preference for a specific behavior, increasing the performance of learning, and the amount of work an individual completes (Mohd et al., 2012; Rehman & Haider, 2013). Motivation involves any behavior directed towards an aim (Morgan, 1984). Therefore, individuals believe that they will succeed by actively participating in the activities that require effort for learning. It is in this way that they acquire motivation. By this means, they spend their time and energy to achieve the aims whose criteria are specified by them (Ülgen, 1994).

In the previous studies, the importance of examining motivational factors was investigated in various contexts and it was recognized that they either facilitate or restrain KSB (Kankanhalli et al., 2005; Cruz, Perez, & Cantero, 2009; Chang & Chuang, 2011; Balau & Utz, 2016; Silic & Back, 2017). In this context, understanding people’s motivation in the knowledge sharing process is important. Thus, we can understand people’s personal knowledge sharing processes and why they are or are not willing to share (Endres, Endres, Chowdhury & Alam, 2007). Individual motivation attributes a critical importance to facilitate or prevent knowledge sharing, and it is possible to say that it can affect individual processes in acquiring knowledge (Sondergaard, Kerr & Clegg, 2007). Hence, the solutions to many problems require improving internal and external motivation (Yang, 2004). Internal motivation involves pleasure and satisfaction resulting from performing a behavior (Deci & Ryan, 1987), while external motivation emphasizes a behavior carried out to achieve certain aims/rewards (Vellerand, 1997). Internal and external motivation may affect not only personal intentions regarding an activity, but also the real behaviors.

The role of motivation has been recognized and emphasized in the knowledge sharing literature (e.g., Davenport & Prusak, 1998; Goodman & Darr, 1998; Hansen, Mors, & Lovas, 2005). In addition, it is stated in the literature that there is a reciprocal relationship between KSB and motivation (Majid & Yueng, 2007; Cheng & Ku, 2009).
Sense of community

A learning community is a group of people supporting each other in a learning environment (Wilson & Ryder, 1998). In addition, such a group has to be integrated in terms of knowledge acquisition, creation, and transmission in order to be a learning community (McCalla, 2000). The term learning community refers to an area in which people define the problems influencing them, produce and implement solutions, and learn via group activities. The literature suggests that sense of community has an important influence on online learning environments, perceiving the social environment, and the students’ learning performances (Kreijns, Kirschner, Jochems & Buuren, 2007; Abedin, Daneshgar & D’Ambrina, 2011). This indicates that sense of community may be associated with the variables related to learning. Therefore, it is believed that sense of community and KSB, which play important roles in the learning process, are associated with one another.

Sense of community is the degree to which a person feels the sense of belonging to a certain group (Yoo, Suh & Lee, 2002). It is the sense of belonging felt by the group members; the idea that group members are important for each other, and; the common shared belief needed by the members (McMillan & Chavis, 1986). It leads to the presentation of knowledge owned and maintained by the learning community through a common perspective for the benefit of community (Wasko & Faraj, 2000). Hence, the knowledge sharing process results in internal motivation rather than members being motivated by external factors. KSB helps community members to improve their sense of being part of the community. Certain studies indicate that sense of community may increase the possibility of community members participating in online environments and making contributions to these environments (Hars & Ou, 2002; Yoo et al., 2002). In this regard, a strong sense of community justifies its importance in the knowledge sharing process (Sharratt & Usoro, 2003).

Research objective

The knowledge sharing process is very important for the success of online learning environments (Ma & Yuen, 2011). Nevertheless, some participants experience difficulty in working through this process with other individuals within the community. Knowledge sharing is a complex and time-consuming process, because it is important to understand how to create and organize knowledge before sharing. Knowledge sharing may be problematic because of human-related or technical-related factors. Knowing the source of this problem seems important for the development of the learning process. In this sense, it is believed that it is important to investigate the variables that affect KSB from an explanatory point of view.

The main problem is in encouraging individuals to share knowledge: to increase their willingness and frequency to share knowledge in online learning environments where knowledge sharing is principle. Students’ behaviors in the process of sharing knowledge can only be encouraged and facilitated. For this reason, in this process there is a need for studies to determine the factors at a personal level that encourage or restrain the students’ KSB. While there is a lot of research on knowledge sharing in different areas, research specifically relating to this notion in an online learning community is quite limited.

Nonetheless, there has been an increasing interest in exploring the factors that facilitate or hinder individuals’ KSB in the virtual communities. Wang and Noe (2010) presented a framework of KSB, including environmental factors (organizational context, interpersonal and team characteristics, cultural characteristics), individual characteristics and motivational factors. According to this framework, new future research is needed on topics concerning individual characteristics and motivational factors.

The aim of this study is to investigate the KSE, motivation and sense of community variables influencing the prediction of KSB which affect the interaction, participation and learning in online learning environments. In this context, the research question for this study is: “To what extent undergraduate is students’ KSB (knowledge giving, knowledge receiving) predicted by their KSE, motivation (external effects, internal effects, growth of aim, self-conscious) and sense of community (concordance, independence, similarity)?”

Methodology

Correlational research design was used in this study; this shows the linear relationship between two or more variables (Creswell, 2008). According to Creswell (2008), it involves an assessment of the degree of relationship between two or more variables: a procedure in which subjects’ scores on two variables are simply measured, without manipulation of any variables, to determine whether there is a relationship.
Participants

Data were collected from the 313 undergraduates’ students in two different universities, at Ankara and Karabük, in Turkey. However, after the initial statistical analysis, 29 students’ data were removed and the analyzes were thus carried out with 284 participants. 73% \((N = 208)\) of the participants were female, whereas 27% \((N = 76)\) were male. The mean age of all participants was 20.5 years \((SD = 1.99)\). The participants’ other characteristics are displayed in Table 1. Participation was on a voluntary basis and no financial incentive was offered.

\[\text{Table 1. The participants’ characteristics} \]

<table>
<thead>
<tr>
<th>Demographic characteristic</th>
<th>(N)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>76</td>
<td>26.8</td>
</tr>
<tr>
<td>Female</td>
<td>208</td>
<td>73.2</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Younger (\leq 20)</td>
<td>160</td>
<td>49.7</td>
</tr>
<tr>
<td>Older (&gt; 20)</td>
<td>124</td>
<td>50.3</td>
</tr>
<tr>
<td>Education Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty of Education</td>
<td>220</td>
<td>77.5</td>
</tr>
<tr>
<td>Vocational School</td>
<td>64</td>
<td>22.5</td>
</tr>
</tbody>
</table>

Measurement instruments

Data were collected through online instruments. The instruments used in this study are given below.

Motivation

The instrument measuring motivation was developed by Semerci (2010). The original instrument comprised 35 items with 4 factors on a 5-point Likert scale. The reliability and validity of the scale was carried out by Semerci (2010) with 300 participants. For structural validity, explanatory factor analysis was performed and the factorizing method was principal components analysis, and the spinning method was Varimax. The results showed that the scale consisted of four sub-scales which were external effects, internal effects, growth of aim and self-consciousness. The total variance was 37.91%. For the reliability of the scale, item-total correlation and Cronbach’s alpha coefficient of internal consistency were carried out. Item-total correlations were found to range between 0.36 and 0.58 \((p < .001)\). Correlation coefficient between two half points was 0.895 \((p < .01)\). Cronbach’s alpha coefficient of scale was 0.896. The Cronbach’s alpha value for this study was .94. Certain scale items are given below as an example.

- I like to learn new knowledge while preparing my homework.
- I ask questions to learn new knowledge in my lessons.
- I like helping my friends about the course topics.

Sense of community

In order to measure sense of community, an instrument developed by Gökçearslan (2013) was used. The original instrument comprised 28 items with 3 factors on a 4-point Likert scale. The reliability and validity of the scale was carried out by Gökçearslan (2013) with 245 participants who had participated in online learning environments previously. Explanatory and confirmatory factor analysis was employed for the structural validity of the scale. The results of the exploratory factor analyses revealed that the scale consisted of three sub-scales: concordance, independence and similarity. The total variance was 42.65%. The confirmatory factor analysis indicated that the scale model was theoretically and statistically appropriate. Cronbach’s alpha coefficient of internal consistency was found to be 0.88 for all factors in this study, as with original instrument. Certain scale items are given below as an example.

- I hesitate to ask questions to the members of the online learning community.
- Participation in the online learning community increases my confidence about participating in course discussions.
**Knowledge Sharing Self-efficacy (KSE)**

KSE, as an instrument, was originally developed by Tseng and Kuo (2014). It is composed of 8 items on a percentage scale, ranging in 10-unit intervals from 0% (not at all confident) to 100% (totally confident). The researchers performed confirmatory factor analysis: the factor loading was between 0.8 and 0.88 as a single factor. Cronbach Alpha internal consistency coefficient was .93 for the whole scale (Tseng and Kuo, 2014). The scale was adapted into Turkish by Ergün and Avcı Yücel (2015). The reliability and validity of the scale was confirmed with 255 participants for adaptation. Exploratory factor analysis was employed, the factorizing method was principal components analysis and the spinning method was Varimax. The results of the analyses showed a single factor solution as original scale, and the factor loading was between .48 and .75 for each item of the scale. The total variance of the scale was 66.23%. Cronbach’s Alpha internal consistency coefficient was .93 for the whole scale for this study, as with original scale. The results showed that it was a valid and reliable measurement tool for this research. Certain scale items are given below as examples.

- I have confidence in sharing my teaching resources with other members.
- I have confidence in expressing my emotions with other members.

**Knowledge Sharing Behavior (KSB)**

The KSB scale was developed by Tseng and Kuo (2014). It was modified to measure the behavior in which members give and receive resources, knowledge, experience, or emotional support with other members in the online community of practice. Tseng and Kuo (2014) performed confirmatory factor analysis with two factors: KGB (the factor loading was between 0.83 and 0.92) and KRB (the factor loading was between 0.77 and 0.88). Cronbach Alpha internal consistency coefficient was respectively .95 and .91 (Tseng and Kuo, 2014). Turkish adaptation study was conducted by Avcı Yücel and Ergün (2015). It is composed of 9 items on a 7-point Likert scale, with a score of 1 indicating “strongly disagree” and 7 “strongly agree.” Both exploratory factor analysis and confirmatory factor analysis were conducted. Exploratory factor analysis was employed, the factorizing method was principal components analysis and the spinning method was Varimax. The scale consisted of two factors, as in the original scale. The total variance of the scale was 71.91%. The results of confirmatory factor analysis showed it to be a good fit. The scale of internal consistency coefficient was between .90 and .87, and item-total correlation co-efficiencies varied between .587 and .751. The Cronbach alpha for each subscale was .80 for knowledge receiving, .84 for knowledge giving and .90 for the whole scale. Cronbach Alpha internal consistency coefficient was .85 for the whole scale for this study. Some of the scale items are given below as examples.

- I obtain other members’ teaching experience, knowledge or skill in online environments.
- I read other members’ posted sharing in online environments
- I often respond to the topics discussed in online environments.
- I often contribute my teaching experience, knowledge or skill in online environments.

**Data analysis**

Prior to data analysis, multiple regression analysis assumptions were examined. The sample size \((N = 313)\) was found to be adequate for analysis. However, some missing data were found for each variable; twelve of them were therefore removed. Skewness-kurtosis coefficients were calculated for each observation. Data were removed from six observations because they were found to be greater than 1. Data from a further four observations were excluded after using z statistics and box graphics for univariate extreme value analysis. For multivariate outliers, Mahalonobis distance measure was used. Seven observations displaying multivariate outliers were also eliminated from the data set.

After examining the suitability of the data, analysis was performed with 284 data. On the issue of multicollinearity, the variables under study, starting with the correlation matrix for all variables, were checked. Multicollinearity becomes a serious problem when the coefficient is higher than 0.90 (Tabachnick & Fidell, 2001). In this study, the highest correlation coefficient was 0.477. The Variance Inflation Factor (VIF) values ranged from 1.23 to 2.26. Hair, Anderson, Tatham and William (1998) suggest that a VIF of less than 10 is indicative of inconsequential collinearity. These results show that there was no multicollinearity for this study and multiple regression analysis could be used.
To explore if a common method bias exists due to the method of data collection based on the self-report questionnaire, we performed Harman’s single-factor test (Podsakoff, MacKenzie, Lee & Podsakoff, 2003). The result showed that there were multiple factors, which eigenvalues were greater than 1, the total variance was 67%. The first factor explained by one factor is 23% of the total variance. Therefore, common method bias was not a problem for this study, because the single factor wasn’t the cause of most of the total variance. SPSS 16.0 software was used for the statistical analysis. Pearson product-moment correlation and stepwise regression were used.

Results

In this research, motivation, sense of community, knowledge sharing attitude, KSE and KSB data has been gathered from students. According to the responses obtained from students, descriptive statistics are presented in Table 2 below.

As shown in Table 2, students had a high level of motivation related to external effects ($M = 141.01, SS = 18.40$), while internal effects ($M = 34.65, SS = 5.98$), self-conscious ($M = 26.80, SS = 4.79$) and growth of aim ($M = 27.78, SS = 4.24$) were at medium levels. The results indicated that students’ perceptions of concordance ($M = 42.28, SS = 6.78$), independence ($M = 25.81, SS = 7.26$) and similarity ($M = 8.39, SS = 1.85$) values were close to each other’s. The level of students’ KRB ($M = 20.81, SS = 4.58$), is more than KGB ($M = 19.32, SS = 6.83$).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Number of items</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SS</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>External effects</td>
<td>12</td>
<td>284</td>
<td>75</td>
<td>175</td>
<td>141.01</td>
<td>18.40</td>
<td>-.989</td>
</tr>
<tr>
<td></td>
<td>Internal effects</td>
<td>9</td>
<td>284</td>
<td>12</td>
<td>45</td>
<td>34.65</td>
<td>5.98</td>
<td>-.532</td>
</tr>
<tr>
<td></td>
<td>Growth of aim</td>
<td>7</td>
<td>284</td>
<td>8</td>
<td>35</td>
<td>27.78</td>
<td>4.24</td>
<td>-.558</td>
</tr>
<tr>
<td></td>
<td>Self-conscious</td>
<td>7</td>
<td>284</td>
<td>12</td>
<td>35</td>
<td>26.80</td>
<td>4.79</td>
<td>-.397</td>
</tr>
<tr>
<td>Sense of community</td>
<td>Concordance</td>
<td>14</td>
<td>284</td>
<td>15</td>
<td>56</td>
<td>42.28</td>
<td>6.78</td>
<td>-.414</td>
</tr>
<tr>
<td></td>
<td>Independence</td>
<td>11</td>
<td>284</td>
<td>11</td>
<td>44</td>
<td>25.81</td>
<td>7.26</td>
<td>.298</td>
</tr>
<tr>
<td></td>
<td>Similarity</td>
<td>3</td>
<td>284</td>
<td>3</td>
<td>12</td>
<td>8.39</td>
<td>1.85</td>
<td>-.436</td>
</tr>
<tr>
<td>KSB</td>
<td>KGB</td>
<td>4</td>
<td>284</td>
<td>5</td>
<td>35</td>
<td>19.32</td>
<td>6.83</td>
<td>.091</td>
</tr>
<tr>
<td></td>
<td>KRB</td>
<td>5</td>
<td>284</td>
<td>8</td>
<td>28</td>
<td>20.81</td>
<td>4.58</td>
<td>-.185</td>
</tr>
<tr>
<td>KSE</td>
<td></td>
<td>8</td>
<td>284</td>
<td>8</td>
<td>80</td>
<td>48.48</td>
<td>16.96</td>
<td>-.164</td>
</tr>
</tbody>
</table>

The Pearson correlation coefficients were calculated to examine the relationships between students’ KSB and motivation, sense of community and KSE (Table 3). The results indicated that KRB showed the highest positive relationship between KSE ($r = .539, p < .05$). Similarly, there were positive correlations between KGB and other scales, showing the highest positive relationship with KSE ($r = .677, p < .05$). Stepwise multiple regression analysis was performed to identify to what extent students’ KSE, sense of community and motivation predict the students’ KSB.

<table>
<thead>
<tr>
<th>Table 3. Correlations between variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
</tr>
<tr>
<td>External effects</td>
</tr>
<tr>
<td>KRB</td>
</tr>
<tr>
<td>KGB</td>
</tr>
</tbody>
</table>

Predicting knowledge receiving behaviors

Stepwise multiple regression analysis was carried out to obtain those variables predicting the KRB of the students. The results of the stepwise regression analysis were displayed as four models (Table 4). In the first model, KSE explains 32.8% of the total variance in KRB. The contributions of external effects in Model 2 are 16%, independence in Model 3 is 1.5% and growth of aim in Model 4 is approximately 1%. Total variance of the four variables is 47%. KSE was the most effective independent variable in predicting the KRB. Regression coefficients of each variable within the KRB show that along with the increase in the levels of student KSE ($\beta$
=.402, p < .05), external effects (β =.320, p < .05) and growth of aim (β =.121, p < .05). Conversely, the higher independence (β = -.141, p < .05) gets, the lower the levels of KRB.

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>Adjusted R²</th>
<th>Standard error</th>
<th>β</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>.539</td>
<td>.290</td>
<td>.288</td>
<td>3.867</td>
<td>.539</td>
<td>10.745</td>
</tr>
<tr>
<td></td>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>.670</td>
<td>.449</td>
<td>.445</td>
<td>3.413</td>
<td>.425</td>
<td>9.224</td>
</tr>
<tr>
<td></td>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>External Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>(Constant)</td>
<td>.681</td>
<td>.464</td>
<td>.459</td>
<td>3.372</td>
<td>.419</td>
<td>9.210</td>
</tr>
<tr>
<td></td>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>External Effects</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Independence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.126</td>
<td>-2.817</td>
</tr>
<tr>
<td>4</td>
<td>(Constant)</td>
<td>.688</td>
<td>.473</td>
<td>.466</td>
<td>3.350</td>
<td>.402</td>
<td>8.740</td>
</tr>
<tr>
<td></td>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>External Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Independence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.141</td>
<td>-3.149</td>
</tr>
<tr>
<td></td>
<td>Growth of aim</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.121</td>
<td>2.163</td>
</tr>
</tbody>
</table>

Table 4. Summary of stepwise regression analysis predicting KRB (N = 284)

Predicting knowledge giving behaviors

Stepwise multiple regression analysis was carried out to obtain the variables predicting the KGB of students. The results are shown in Table 5 below.

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>Adjusted R²</th>
<th>Standard error</th>
<th>β</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Constant)</td>
<td>.677</td>
<td>.458</td>
<td>.456</td>
<td>5.040</td>
<td>.677</td>
<td>15.429</td>
</tr>
<tr>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (Constant)</td>
<td>.703</td>
<td>.495</td>
<td>.491</td>
<td>4.873</td>
<td>.617</td>
<td>13.887</td>
</tr>
<tr>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.201</td>
<td>4.536</td>
</tr>
<tr>
<td>3 (Constant)</td>
<td>.709</td>
<td>.502</td>
<td>.497</td>
<td>4.846</td>
<td>.625</td>
<td>14.095</td>
</tr>
<tr>
<td>K_selfefficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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Table 5 presents the results of the analysis, displayed in three models. Students’ KGB is mostly associated with KSE and this itself explains the variation of 45% in the first model. Internal effects in Model 2 are described as 4% and independence in Model 3 as 1%. Total variance of the three variables is 50%. KSE was the most effective independent variable that also predicted the KGB. Regression coefficients calculated regarding KGB indicate an increase in students’ KSE (β =.625, p < .05), internal effects (β =.201, p < .05) and independence (β =.087, p < .05) that correspond to an increase in the KGB.

Discussion and conclusions

This study investigated to what extent students’ self-efficacy, motivation, and sense of community predict their KSB. Knowledge sharing takes time and effort, and is a challenging task requiring learners to be willing to interact with one another (Ghadirian, MohdAyub, Silong, Abu Bakar & HosseinZadeh, 2014; Van Acker et al., 2014). In this study, knowledge sharing is consisted of two factors: knowledge receiving and knowledge giving. It has been seen that both knowledge receiving and knowledge giving have the strongest relationship with KSE. The best predictor of both factors is KSE. This result is consistent with the results of the previous studies in the literature. Bock and Kim (2002) stated that self-efficacy is an important factor affecting internal motivation, which is necessary for the sharing of knowledge. Hsu et al. (2007) examined the relationships between KSB and variables such as self-efficacy, trust, and outcome expectations. Furthermore, Yılmaz (2016) stated that students’ self-efficacy perceptions of their technical skills affect KSB positively. They found that self-efficacy has both direct and indirect effects on KSB. According to the researchers, this shows that self-efficacy plays an important role in directing people’s behaviors. Self-efficacy also plays an important role in one’s fulfilling a behavior
consciously (Bandura, 1982); in addition, it has an important place in the knowledge sharing process. Undergraduate students with high self-efficacy have greater trust in themselves regarding their skills and abilities, which leads to a high level of motivation. Such students maintain their actions and activities of knowledge sharing with more enthusiasm and use their own cognitive resources to carry out their tasks successfully (Bandura, 1997). They also make use of other people’s cognitive resources for learning. Therefore, it is possible to say that undergraduate students with high levels of KSE tend to be active in both KRB and KGB in online environments.

The study results indicate that self-efficacy alone cannot predict KSB. KSE, along with the factors of internal effects and independence, predicts 50% of KGB. Accordingly, as KSE, internal effects, and independence increase, KGB rises as well. It has been found that KSE, external effects, independence, and growth of aim predict 47% of KRB. Accordingly, as undergraduate students’ KSE, external effects, independence, and growth aim increase, their KRB rises as well.

Knowledge sharing is important because it can increase learning capacity through knowledge exchange in a community, which in turn creates awareness (Dyer & Nobeoka, 2000). Therefore, it is important in supporting the development of the learning process. Learning refers to gains obtained through the interaction and participation established between learners. These interactions can take place via participation in online learning environments (i.e., receiving and giving knowledge). One of the main problems in online learning is encouraging learners to share their knowledge. One of the factors directing people to make a move for a certain purpose is motivation. Motivation refers to those methods that attribute efforts, direction, or purpose to the requisite behaviors, and plays an important role in the knowledge sharing process (Hansen et al., 2005; Ma & Yuan, 2010; Apandi, Omar, & Abdullah, 2015). While the role and the importance of motivation is emphasized in the knowledge sharing literature, there are nonetheless other studies with results indicating that there is no relationship between external motivation and knowledge sharing (Kwok & Gao, 2005; Lin, 2007). The results of the current study are indicative of the fact that motivation is crucial in the knowledge sharing process. External effects and growth of aim, which are key motivation factors, were seen to have an effect on knowledge receiving, while only internal effects were seen to have an effect on knowledge giving. Growth of aim, which is a clear effect on knowledge receiving, is associated with the development of a vision. Propositions such as wanting to get high scores, wanting to be one of the first placed students, and studying specifically to get high scores from the exams are predictors of growth of aim. For instance, such people aim to get high scores by receiving knowledge from their environment. Thus, they need the knowledge and experiences in the environment, which leads them to have tendency to receive knowledge. External effects refer to behaviors exhibited to achieve certain aims. Therefore, it is possible to say that students read message threads in online environments so as to achieve certain aims and demand knowledge by either asking questions or making suggestions; these actions motivate them. People with high external effects care about what other people say. Hence, they may be in need of the knowledge or support provided by other people. In the knowledge giving process, students need to be motivated by internal effects (i.e., the idea that their behaviors will be useful). Apandi et al. (2015) state that people who are internally motivated participate in the knowledge sharing process more and avoid free-riding behaviors. Contributing to ongoing message threads in online environments, sending messages to initiate a new subject, or responding to incoming messages can be considered to be a part of the internal effects process. In this sense, it is of note that external effects tend to influence knowledge receiving while internal effects affect knowledge giving.

The independence factor predicts both knowledge receiving and giving. This is a factor involving situations in which individuals feel uncomfortable in online learning environments, do not trust other members, and they believe that the environment will not contribute to their improvement in any way. The independence factor negatively affects knowledge receiving, yet positively affects knowledge giving. As the students’ independence factor increases, so does knowledge receiving. As a matter of fact, it is stated in the literature that failure to meet the expectation of trust in the knowledge sharing process (i.e., receiving and giving knowledge) negatively affects knowledge sharing (Mayer & Davis, 1999). Thus, it is possible to say that when students do not trust the cognitive sources of other people in online learning environments and believe that the knowledge they will receive will not improve them, they tend not to receive knowledge in the environment. This is quite contrary to knowledge giving. As the KGB increases, the independence factor increases as well. However, this effect is less than 1%. Students with a high independence factor tend to give knowledge in knowledge sharing environments, even if they do not trust others. This may indicate that students with high self-efficacy regarding the usefulness of their knowledge tend to share their knowledge, which they believe to be correct, in the environment. It is also possible, however, that such students give knowledge to increase their prestige or reputation in the environment, even when they do not trust such environments. As a matter of fact, there are studies in the literature asserting that reputation does indeed affect knowledge sharing (Wang & Noe, 2010; Chang & Chuang, 2011). Wang and
Noe (2010) state that perceived benefits (i.e., taking actions with the expectations of respect, prestige, and tangible incentives) is one of the most studied antecedents of knowledge sharing. One of the basic factors enhancing KSB in learning environments is reputation, which is the basic perceived usefulness. Establishing a reputation and enhancing status are therefore important factors stimulating participants to provide content by responding more frequently and more intelligently (Chang & Chuang, 2011).

This study concludes that KRB and KGB display different characteristics from one another. Knowledge giving mostly involves active participation and exposure, because it requires students’ own knowledge sharing with others in online environments. However, it is also necessary to receive knowledge in order to give knowledge. Therefore, this knowledge exchange is the key trigger in the sharing process. Especially, interaction and participation between the students in different environments is important for the realization of learning. For this reason, students are expected to be either actively or passively involved in the interaction and participation process. Particularly in the formation of meta-cognitive knowledge, it is important for students to participate in the process of knowledge building and sharing. “In the knowledge building process, students are expected to reflect their meta-cognitive opinions. Such reflection is difficult and requires synthesis, but improves the knowledge building process by providing more creative and learning supportive content” (Avcı Yücel & Usluel, 2016, p. 45). Thus, participation and interaction in online environments can serve to reduce feelings of disconnection and isolation (Duncan-Howell, 2010), support new knowledge building and creation (Avcı Yücel & Usluel, 2016; Wang, Yang, & Chou, 2008) and thus facilitate the knowledge sharing process.

Online learning environments have faced a number of challenges, such as technical difficulties (Jaggars, 2014), lack of understanding as to how to effectively share knowledge, lack of social networking skills, inability to use modern technology, communication barrier skills, lack of time, lack of incentives or rewards for knowledge sharing, the appropriate organization of knowledge before sharing, and the adequate frequency of knowledge sharing (Lin et al., 2009; Shari et al., 2014; Awodoyin, Osisanwo, Adetoro & Adeyemo, 2016). Among the most difficult challenges faced by online environments is fostering and sustaining knowledge sharing (Hsu et al., 2007; Lin et al., 2009). Nonetheless, the exchange of knowledge is gaining importance, especially in ensuring sustainability in online environments. Therefore, the results of this study should grow in importance in terms of showing the factors affecting the knowledge sharing process.

The results of this study indicate that KSE, motivation, and sense of community have significant influence on knowledge sharing. Numerous studies indicate that dispositional variables such as motivation and self-efficacy may have either direct or indirect effect on people’s KSB (Hew & Hara, 2007; Chen, 2011; Liao, To & Hsu, 2013). Considering these variables, it is necessary to keep learner participation interaction with one another for KSB that require time and effort as voluntary. If learners believe that they can improve their relationships with other members, they are expected to display a more positive attitude towards knowledge sharing (Bock & Kim, 2002). Well-organized learning activities have a great effect on learners’ interactions with one another. Teachers’ creation of various discussion environments, as well as sharing and providing support when needed, may improve learners’ motivation levels and help them feel a part of the community. Hence, it becomes possible to contribute to the knowledge sharing process.

Based on the results of this study, the following recommendations are put forward for future studies:

- Demographic data related to the participants were neglected in this study. A new study might be conducted using the variables associated with KSB as the control variables.
- Apart from the effects of the variables focused on in this study, the effect of perceived benefit and, thus, respect and reputation on KSB, should be investigated.
- There are studies indicating that knowledge sharing affects learning performance positively. For example, Eid and Al-Jabri (2016) stress the importance of knowledge sharing for increasing learning performance. They also point to the importance of social networking tools for knowledge sharing. Thus, new studies may focus on such tools or activities influencing individuals’ motivations, trusts, self-efficacy levels, and sense of community levels and perceived benefits in these environments, which may increase their KSB. Also, future studies may dwell on students’ characteristics, perceptions, purposes, and resources (support), as well as environmental factors that can have an effect their KSB. In this way, the effect of KSB on learning performance may be further explored.

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Innovative Use of Mobile Video Conferencing in Face-to-Face Collaborative Science Learning: The Case of Reflection in Optics

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ABSTRACT

Multimedia learning environments facilitate the construction of certain forms of representations and allow users to combine forms of representation that address different modalities. A promising approach entails having students construct representations of the domain. The process of constructing a representation elicits self-explanation effects and consists of dynamic iterations and interactions between the constructed representations and mental representations, and therefore helps students to refine and disambiguate their domain knowledge. Because mobile multimedia learning environments have enabled numerous new forms of presenting and communicating information, this study restores interest in the method of adopting mobile video conferencing in learning, and proposes its use in face-to-face collaborative learning of the first law of reflection in optics with the aim of harnessing the synergy of both communication modes. A total of 34 junior high school students participated in the study. The results showed that the participants acquired a new aspect of learning regarding the law of reflection, and their metacognitive awareness increased as a result of using the mobile video, which regulated their explorative learning process. This study provided an unprecedented and meaningful learning experience to students and stimulated teachers to explore the full potential of technologies around them in education.

Keywords

Computer-mediated communication, Cooperative/Collaborative learning, Optics, Mobile video conferencing

Introduction

The adoption of technology in education sometimes seems constrained by the original design. Because mobile devices with advanced computing and networking capacities are now prevalent, it is crucial to examine the numerous new learning opportunities, consisting of the flexibility in increasing knowledge, the new forms of collaboration and work, and the increasing variety and accessibility of learning occasions and resources (Ghislandi et al., 2013). Boyle and Ravenscroft (2012) mentioned that many studies have focused on familiar methods of structuring, which are superimposed on new technology, rather than on a fresh examination of a learning situation followed by a creative configuration to exploit new opportunities. In other words, there should be a renewal of interest in seeking new learning opportunities provided by technology.

Video conferencing is a type of distance learning, which provides live images as instructional content for students in various fixed remote locations. With the incorporation of mobile devices, mobile video conferencing should provide a new method of learning and an unprecedented learning experience. Instead of being used for remote learners, mobile video conferencing may be implemented in face-to-face collaborative learning. This idea is inspired by the use of desktop computers for computer-mediated communication (CMC) while students are in the same classroom (Chen, Looi, Chee-Kit, & Tan, 2010; Chen & Looi, 2007). Huang et al. (2012) argued that using handheld devices in face-to-face group collaboration might develop unique communication patterns and increase meaningful communication among group members. For instance, the combination of handheld devices and a shared display promoted student engagement, generated deep discussion, and provided a social workspace for students to participate in lively interactions (Lai & White, 2012).

Students can use mobile phones to simulate and present what they see, such as images and videos displayed on the mobile phone screens. The images and videos are the results of a formation of optic phenomena and benefit from the optic principles and theories that students explore. In other words, the images and videos displayed are representations students constructed to present their understanding of optics. Cox (1999) argued that the process of constructing a representation elicits self-explanation effects and consists of dynamic iterations and interactions between the constructed representations and mental representations, and therefore helps students to refine and disambiguate their domain knowledge. Moreover, self-constructed external representations can help translate information from one type of representation to another, thus supporting an increased understanding of the underlying concepts and situations (Stern et al., 2003). Constructing representations, regardless of the format, is
associated with significantly high levels of situational knowledge, a prerequisite for going beyond the superficial details of phenomena.

Moreover, mobile video conferencing tools help provide rich context cues, which can facilitate students to connect abstract scientific concepts to real world phenomena. Contextual cues are the objects around target objects, the spatial layout of target objects, or the trajectories of target objects (Li, Chen, & Yang, 2013). Chun and Lian (1998) defined contextual cueing as how the human brain gathers information from visual elements and its surroundings. The contextual cues, in the learning of optics, are asserted to help students in their reflective and active examination of the science phenomenon, and to regulate the explorative cognitive process of learning.

This study asserts that mobile devices can play a different role in helping students explore and represent optic phenomena. The current study thus proposes that because a renewed video conference integrates live videos and physical artifacts, it can provide the experience of contextualized exploration, in which students can observe and manipulate the formation of a science phenomenon by using their senses of sight, realize the approximate formation of the phenomenon as a whole, and explore how related factors affect the formation of such a phenomenon. Mobile video conferencing in an authentic context is expected to seamlessly integrate live videos and physical artifacts to expose students to learning occasions in a tangible and virtual environment, where students can take advantage of these new contexts for a comprehensive learning experience.

Subject content and pedagogical challenges

The science learning topic chosen for the current study is the subject of optics at the junior high school level. The content includes light traveling and light reflection, which are included in the chapter of optics. Light constitutes a challenging area of learning, because its production and propagation are imperceptible. A major difficulty for many students is to conceive light as existing and propagating in space, between sources and effects (Andersson & Bach, 2005). Light propagating between sources and effects cannot be seen. Its physical parameters (such as speed and image formation) are beyond human perception, and yet are generally represented in science as stationary and continuous (Galili & Hazon, 2000). Thus, if students are to develop an understanding of optical phenomena, they must synthesize knowledge concerning light propagation, the illumination pattern, and the observer’s visual pattern (Langley, Ronen, & Elyon, 1997). An explanation of reflection formation requires a synthesis of knowledge, which includes the following:

- Light as an entity produced by a light source, propagating in space
- When light is incident with a flat surface, reflection is formed as the angle at which the light is incident on the surface equals the angle at which it is reflected
- The role of the eye as a receptor

The key idea of optics is seeing explained by light entering the eye from the object seen, but students are not aware of the essential role of their vision in the optic system for the reception of light (Andersson & Bach, 2005), and cannot associate sight with light incident in their own eyes. The process is so self-evident that students may not conceptualize it. Langley et al. (1997) suggested that it is necessary to devise optical experiences that combine a sharp sensation of incident light with a clear perception of a visual pattern.

Optics is essentially an interdisciplinary subject. Physics (the nature of light), physiology (the functioning of the eye), and psychology (the interpretation of visual perception) are all required for comprehensive discussions of optical phenomena (Galili & Hazon, 2000). For teachers trying to improve teaching in optics, the challenges are in how students can conceive light concretely and how instruction can motivate students to think actively and with interest about light and its properties (Andersson & Bach, 2005).

Proposed use of mobile video conferencing

Because the challenges of learning optics are in how students can conceive light concretely and how they can think actively through the interpretation and expression of the optical phenomena they observe (Andersson & Bach, 2005), the proposed use of video conferencing should promote students’ interpretive and expressive processes of learning.

The formation of an optical virtual image depends on the spatial relationship among the location of the person, the mirror, and the viewer. Such a spatial relationship serves as additional contextual cues to help students understand how light travels in space and provide memory clues for later recall. In addition, because of the
portability of mobile video conferencing tools, students can change their position at any moment and simultaneously verify how the virtual image varies accordingly. In the proposed learning design, the immediate and relevant variation of virtual images in the live videos under students’ unobstructive control may form a mechanism scaffolding their collaborative exploration.

Through direct contact with the mirror, students can use the mobile video conferencing tool to deliver the captured video of their partner’s virtual image to each other. According to the constructivist approach, direct contact with objects and consequent manipulation encourage learners to think, formulate hypotheses, and test their hypotheses (Bertacchini et al., 2012). That represents what is received by the eyes of the viewer. The image can remind students that the eyes act as receptors in recognizing virtual images. Andersson and Bach (2005) suggested that, for improved learning in optics from the beginning, students should have opportunities to use the key idea of optics as a tool to explain real-world phenomena.

The camera in a mobile device can simulate the human eye as the receptor of reflected light from the object that the human observes. The received image can be displayed on the mobile phone screen, reminding students that how and what they see are the same for mobile phones. Thus, students can step out as an observer to obtain a holistic view of light propagating between sources and effects, and mobile phones can be readily used as a visualization tool to present the visuals that students observe. The video conferencing tool thus can play a role in assisting students to further their understanding of optic light reflection because it can simulate the eyes in catching light diverging from an object, incident with the mirror, and impinging on the camera. Thus, modern mobile devices can provide images and videos for an interpretive purpose, enabling students to clarify difficult concepts. In the interpretive use, the user is primarily a viewer attempting to extract meaning from visualizations. Through the expressive and interpretive use of a mobile device, students are expected to reflect on their learning and use the device to regulate their explorative learning process.

In addition, using mobile devices, students are empowered with the flexibility and mobility to share and express captured images and videos with peers. Students can collaboratively examine the optical phenomena in the field and the videos on the mobile phone screens and express their understanding and beliefs. In the expressive use, the student is an author attempting to convey meaning through the construction of visualizations (Gordin & Pea, 1995). This articulation of knowledge and beliefs can help to reveal gaps or conflicts in the student’s understanding and can provide the basis for a discussion of the beliefs. Once students have articulated their beliefs, they may have increased motivation to engage in interpretive activities.

In the proposed learning, students are required to collaboratively capture and share images to explore the optics principles. The images captured and shared in mobile devices should enable students to easily refer to the visualizations, thereby supporting them in coordinating their collaboration process by conducting communicative activities such as maintaining a common focus and coherence and consistency in their shared understanding, and reaching an agreement about relevant concepts, principles, and procedures through arguments and explanations (Sløf et al., 2013). Moreover, because students can consciously focus and elaborate on the emit-and-receptor mechanism and manipulate the images to create and express meaningful information, the use of technology for learning necessarily requires learners to exercise a certain level of regulation in their course of actions and to foster some form of regulation of cognition (Lee, 2013).

**Activity design**

Knowledge of two basic optics processes is intended to be delivered in the learning activities: the formation of vision and the law of reflection. The proposed learning design uses mobile phones and video conferencing tools to help students see virtual images in circumstances in which they usually cannot see them. Their partners can capture and deliver the virtual images to them by using mobile video conferencing tools. During the learning activities, students can dynamically vary their locations to observe how their virtual image varies according to the law of reflection. Students are expected to consolidate these two basic concepts in a self-created dynamic learning context that supports the exploration, experience, discussion, and validation of their reasoning and assumptions.

The learning activities include eight tasks varying from a basic one that helps students recall and verify their prior knowledge about the basic principles of optics to an advanced one that requires students to elaborate and apply what they learned to solve a challenging question. The task results help students answer the test questions. In the beginning, each team of three students is asked to stand in front of a mirror and view their images in the
mirror. Students are told to use a mobile phone camera as eyes to capture their images in the mirror and to think about the formation of a virtual image. The next task involves students finding a circumstance in which they cannot see their own image but their partner can see it. The task helps students learn the existence of their virtual images even though they cannot see them (Figure 1).

![Figure 1. Formation of a virtual image](image)

This phase of learning requires students to consolidate the experience of the virtual image in the previous phase with the law of reflection and provides them with the opportunity to manipulate the corresponding optical phenomena. Instruction is provided on the use of mobile phones and video conferencing tools (Figure 2 and Figure 3). As shown in Figure 2, while Student A stands in front of the mirror, Student B is asked to use the video conferencing tool to send Student A the live video of his or her virtual image viewed from Student B’s position, and vice versa. This is achieved using the camera in the back panel when the students hold the mobile phones and face the screen. In other words, instead of capturing the image of their physical presence as a traditional video conferencing tool does, students are suggested to use the mobile video conferencing tool to capture the virtual image of their partners.

![Figure 2. Proposed use of the mobile video conferencing tool](image)

Meanwhile, students are instructed to apply and draw the law of reflection on the field by using a ruler, protractor, and laser-marking device (Figure 4).

![Figure 3. Students use mobile devices to help each other view their own virtual images](image)

![Figure 4. Students use mobile devices to help each other view their own virtual images](image)
After familiarizing themselves with the reflection point in the mirror, students are asked to freely mobilize themselves in front of the mirror and examine how the reflection image changes correspondingly. In addition to relying on oral communication to describe and clarify the phenomenon, students can use the video conferencing tool to provide visual support. By doing this, students can be aware that the formation of the virtual image depends on the viewer’s position.

The final challenging task requires students to locate the path (2W in Figure 5) in which the partner must stand to see him or her along the tapped line on the ground (the dotted line in Figure 5). Students may have one member move one step each time while his or her partner stands still for the possibility of scrutinizing the observed phenomenon. At each step, students use mobile video tools to capture and deliver the virtual image to the partner. The partner receiving the virtual image may refer to the change in the virtual image and discuss it with the team member.

All the tasks last approximately 30 minutes. After finishing the tasks, students complete a survey, an interview, and a posttest.

**Evaluation**

The participants consisted of 34 junior high school students who had finished their learning of optics in a traditional lecture with a paper-and-pen format in a classroom prior to the evaluation. The proposed learning was conducted 8 months later because of the course schedule limitation.

The core question concerned the students’ use of mobile phone video conferencing features to complete a science learning practice. The entire learning design is different from traditional classroom teaching; hence, there is little value to assess students’ learning performance gains compared to the traditional learning (Sharples, 2009), but rather to explore and document the development of their science learning through the use of the mobile video conferencing tool. In addition to the questions about the participants’ prior experience in the teaching and learning of optics (Table 1), the evaluation surveyed whether the proposed learning provides students with a new aspect of learning in optics as well as whether it helps them regulate their cognitive process of learning to enable consciously focusing and elaborating on the emit-and-receptor mechanism and manipulating the images to create and express information meaningfully.

The performance test, survey questionnaire, observations, and interview are used as the main source of data not only for triangulation but also for enabling a close examination of how student learning is socially and technologically shaped in the proposed learning and identify any reflections and implications induced. Although
some researchers would disagree with single case studies involving few participants, the intention of case study research is not to offer evidence that can be generalized but to provide an understanding of the emerging phenomenon (Gromik, 2012).

**Pre- and post-knowledge tests**

The pre- and posttests use the same test items to assess optics knowledge possessed by students before and after the experiment. The purpose of using the same test items is to examine whether students learn in the proposed novel learning. The test has seven questions, which were evaluated by two junior high school teachers, confirming their appropriateness for the knowledge level of the participants.

**Perception of the proposed learning practice**

The development of the questionnaire followed Hung et al. (2014) and Chu et al. (2010), who addressed students’ responses to the use of advanced computer and mobile devices in learning science and geography. The survey consists of six questions and examines students’ responses about whether the proposed use of mobile video conferencing tools provides them with an increased understanding and/or encourages them to use new methods or thinking styles in learning (Table 3).

**Modified metacognitive awareness inventory**

The assessment of students’ self-understanding or awareness of their metacognitive processes is referred to as the Metacognitive Awareness Inventory (MAI) (Kleitman & Stankov, 2007; Schraw & Dennison, 1994). The MAI consists of eight components of 52 items and measures knowledge about cognition and the regulation of cognition. Because the current study focuses on the regulation of cognition, five components were selected. Their operational definitions are as follows: planning refers to goal setting and allocating resources prior to learning, information management skills refers to skills and strategy sequences used to process information efficiently, monitoring refers to the assessment of one’s learning or strategy used, debugging refers to the use of strategies to correct comprehension and performance errors, and evaluation refers to the analysis of performance and strategy effectiveness after a learning episode (Schrawand & Dennison, 1994).

Because this study was intended for understanding the interactional relationship between participants’ regulation of cognition and their use of video conferencing tools in collaborative learning, three out of five components of the MAI were adopted and modified. The selected components are as follows: information management strategies (four items), monitoring (four items), and debugging strategies (three items) (Table 4). Each item was first verified for relevance to the study. In addition, most items were reworded to ensure that the participants could understand. Finally, the items in the postactivity survey were added context to assist with participants’ responses to the proposed learning. Instead of using a continuous 100-mm bipolar scale, this study used a 5-point Likert scale (1 = never, 2 = seldom, 3 = sometimes, 4 = often, 5 = always), as suggested by Sperling et al. (2002).

**Semi-structured interviews**

The interview is used to understand how the video conferencing tool performs in terms of usability and how it mediates students’ collaborative exploration by maintaining a common focus and shared understanding through arguments and explanations. Participants were asked about the following:

- Technical aspect: How do the mobile video tools work to provide an integrative presentation of videos and mirrored images manageably and unobtrusively? Do the images in the mobile video conferencing tools support their exploration (in terms of quality, delay, and ease of manipulation)?

- Individual learning support: Do the mobile video tools support students’ reasoning of the principles of light reflection and how?

- Collaborative group learning support: Do the mobile video tools support students’ collaboration with peers for their explorative learning? How do they feel about their teamwork?
Field observation

Two video camcorders are placed on either side of the field while students’ perform the task to record how students work and use the video conferencing tools individually and collaboratively by using verbal conversation and physical gestures. The focus of observation is also on the role of different communication modes to investigate how face-to-face learning and mobile video conferencing are combined to support collaborative learning. The researcher observed the participants’ performance and watched the video clips to transcribe the actions and interactions within the group. Another researcher verified the accuracy of the transcription by comparing the video with the transcripts.

Results

The students recalled their experience in the teaching and learning of optics in a lecture format, and the survey results are listed in Table 1, showing that most of the students acknowledged receiving training in optics. However, the students’ self-evaluated understanding of this topic and knowledge of its application in daily life decreased.

| Table 1. Participants’ prior learning experience in optics (N = 34) |
|--------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean (SD) | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| I have had learned the optic topic of light reflection. | 3.82 (0.83) | (2.9%) | (0%) | (26.4%) | (52.9%) | (17.6%) |
| I understand the theory of light reflection. | 3.21 (0.95) | (2.9%) | (14.7%) | (52.9%) | (17.6%) | (11.7%) |
| I know the application of light reflection in daily life. | 3.59 (0.92) | (2.9%) | (5.8%) | (35.2%) | (41.1%) | (14.7%) |

In the interview, all the students replied that they could not give examples related to the reflection law of optics. However, when they were reminded of the traffic convex mirror, they recalled such experience in their daily life and such examples in their textbook. This revealed the problem of science learning in a lecture format: students cannot proactively relate what they learn in the classroom to their experience in daily life.

Regarding the use of mobile devices, all the students reported that they own mobile devices and have the experience of using them to take photos. Regarding video conferencing, some of the students mentioned that they had such experience but only in using a desktop computer. None of the students had used a mobile device for video conferencing. Those who had experience in desktop video conferencing expressed that they could think of shooting only themselves rather than others when they attended the video conference. This revealed that the use of a tool in general is constrained by the affordance induced in its preassigned use.

Regarding the proposed innovative use of mobile video conferencing tools, most of the students reported that they appreciated the novelty of the method of using mobile devices in the activity and that they had no technical trouble in the assigned tasks. This finding was common in recent studies on mobile learning. The reasons may be the advance of mobile technology, improvement of human–computer interaction, and improved understanding of how such technology should be designed and used in education.

Knowledge tests

Because the test score was given by two independent raters, an intraclass correlation (ICC) coefficient was estimated for the inter-rater reliability of each item between the two raters. The ICC coefficients were between .871 and .908, indicating a good to excellent level of inter-rater reliability for the knowledge test.

For the knowledge test, the results of the paired-samples t tests are presented in Table 2. The results indicate that the knowledge of optics increased from an average of 52.85 to 61.91 (t(33) = 6.262, p < .001), yielding a medium effect size of 0.72 according to Cohen’s guidelines (Cohen, 1988). As a whole, the students improved by approximately 9.06 points. The use of mobile video conferencing tools showed beneficial effects on optics knowledge.
Table 2. Results of the paired-samples t test for the knowledge test (N = 34)

<table>
<thead>
<tr>
<th></th>
<th>Pre-test Mean (SD)</th>
<th>Post-test Mean (SD)</th>
<th>Post-Pre Difference Mean (SD)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score (Items 1-7, Max = 70)</td>
<td>52.85 (12.99)</td>
<td>61.91 (8.20)</td>
<td>9.06 (8.43)</td>
<td>t = 6.262***</td>
</tr>
</tbody>
</table>

Note. ***p < .001.

Perception of the proposed learning practice

The survey results in Table 3 show that the students had positive responses to the use of mobile video conferencing tools in the proposed learning and cultivating new aspects of thinking. On the 5-point Likert scale, the five items’ average scores were all above 4.2. The students agreed that the proposed learning provided them with new findings or knowledge, enabled them to try new thinking styles, and an improved understanding of the theory of light reflection.

Table 3. Participants’ new aspect of learning in the proposed learning of optics (N = 34)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of mobile video conference tools in this learning activity makes me better understand the theory of light reflection.</td>
<td>4.50 (0.71)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>4 (11.7%)</td>
<td>9 (26.4%)</td>
<td>21 (61.7%)</td>
</tr>
<tr>
<td>I had new findings or knowledge about the law of reflection owing to the use of this mobile video conference tools to learn in the authentic environment</td>
<td>4.41 (0.56)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (2.9%)</td>
<td>18 (52.9%)</td>
<td>15 (44.1%)</td>
</tr>
<tr>
<td>I have tried new ways or thinking styles to learn owing to the use of this mobile video conference tools.</td>
<td>4.41 (0.66)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>3 (8.8%)</td>
<td>14 (41.1%)</td>
<td>17 (50.7%)</td>
</tr>
<tr>
<td>The proposed use of mobile video conference tools is helpful to me in learning how to identify the features of the light reflection in optics.</td>
<td>4.41 (0.82)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>7 (20.5%)</td>
<td>6 (17.6%)</td>
<td>21 (61.7%)</td>
</tr>
<tr>
<td>When using this mobile video conference tools, I was engaged to understand and prove the law of reflection in optics.</td>
<td>4.21 (0.81)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>8 (23.5%)</td>
<td>11 (32.3%)</td>
<td>15 (44.1%)</td>
</tr>
</tbody>
</table>

In the interview, when asked whether the proposed learning enabled them to understand optics from a different perspective, most of the students replied that it did. The students acknowledged that this learning activity caused them to think about the theory of light reflection when they observed the optical phenomenon. One group of students expressed that they were immersed in the phenomena of light reflection, and that such learning context was authentic; hence, they could play a role in the phenomena and change the phenomena, which caused them to reflect. The students acknowledged that they would ask each other about the theories of optics because they had to understand them to perform the learning task. According to these results, the students seemed to actively acquire knowledge, rather than by accepting the knowledge passively.

Participants’ metacognitive awareness of learning

The proposed use of mobile video conferencing tools aims to support students to interpret and express their understanding of optical phenomena and to reflect on their learning. In addition, students can use videos to regulate their individual learning and collaboratively explore the subject content with their teammates. The quantitative evidence of students’ awareness of their metacognition based on their responses of general learning prior to the study and the proposed learning. Regarding the reliability of the survey results, the Cronbach alpha was calculated for this sample and was .74 for the subscale of information management strategies (four items), .67 for the subscale of monitoring (four items), and .61 for the subscale of debugging strategies (three items). The modified test as a whole had a Cronbach alpha of .88, indicating a satisfactory level of reliability. Paired-samples t tests or Wilcoxon signed rank tests were performed to determine whether students’ level of metacognitive awareness was changed. The Shapiro–Wilk test (Field, 2000; Shapiro & Wilk, 1965) was conducted to validate the normality of the different scores between pre- and posttests to determine the
application of paired-samples \( t \) tests or Wilcoxon signed rank tests. Paired-samples \( t \) tests were used to assess the pre- and posttest score change when the assumption of normality was satisfied, whereas Wilcoxon signed rank tests were used when normality could not be assumed.

Table 4 presents the results of the paired-samples \( t \) tests and Wilcoxon signed rank tests for the metacognitive awareness test. The results indicate that students’ metacognitive awareness increased significantly from an average of 41.32 to 44.68 (\( t(33) = 4.601, p < .001 \)), yielding a medium effect size of 0.5 according to Cohen’s guidelines. All of the three components of metacognitive awareness also increased significantly: information management strategies, from an average of 15.18 to 16.09 (\( t(33) = 2.351, p = .025 \)); monitoring, from 14.82 to 16.53 (\( t(33) = 4.619, p < .001 \)); and debugging strategies, from 11.32 to 12.06 (\( t(33) = 2.973, p = .005 \)). The pre- and postactivity changes in metacognitive awareness in each item was also explored using the Wilcoxon signed rank tests. Six out of ten items had a significant increase (Items I-2, I-4, II-1, II-3, II-4, and III-1). The results indicate that, among the information management strategies, students could focus more on the meaning and importance of new information and try to translate new information into their own words. Among the monitoring strategies, the students found themselves pausing regularly to assess their comprehension. They also asked themselves whether they had considered all options when solving a problem and how well they were doing while learning.

| Table 4. Comparison of pre- and post-activity MAI (N = 34) |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Component (I) information management strategies** | Pre-test mean (SD) | Post-test mean (SD) | Post-Pre difference mean (SD) | \( t \)-value* or Z-value** |
| I consciously focus my attention on important information (in the proposed learning activity). | 15.18 (2.96) | 16.09 (2.99) | 0.91 (2.26) | 4.601* |
| I focus on the meaning and significance of new information. | 3.82 (0.94) | 4.06 (0.74) | 0.24 (0.10) | 2.138* |
| I create my own examples to make information more meaningful. | 3.62 (0.89) | 3.68 (1.01) | 0.06 (0.19) | 0.109 |
| I try to translate new information into my own words. | 3.74 (0.93) | 4.12 (1.01) | 0.38 (0.12) | 2.829** |
| **Component (II) monitoring** | 14.82 (2.59) | 16.53 (2.36) | 1.71 (2.15) | 4.619*** |
| I ask myself if I have considered all options when solving a problem. | 3.79 (0.85) | 4.18 (0.76) | 0.38 (0.89) | 2.289* |
| I find myself analyzing the usefulness of strategies while I study. | 3.88 (0.81) | 4.15 (0.82) | 0.27 (0.75) | 1.964 |
| I find myself pausing regularly to check my comprehension. | 3.41 (1.10) | 4.03 (0.87) | 0.62 (0.89) | 3.408** |
| I ask myself questions about how well I am doing while I am learning something new. | 3.74 (0.86) | 4.18 (0.67) | 0.44 (0.86) | 2.631*** |
| **Component (III) debugging strategies** | 11.32 (1.84) | 12.06 (2.03) | 0.74 (1.44) | 2.973*** |
| I change strategies when I fail to understand. | 3.79 (0.81) | 4.06 (0.92) | 0.27 (0.67) | 2.183 |
| I reevaluate my assumptions when I get confused. | 3.76 (0.78) | 3.94 (0.69) | 0.18 (0.67) | 1.500 |
| I stop and go back over new information that is not clear. | 3.76 (0.86) | 4.06 (0.85) | 0.29 (0.97) | 1.674 |
| **Total Score** | 41.32 (6.73) | 44.68 (6.73) | 3.35 (4.25) | 4.601*** |

Note. *Paired \( t \)-test. **Wilcoxon Signed Rank Test. * p < .05; ** p < .01; *** p < .001.

One student mentioned, “through the use of the video conferencing tool in the proposed learning, we really got some sense of applying what we learned in optics.” Another student added, “using video conferencing tools makes us think deeper about the theories and the phenomena we observed. I felt that I could master the knowledge in a way that I can apply well.” A third student mentioned, “video conferencing made me think and helped me create my own imagination. Meanwhile, I could prove whether what I thought was correct.” One group elaborated on the interactions among peers with the following comments: “Through the use of a video conference, our movements and observation would tell us whether we were right or wrong; that is, whenever we suspect our assumption, we would discuss and refer to the videos we observed.” Video conferencing in the proposed learning helps students actively prove their assumptions, a cognitive act of regulating their explorative process of learning.

The results showed that, because of the portability of mobile devices and the coexistence of face-to-face and video conferencing, students could unobstructively interpret and express the formation of virtual images in a
mirror and have discussions immediately and intimately. Students could (1) reflect on what was lacking in what they learned before, (2) observe and manipulate the phenomena to think deeper and verify related assumptions, and (3) think of mastering the knowledge for its applicability in daily life. These results showed the students’ knowledge about their own cognition and regulation of their own cognition, and thus their awareness of their metacognitive processes (Kleitman & Stankov, 2007; Schraw & Dennison, 1994).

Discussion

This study restores interest in adopting video conferencing in science learning. The role of video conferencing has changed from a passive delivery of instructional content to a consideration of stimulating students’ cognitive and social-cognitive interaction. This study has a design of cohesive subject content with learners’ movement, closer alignment between the optics of light reflection and learner movement. By using their senses of sight and mobility, students can observe and manipulate the formation of a science phenomenon to realize the approximate formation of the phenomenon as a whole. Learners’ mobility in this study is different from most prior mobile learning, wondering around in an authentic context to initiate the reception of augmented information for approaching the subject content. The study results show that different groups embodied themselves for their own reasons when collaboratively testing the assumption that they made during the explorative process of learning. The students’ embodiment was attributed to how the optical phenomenon was formed and the knowledge they explored. The design follows Walther’s (2005) assertion that mobile gaming is a game that takes a changing relative or absolute position/location into account. This excludes games for which mobile devices merely provide a delivery channel in which key features of mobility are not relevant to the game mechanics.

The video in the proposed design serves to replace students’ eyes and supports them to examine optics from a holistic view and reflect on their explorative process of science learning. Students generally are not aware of the functionality of their eyes in light reception, and lose the metacognitive ability to synthesize their optical experience into instructional content. This challenge seems to be resolved by the integration of the video tools into the subject content. In addition, the integration of computer-mediated and face-to-face communication plays a crucial role in unifying and strengthening the student collaborative learning experience described in this paper. The interview results and field observations showed that, on the basis of the conferencing videos, students answered questions raised by their members in a face-to-face manner, made decisions on how to proceed, assessed the progress, and eventually decided when to stop the task. Face-to-face interactions fostered group meaning-negotiation, and the videos in the mobile devices not only served as media to mediate students’ arguments but also helped them regulate their explorative process of learning.

Finally, numerous technology tools may provide rich pedagogical design opportunities for teachers to tailor their versatile learning activities. Thompson (2013) mentioned that various patterns of technology use could be associated with different approaches to learning. The rich pedagogical role of the video conferencing tool depends on how it is adopted in the classroom. It is not necessarily a question of learning new technology but rather of learning old technology comprehensively or learning to apply existing techniques and strategies in new contexts (Levy, 2009). The study results are expected to inspire teachers to apply similar approaches in adopting various technology tools in their contexts.

Conclusions

With modern mobile and video technologies, the use of videos connecting two distance learners in a mobile context is not a challenging issue anymore. What matters is how teachers think about the video conferencing technology and the opportunities it provides. This study proposes an innovative instructional view of mobile video conferencing. The results showed that the novelty use of technology attracted students. Moreover, the conferencing video was a provocative tool, which lead to constructive learning as well as metacognitively regulated explorative learning.

Further research is necessary to improve the preliminary design research. Future studies should include more participants to improve the reliability of the study results. As the proposed technology is a novel approach to science learning, further research might evaluate teachers and students’ acceptance of using the tools. Finally, generalizing the design to various subject domains could be undertaken to further explore the use of mobile technologies.
Acknowledgements

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References


Guest Editorial: Technology Enhanced Contextual Game-Based Language Learning

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Introduction

The playing of games holds an important significance in the language development of human beings, regardless of learners’ age. Game playing allows for effective learning in language classes as it facilitates students’ exploration of alternative decisions and actions, without risking failure which might be experienced in the real world (Martinson & Chu, 2008). However, not all games contribute to language learning and in the case of this special issue, only those which involve language input and output at the three levels of linguistic form, semantic meaning and pragmatic use, were considered (Cook, 2000) for inclusion. It is widely believed that contextual learning provides second language (L2) learners with the opportunity to forge direct links between L2 forms and the underlying concept/s, thus facilitating L2 learning (Lan, Fang, Legault, & Li, 2015) and satisfying the already noted requirements for using games in language learning.

The concept of contextual learning is not new. Since John Dewey proposed the concepts of project-based learning and experiential education (Dewey, 1938), it has remained an important tenet in L2 learning (Ellis, 2008). Meaningful context-dependent social interactions in an authentic environment remain one of the key elements to second language acquisition as it provides L2 learners with essential scaffolding necessary to successfully integrate an L2 (Eun & Lim, 2009; Lan, Lyu, & Chin, in print; Lantolf & Thorne, 2006). Contexts can be viewed as all perceived phenomena, including the physical surroundings, in which language occurs (Prince, 1996). Language input from the environment, including contextual and non-linguistic cues, can easily be comprehended by the L2 learner as it occurs in a low stress environment (Ray, 2012).

In accordance with the belief that contextual learning of L2 is highly beneficial, the creation of authentic L2 learning contexts is strongly suggested by several commonly referred to foreign language teaching/learning guidelines including The Common European Framework of Reference for Languages (Council of Europe, 2001) and the proficiency guidelines developed by the American Council for the Teaching of Foreign Languages (American Council for the Teaching of Foreign Languages, 2012). Nowadays, through the support of advanced technology, the learning context for languages is no longer restricted to that of the conventional L2 classroom. In fact, omni-environments (either real or virtual) can be accessed by the learner as an authentic learning context. For example: (1) computer mediated communication (CMC) enables learners to join virtual communities to explore foreign cultures and learn an L2 (e.g., Pasfield-Neofitou, 2011; Stickler & Emke, 2011); (2) mobile devices seamlessly present real world situations as learning contexts for a target language (e.g., Lan & Lin, 2016); (3) augmented reality devices remove the barriers between the real and virtual world (Godwin-Jones, 2016; Ozcelik & Acarturk, 2011; Yuen, Yaoyuneyong, & Johnson, 2013); and (4) 3D created environments facilitate the L2 learner’s immersion in a brand-new world (e.g., Lan, 2014; Lan, 2015; Lan, Kan, Sung, & Chang, 2016; Scholz, 2017; Yeh & Lan, 2018).

To this end, this special issue aims to provide a platform where researchers can present their research efforts offering insights into: (1) the approaches governing the application of technology to enhance L2 game-based learning in context; (2) the evaluation of game-based language learning in different contexts, such as the real world, conventional classroom and the virtual world, with technological support; (3) the comparison of game-based learning outcomes obtained through the use of different technologies in conventional L2 classroom contexts and; (4) the impact of technology enhanced contextual game-based language learning on the transference of knowledge between formal L2 learning and real life application. The process remains open to further research and exploration and the publication of this special issue can facilitate additional understanding as to the potential of contextual games in TELL. After a rigorous review process, ten significant, noteworthy research papers were accepted for inclusion in this special issue. These papers clearly explain how a technology-rich contextual game can be adopted in TELL, thus providing learners, educators and researchers with valuable insights into this domain, from different perspectives.
The first paper documents how Rusman, Ternier and Specht developed a mobile game called “ELENA goes shopping” to help familiarise children with language/s spoken in neighbouring countries/areas. A design research approach was adopted in this three cycled study. Both the children, and adults, involved in this research used and evaluated the mobile game. Multiple data, including responses from questionnaires, semi-structured interviews as well as a language learning outcome test, were collected during the study. The results confirmed that the “ELENA goes shopping” mobile game does indeed aid children in gaining knowledge of another language.

The second paper, entitled “Application of a gamified interactive response system to enhance the intrinsic and extrinsic motivation, student engagement, and attention of English learners” was written by Sun and Hsieh. This work introduced a gamified interactive response system (IRS) for English learning by Taiwanese junior high school students. A total of 144 grade seven students were divided into three classes, through the use of different pooling tools in English classes. Both qualitative and quantitative data, regarding intrinsic and extrinsic motivation, student engagement and attention span were collected and, subsequently, analysed. Based on the results obtained from the analysed data, the authors confirmed the benefits of using the proposed gamified IRS in the English language learning of junior school students.

In the third study Lin, Hwang, Fu and Chen examined how flipped contextual game-based learning enhanced the English business writing skills of students who studied English as a foreign language. A mixed methods approach was adopted in this study which had a total of 68 participants. Thirty-five participants made up the experimental group which used the flipped contextual game-based learning approach and 33 participants resorted under the control group which used the conventional contextual game-based approach. Both quantitative and qualitative data, including students’ writing performance, writing errors and reflections on the learning approach, were collected and analyzed. The results obtained from this study confirmed that the proposed approach yielded better writing performances, increased motivation and reduced writing errors.

The fourth paper, entitled “Chinese character composition game with the augment paper,” presents Wen’s documentation of the design and evaluation of a digital Chinese character composition game with a paper-interface (Augmented Reality-based Chinese Characters, ARC). The ARC game aims to enhance the study of Chinese characters by Chinese second language (CSL) beginner earner students in Singapore. Both Chinese character knowledge and cooperative learning were evaluated in this study. The results suggested that the ARC system benefited CSL beginners’ natural interactions during the learning process and thus ameliorated their Chinese character learning.

The fifth paper by Wei, Kao, Lu and Liu evaluated an English vocabulary learning game which featured competitive gaming scenarios and personalised assistance to enhance college students’ acquisition of English vocabulary. A total of 120 college students participated in this study. The results obtained from the study noted that the proposed game benefited the students’ English vocabulary learning as well as improving performances and lowering anxiety levels.

The sixth paper, “Using game-based learning with Kinect technology in foreign language education course,” authored by Yükseltürk, Altink and Bager, investigated the ways in which the integration of game-based learning and Kinect technology would benefit college students’ English studies with the focus being on improved self-efficacy and attitude towards English. A total of 62 students were divided into two groups: the experimental group which took part in the proposed game-based learning activities and the control group which underwent conventional teaching. Based on the results obtained from the study, the researchers confirmed that the integration of game-based learning and Kinect technology were, indeed, beneficial to college students’ self-efficacy and that it improved their attitude towards English learning.

Yang and Quadir, in the seventh paper entitled “Effects of prior knowledge on learning performance and anxiety in an English learning online role-playing game” investigated: relationships amongst English learners and their proficiency in English prior to game playing experiences, learning performance and learning anxiety. A MMORPG-based educational game was developed and used to facilitate elementary students’ English learning. A total of 55 grade six pupils participated in this study. The relationship/s between the four variables were confirmed and suggestions for the application of digital game-based learning were also provided by the authors. In the next paper, Chen, Chen and Dai developed a contextual game-based English learning system named “PlanetAdventure” containing three narrative elements: storyline, character and quest. A total of 61 first-year college students participated in this study. Three types of data were collected and analysed namely: students’ English results, perceptions and behaviour indicators. The results of this study indicated that students’ English studies benefited from the use of the PlanetAdventure system.
Vazquez-Calvo, in the ninth paper, adopted the case study method to explore an online gamer’s language learning through game translation. Multiple kinds of data were collected, including: interviews, online observations and screencast videos. The data analysis focused on the gamer’s fandom, literacy practices and workflow when doing game translation. Based on the analysis results, the author identified the features of online gamers’ language learning.

Last, but not least, the tenth paper by Lan, Hsiao, and Shih elucidated the design principles of game-based 3D virtual language learning environments for special education students. Four special education pupils, with different inherent disabilities, participated in this study. All four students were comorbid with language delay. After observing their learning processes, the researchers adopted a two-cycled design-based research approach to aid in the refinement of a 3D virtual learning environment for language learning. The principles governing the design of an effective 3D learning environment were therefore proposed to broaden researchers’ and designers’ reference domain.

All the previously listed papers provide insights into the potential of combining digital technology and contexts for language learning. Various technologies, such as mobile technology, augmented reality, and 3D virtual worlds were adopted in these studies. In addition, the variables explored were multi-faceted including: learning performances, attitudes and learning behaviours, to name but a few. Thus, the papers included in this special issue will likely provide readers with a deep and extensive understanding as to the potential uses of contextual games for language learning. More areas for future research will undoubtedly be identified by reading the articles contained in this special issue.

References


Early Second Language Learning and Adult Involvement in a Real-World Context: Design and Evaluation of the “ELENA Goes Shopping” Mobile Game

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ABSTRACT
This article describes the theory-informed design of the “ELENA goes shopping” mobile game and reports on the evaluation of its effectiveness through a design research approach. The game aimed to foster young children’s (aged 4-8) interest in a neighboring (geographically proximate) language and to familiarize them with its sounds, pronunciation and vocabulary. Additionally, it strove to involve adults in young children’s language learning activities. To achieve these objectives, the game connects playful learning activities to an accessible, familiar real-world setting (supermarket). The game was developed and evaluated through three iterative design research cycles. First, interdisciplinary experts (n = 8) evaluated the game by means of a questionnaire and focus group discussion. In the second and third cycles, the game’s feasibility and usability was evaluated via questionnaires, semi-structured interviews and a language learning outcome test. Results revealed that children (34) and adults (14) alike found the game useful for familiarization with and motivation to learn another language, and feasible to involve adults. Nevertheless, children could play the game autonomously with minimum adult assistance. A dependent t-test on a repeated vocabulary test revealed adults’ and children’s perception that the game helped them familiarize with another language to be consistent with test results. A limitation to this study is that the test was administered immediately after game playing. Future studies could explore effects of “real-world” contextualization on early second language learning and vocabulary recall by measuring after longer time spans and compare results versus a non-contextualized game.

Keywords
Mobile assisted (early) language learning, Game-based language learning, Situated/contextualized learning, Seamless learning

Introduction
The importance of mastering languages, alongside the mother tongue, is broadly acknowledged (Herder & De Bot, 2005). Consequently, the theme of early second language learning gained attention, as starting early can boost the total time spent on language learning and tap into the specific cognitive possibilities and linguistic sensitivity of young children (Edelenbos, Johnstone & Kubanek, 2006). English remains the dominant language in early second language learning contexts (Extra & Yagmur, 2012), also in regions where other language options are within children’s geographical proximity. Such a region exists around the Netherlands-Belgium-German borders (called “Euregio”) where Dutch, French, and German are spoken within a geographically limited area (about 60 km2). Yet, opportunities for neighborhood-based early language learning are also neglected here. Seven European partners therefore collaborated in the ELENA-project (Early e-learning of neighboring languages) to develop digital learning material for the improved teaching of neighboring languages from an early age (4 to 8 years).

The project included the development of a mobile game, interlinked to the online learning materials for independent language learning at school. The game was developed in a design research approach, which according to Plomp & Nieveen (2013) entails “(1) designing an intervention in a real-world setting, (2) cycles of analysis, design and development, evaluation, and revision, (3) a focus on understanding and improving interventions (4) measurement of surplus value of design, partly by its practicality for users in real contexts, (5) design that is grounded in theory, and (6) involvement of practitioners in the various stages and activities of the research” (p. 21). The game aims to promote young children’s interest in a neighboring language, to familiarize them with sounds and pronunciation, to teach new vocabulary and to connect to the themes offered for online independent language learning at school. The game also strives to involve adult companions (e.g., (grand)parents, child care professionals, scout leaders) and to inform them regarding children’s early language learning activities. It does so by using play to connect language learning to everyday experiences in a familiar, real-world setting, namely a supermarket.

This article describes the game’s design principles, grounded in the theory of early second language learning, a theory of play and mobile learning, and reports on evaluation results of three design research cycles. The
evaluation focusses on how the game design principles relate to stakeholders’ (experts, children, adult companions) perceived effectiveness in achieving the underlying objectives. Findings are presented, and conclusions drawn regarding the effectiveness of the game design.

Theoretical background, design principles and game scenario

Design principles – The “early language learning” perspective

Early second language learning, alongside the mother tongue, offers several benefits. Language experts indicate that young children are highly language sensitive and can relatively easily learn several languages in parallel (Onderwijsraad, 2008). Until the age of 7 or 8, they display extra openness towards languages, learning without effort or intention, and in an intrinsically motivated, spontaneous, playful manner. Later on, they become more aware of the structure and rules of languages and start to learn accordingly. Although opponents of early second language learning fear that learning extra languages alongside the first language will negatively affect the mastering of children’s mother tongue, there is no evidence to that effect (Herder & De Bot, 2005; Onderwijsraad, 2008).

Several general principles can guide early (second) language learning. It is especially important to involve all young learners’ senses (Edelenbos, Johnstone & Kubanek, 2006): learning should be supported visually and multi-sensory. They learn easier when initially learning things related to their direct environment, becoming familiar with the phenomenon of using different words for the same object, but also when the experience connects to their immediate personal perception. Therefore, learning should be situated in meaningful contexts and linked to themes adapted to personal interests and characteristics, such as age, level and aptitude of the children (Eun & Lim, 2009; Lanolf & Thorne, 2006). It is also important to train the ear (as comprehension precedes production) and pronunciation, to become familiar with the sound system of the language. “Immersion” (learning a language by using it directly during lessons) (Edelenbos, Johnstone & Kubanek, 2006) and learning through imitation (e.g., repeating what a character says) are very efficient learning approaches at an early age. Other important principles mentioned by Edelenbos, Johnstone and Kubanek (2006) relate to “children’s internal enjoyment of and motivation to learn an additional language; repeated and frequent (out-of-school) exposure to the language; and awareness of the relationship between the sound and written systems of the languages they know and are learning” (p. 156). Moreover, initiation of sustainable early second language learning within a school requires the involvement of all parties (from school management to parents (Onderwijsraad, 2008; Enever, 2011).

Design principles – The “theory of play” perspective

As young children seem to learn languages relatively easily and naturally through play (Edelenbos, Johnstone & Kubanek, 2006), we examined how theory on young children’s “play” could shape the design of an early second language learning game.

Sykes and Reinhardt (2013) distinguish various design elements in second language learning pedagogy that digital games might affect, namely the nature of learning tasks and goal orientation, interaction, feedback, creation of context, and motivation of learners. The National Play Policy of Ireland (2004) as cited in Kernan (2007) defines play as “freely chosen personally directed behavior; motivated from within by needs, wants and desires. Through play children explore social, material and imaginary worlds and their relationship with them, elaborating all the while a flexible range of responses to the challenges they encounter” (p. 5). Although the idea of designing a scenario to support learning conflicts with the “freely chosen” part of the play definition, we still found several key forms of play that could shape the design. In Kernan’s list (2007, p. 19), three forms of play seemed to be especially informative. Firstly, “exploratory play,” using physical skills and sensations to learn about materials and their properties, what they feel like and what can be done with them. Secondly, “pretend, fantasy and socio-dramatic play,” which includes “role play, pretending with objects, pretend actions and situations, persistence within the imaginary play frame to create a play episode or event(...)” Thirdly, “language or word play,” “unrehearsed and spontaneous manipulation of sounds, and words often with rhythmic and repetitive elements(...)”. These forms of play (partly) overlap with the “object play” (manipulating and discovering characteristics of objects), “imaginative and pretend play” (creating their own sense of mind by pretending) and “storytelling-narrative play” (stories help to understand ourselves and others) patterns identified as elemental forms of play by the National Institute for Play (2009).
Design principles – The “mobile technology for language learning” perspective

One of the most critical affordances of mobile devices is that they facilitate learning in any location and thus can support site-specific contextualized learning experiences (Laurillard, 2007). Wang, Liu and Hwang (2017, p. 655) also acknowledge that “contextual language learning could be one of the most important applications of mobile and wireless communication technologies.” “Real-world,” contextualized and integrated learning experiences help learners understand the importance of learning something and its relevance for their own life (Blumenfeld, Kempler & Krajcik, 2006; Hickey, Moore & Pelligrino, 2001).

Learners can be supported in these types of learning experiences through several affordances of a mobile device (Suárez, Specht, Prinsen, Kalz & Ternier, 2018): (1) through the delivery of instruction by means of location-based, procedural, and metacognitive guidance; (2) through access to content; (3) through data collection; (4) communication, and (5) contextual support. Multiple sensory, cultural and environmental cues can aid the understanding of the user of information within a context and can be tailored to users (De Jong, Specht & Koper, 2010). In turn, this may enhance encoding, comprehension and recall (Westera, 2011). A more practical advantage is that time otherwise “wasted” (e.g., for travel) can be used for learning. Kukulska-Hulme (2012, p. 9) indeed proposes a conceptual framework, where “time, place, and activity are dimensions for designing mobile-supported language learning in informal settings.” Additionally, we propose to connect (guided/scripted learning or user-generated) activities with local observations, activities and experiences, to ensure interaction between the user, the device and the environment. This is in line with Richardson’s (2016) remark to facilitate language learning according to “a more holistic learner engagement with space.” The importance of a relation between these design elements are shown in a study of Sandberg, Maris and de Geus (2011). They examined effects of a mobile early English language scenario about Zoo animals on English word retention, concluding that with their scenario (that could also be played outside of the Zoo), children mainly spent more time on language tasks, as they enjoyed playing it at home, thus improving retention. They did not find a contextualized learning effect, which could be due to the scenario tapping insufficiently into the context itself. They did show that children enjoyed contextualized language learning and that a mobile scenario could foster their motivation, thus increasing children’s willingness to engage in future language activities outside the classroom.

Design principles and decisions

The design decisions and principles in Table 1 follow from both theoretical and practical considerations for the game. The game scenario directs and guides children and their adult companions to do the shopping required to make pancakes, in a local supermarket, and connects to a theme introduced in the online learning material. It integrates various multimedia components (Duman, Orhon & Gedik, 2015): text, audio, (own) photos, pictures, graphics, and video.

<table>
<thead>
<tr>
<th>Design element</th>
<th>Decision and description</th>
<th>Underlying design principles and practical considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target group</td>
<td>Children aged 4-8.</td>
<td>At this age, children learn by immersion and playfully and are not yet hindered by formal rules and structures of a language.</td>
</tr>
<tr>
<td>Theme</td>
<td>Shopping to make pancakes.</td>
<td>Connects to children’s proximate experiences and tendency to role-play, imagine and pretend, as well as the storytelling aspect of motivation to play. It connects thematically to the online formal learning material.</td>
</tr>
<tr>
<td>Context</td>
<td>Home and any supermarket.</td>
<td>Relates to everyday familiar real-world contexts of children. Taps into the internal motivation of child to learn different words for similar objects.</td>
</tr>
<tr>
<td>Location</td>
<td>Any supermarket.</td>
<td>Activities should not be tied to a specific supermarket, but “playable” in any supermarket, but still make use of affordances the context offers for language learning.</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>To familiarize children with sounds and pronunciation; to learn new vocabulary; to promote interest in languages.</td>
<td>Connects to natural language learning tendency of young children. Importance of training the ear, to become familiar with the sound system.</td>
</tr>
</tbody>
</table>

Table 1. Design principles and decisions of the “ELENA goes shopping” mobile language learning game (Rusman & Ternier, 2014)
| Content | Target words within a theme of the online material. Focus on listening, understanding and speaking the language. | Connects to learning objectives, repetition of previously learned words, using them in context and increasing “out-of-school” exposure to the words. Thematically connects formal and informal learning activities. |
| Learning activities | No collaborative activities. Activities such as: say and record (your name); sing (and record) in alternative ways (fast, slow); listen to a/your recording; search and find/collection and take a picture; show me (by taking a picture); choose (and listen to the alternatives); taste; smell; and count. Encouraging feedback after activity completion. | Connects to learning objectives, facilitates contextualized interaction, multi-sensory approach and feedback (by listening to own productions), takes advantage of the affordances of a mobile device (e.g., offering additional information/ multimedia material on a location), learning by exploration, (word)play, imitation and repetition. Simple and autonomous individual learning activities for children, while adults are meanwhile shopping in the supermarket. Activities do not promote running, shouting etc., to avoid annoyance in the supermarket. |
| Control | Children can play the scenario autonomously (with some adult assistance). | Children explore social, material and imaginary worlds and their relationships autonomously. |
| Assistance/guidance | Elena (a girl aged 7) guides and instructs children’s activities in context and adult companions assist when feasible. | Elena connects to children’s own characteristics and helps to “tell a story.” Fosters adult companion involvement when learning a language (e.g., (grand)parents). |
| Instructional language | In mother tongue, brief, informally formulated instructions (in a “buddy” and “childish” style), repeated in the target language. | Shows relation of the phonetics of the mother tongue and target language. Prevents misunderstanding of the instruction. |
| Time | Max. 30 min, specific and uninterruptible timespan. | Limited concentration and attention span of children. Increases the likelihood of playing the scenario in a supermarket. |
| User interface | Use of graphics and audio instruction. | Supports learning objectives as well as multi-sensory learning. Youngest children cannot read yet, therefore guided by audio messages. |
| Device and access | Playable on any android phone and downloadable via play-store. | Supports large groups of users. Supports open source development and distribution. |

Children receive the first activity of the mobile game on their smartphone and upon completing this activity, they receive the next activity. After completing activities, they receive a puzzle piece, which eventually forms a picture of ELENA making pancakes with her father. This marks the end of the game.

Regarding recent literature on early L2 learning via contextualized games (Wang, Liu & Hwang, 2017), the ‘Elena goes shopping’ game (Rusman & Ternier, 2014) explores a rare combination of the “contextualized, real-world and mobile” “game-based learning” for “early second language learners” and “involvement of adults” elements. Most existing studies concern older children. The only studies we found to be somewhat comparable in terms of all combined concepts and the age of the participants is the Chen and Lin study (2016), facilitating the understanding of poetry. However, the learning activities in this game were not directly linked to the ‘real-world’ environment and did not include adult involvement.

**Design research approach - Development and evaluation with stakeholders**

The requirements for the game scenario as described above led to a first paper-based mock-up version of the game, which was subsequently developed and implemented with the ARLearn tool (Ternier, 2011). ARLearn (Ternier, Klemke, Kalz, Van Ulzen & Specht, 2012) is an open source tool suite for educators and learners, supporting contextualized serious mobile games. It enables the creation and management of game scenarios and runs: instantiations of a game scenario with real-time communication.
We first developed the scenario, elaborating the script text to the level of dialogue between ELENA and the child. It was then discussed with the educational designer and ICT developer, to identify any developmental changes required in the ARLearn suite to implement the scenario. As the target group is young children, we worked with non-textual, audio-only messages. Graphical single/multiple choice messages were newly implemented in ARLearn: for example, this functionality enabled children to select a picture representing their grandfather, rather than offering them the option to select the word “grandfather” as an answer to a question during the game.

Several versions of the game were developed, tested and improved, based on the feedback of various stakeholders, during several design research cycles, as described in Figure 1 and Table 2.

![Design research cycles](image)

**Figure 1. Design research cycles**

<table>
<thead>
<tr>
<th>Mobile game</th>
<th>Evaluated by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 0 (paper scenario)</td>
<td>Educational designer and IT expert</td>
</tr>
<tr>
<td>Version 1 (ARLearn implementation)</td>
<td>International Language Learning experts</td>
</tr>
<tr>
<td>Version 2 (ARLearn implementation, 1st real-world pilot implementation)</td>
<td>Children and accompanying adults - random visitors to a supermarket</td>
</tr>
<tr>
<td>Version 3 (ARLearn implementation, 2nd real-world pilot implementation)</td>
<td>Scouts and supervisors visiting a supermarket</td>
</tr>
</tbody>
</table>

The subsequent sections describe the evaluation findings of each development and evaluation cycle. The game versions were evaluated for their feasibility to support early language learning (pronunciation, vocabulary) in a real-life context; to motivate, interest and involve both children and adult companions in early second language learning, and for their usability.

**Development and evaluation cycle 1: Expert review**

**Context and participants**

Following design and implementation of the 1st “playable” version of the mobile game in ARLearn, eight experts from the ELENA-project (representing second language learning expertise as well as learning, instructional and graphical design expertise) evaluated its feasibility to reach envisioned objectives, as well as the game scenario implementation. These experts were involved in developing the ELENA online learning material to be covered by the mobile game, while not personally involved in the design of the game. The experts individually played the game on smartphones provided during the evaluation session.

**Method and instruments**

The game objectives were briefly presented prior to the participants playing it. After playing the game, they completed a questionnaire individually, featuring 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) questions related to the games’ objectives, a question about children’s estimated game playing time, Systems Usability Scale (SUS) questions (Sauro, 2011) and two open-ended questions to provide suggestions for further game development (Appendix A). Each game objective was represented by 2 Likert scale questions, which were mixed into the questionnaire. Their experiences with playing the game were subsequently discussed in a focus group session.
Results and consequences for the game

Most of the experts were positive regarding the feasibility of the “ELENA goes shopping” mobile game scenario (Rusman & Ternier, 2014) to reach the envisioned key objectives (Table 3). Lack of consensus concerned the statements on the feasibility of the game to improve children’s pronunciation. The game’s usability for children was also evaluated positively. Based on research, a SUS score above 68 is above average. Our usability evaluation resulted in a score of 69.8 according to the SUS scale (Sauro, 2011). Thus the experts perceived our game as both usable and learnable for young children.

<table>
<thead>
<tr>
<th>Evaluation of objectives</th>
<th>Mean</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe the scenario makes children aware of the existence of foreign languages</td>
<td>4</td>
<td>1.14</td>
</tr>
<tr>
<td>I believe the scenario raises children’s interest in foreign languages</td>
<td>3.5</td>
<td>0.86</td>
</tr>
<tr>
<td>I believe children will like/enjoy the scenario</td>
<td>3.88</td>
<td>1.55</td>
</tr>
<tr>
<td>I think the scenario will make early language learning more interesting for children</td>
<td>3.88</td>
<td>0.7</td>
</tr>
<tr>
<td>I think the scenario helps children learn new foreign language vocabulary</td>
<td>3.62</td>
<td>1.12</td>
</tr>
<tr>
<td>I think the scenario helps children repeat/practice learned foreign language vocabulary</td>
<td>3.5</td>
<td>0.86</td>
</tr>
<tr>
<td>I think the scenario helps children learn the significance of foreign language vocabulary in a real-world context</td>
<td>3.75</td>
<td>0.79</td>
</tr>
<tr>
<td>I think the scenario helps children remember foreign language vocabulary better by learning it in a real-world context</td>
<td>4</td>
<td>0.86</td>
</tr>
<tr>
<td>I think the scenario helps to involve (grand)parents with the early language learning of their (grand)children</td>
<td>3.5</td>
<td>1.43</td>
</tr>
<tr>
<td>I would recommend the scenario to children/(grand)parents in my personal environment</td>
<td>3.5</td>
<td>0.57</td>
</tr>
<tr>
<td>I think the scenario helps children practice their pronunciation in another language</td>
<td>2.88</td>
<td>1.55</td>
</tr>
<tr>
<td>I think the scenario helps children recognize foreign pronunciations/sounds</td>
<td>3.57</td>
<td>1.95</td>
</tr>
</tbody>
</table>

Note. * The mean and variance of this question was based on seven respondents.

One result of this first evaluation was to change the target group children’s age, from the original 4-8 year range. The experts indicated a mean “suitable” age of 7 years. Subsequent consensus in the focus group discussion was a 6-8 year range. Experts indicated that game instructions could also be directly offered in the target language (German) and translated in the mother tongue (Dutch). The mean estimation of the game duration, without travel time to a supermarket, was 34 minutes. This length was indicated as just right, though it was stressed that the next version of the mobile game should be shorter and audio instruction fragments as brief as possible. Regarding the interface, instructions were required on operating the smartphone, and the menu/buttons interaction was to be more graphically oriented. Further advice was to relate and focus all activities on the “shopping and making pancakes” theme, without any deviations from this theme. Activities included in the first version, like “counting cars/traffic lights” while traveling to the supermarket, and smelling/tasting products in the supermarket, were therefore removed or replaced by other activities in the second version.

Development and evaluation cycle 2: Real-world implementation with visitors of supermarket

Context and participants

The “ELENA goes shopping” mobile game (Rusman & Ternier, 2014) was adapted to the experts’ suggestions and subsequently evaluated in the first pilot implementation: a real-world supermarket setting with visiting children (aged 6 to 8 years) and accompanying adults. The supermarket manager agreed to participate in the pilot and the availability of an effective mobile data network was checked beforehand. Ten days before the game, customers were informed about the pilot by means of signs in the store. Eight children and seven adults participated in the pilot.

All participating children were lent a smartphone with ear plugs, to diminish “supermarket noises.” A Quick Response (QR)-code was used to initialize the game. They received a short instruction on the use of the smartphone and then played the game. The accompanying adult or researchers at the desk at the supermarket entrance would assist if they experienced problems with the game.

Accompanying adults signed a twofold agreement for: (1) using the gathered data for research/reporting purposes and (2) allowing the use of photos/videos of the pilot for dissemination purposes. After playing the
game and participating in the evaluation, the children received a small gift. Figure 2 gives an impression of the setting of the first “real-world” pilot implementation.

Figure 2. Impressions of the 1st real-world pilot with random visitors of a supermarket

Method and instruments

This evaluation focused on users perceptions of and real-world experiences with the mobile game. These were gathered through semi-structured interviews with children and their accompanying adults ((grand)parents, other family/friends) (Appendices B and C). All interviews were audio recorded and transcribed. Relevant comments with feedback on their perception of the game as well as its usability were then distilled.

Results and consequences for the game

Although instructions were mainly given in the target language (German), with only translation of key instructions in Dutch, most children in the (6-8 year) target group could play the game autonomously. Only incidental help was given by accompanying adults or the researchers, e.g., to find the different products in the supermarket, or with initially finding the “record” button. Children without experience with a smartphone (according to the accompanying adult) could still play the game. Younger children who also wanted to participate were unsuccessful in playing the game, confirming that our current target group (6-8 years) within the ELENA-project is appropriate. The instable mobile data connection was an issue in the supermarket, sometimes hindering loading of a subsequent game activity. However, this was solved when participants walked to another part of the supermarket. The earplugs indeed prevented distortion of “supermarket noises” (music, announcements, bleeping of cash desks etc.), however, the poor fit in the children’s small ears did sometimes result in problematic background noise. The duration of the game was right, as all participants completed the game without becoming bored. The game content was also evaluated positively, with children specifically mentioning the fun of singing activities and collecting puzzle pieces after each activity.

The participating children and adults found the game fun and educative. All the adults accompanying a child stated they would provide a comparable game for learning languages or other specific subjects for their children. The fact that the game was provided free also played a role in this positive evaluation. Most adults had not
previously bought an educative app, some of them did download freely available apps. All interviewed children would like to play a comparable contextualized (location-based) mobile game in the future.

Excerpts from the interviews with both groups:

**Children**

“Great! You’re actually shopping, but then in a game”

“A lot of children would like a mobile phone and now you’re doing things instead of just reading books”

“I understood it all”: “I liked the game”

“It’s nice because now I can talk to someone in a foreign country if I get lost”

“I like to do things instead of standing around [waiting]”

**Adults**

“I think it’s nice to teach children words in this way, to keep them active and engaged with things they have to learn anyhow”

“I’m not an advocate of a mobile phone, so I’d prefer to play it on something other than a mobile.”

[But in a certain place and in a way that they can do it themselves?]

“That’s not an issue for me!!”

[What would you propose, for example?]

“A tablet is the same as a mobile phone, but that complicates it. You can’t carry such a large device when shopping. Then the mobile phone is quite handy, actually”

Although the ARLearn infrastructure already provided means to cache game content, such as audio and video, messages are expressed using HTML. Images embedded in this HTML content were loaded as they were opened, which was problematic in the supermarket, in the absence of Internet. Consequently, the ARLearn toolkit was extended with functionality to support offline caching of images, embedded in a HTML message. This is expected to prevent gaming problems caused by a dysfunctional mobile data connection at a location.

**Development and evaluation cycle 3: Real-world implementation with scouts and adult supervisors**

**Context description and participants**

To evaluate the mobile game with a larger group of children, we organized a pilot with a Scouting group, their supervisors and assisting parents. We were once again interested in users’ game perceptions, the usability of the game, but in addition to evaluating language learning effects.

This pilot was organized in close collaboration with the scouting association. All parents agreed with the use of the collected data for research purposes and also with the use of photo/video material for dissemination purposes. The supermarket manager agreed to participate in the pilot and again participating children received a small gift. After playing the game and gathering all ingredients for making pancakes, the children went to their scouting building to make and eat pancakes. This version of the game allowed a complete download of all game activities, without the activities being directly visible for the user, to prevent download problems while playing the game. Figure 3 provides an impression of the setting of the second “real-world” pilot implementation of the mobile game.
Method and instruments

The researchers welcomed the children and their accompanying adults in small groups at the entrance of the supermarket. The children received a smartphone with the game locally installed. The children and adults received brief instructions, and the children were asked to translate 10 words from Dutch to German (Appendix D), before playing the game. Afterwards, the children were asked to translate the same 10 words (Appendix E), which were part of the game, and answer additional questions about the game. A dependent t-test was used to determine language learning effects, comparing the difference in the mean number of words translated before and after playing the game. The adults also completed a questionnaire (Appendix F), containing 10 open and 7 5-point Likert Scale questions (1 = strongly disagree, 5 = strongly agree) about the game and the 10 SUS questions (Sauro, 2011).

Results and game consequences

Twentysix children and seven adults) participated in this pilot. All parents of the children agreed in advance with the use of data and photo/video material. Most children were in the upper age range or above the age of the target group (Figure 4) of the ELENA-project, also allowing evaluation of the games’ feasibility for older children. None of the children had prior knowledge of German, except one child with a German parent.

Accompanying adults’ perspective - Accompanying adults (parents and scouts supervisors) found the game suitable for the higher end of the intended age range (7 to 8 years), as apparent from the open answers in the questionnaire. They evaluated the game as fun and educative. Adults particularly valued the children being active, but also mentioned that the game helped children to remember and recall things, to learn shopping and become independent, in addition to language learning aspects. The SUS assessment of the game by adults was 64 (n = 6, as 1 questionnaire was incomplete). Research shows an SUS score above 68 to be considered above average. This indicates that adults perceived the game as less usable and learnable for children versus the experts. In interview answers, they especially stated that the children’s earplugs cord sometimes touched the screen. This moved the children to another activity, from which they struggled to navigate back to the right
activity. As the earplugs sometimes fell out of the children’s ears, one of the adults suggested using headphones instead.

The adults also noticed some irritation among shoppers, because of the large group of children playing the game in the supermarket. This will not occur when children play the game individually, accompanied only by their parents while shopping.

The overall evaluation of the game by adults showed that the game was valued mainly for its feasibility to motivate children to learn another language and make language learning more interesting (Table 4). In these results, we see that adults shared the experts’ doubts whether the game assists children to learn to recognize foreign pronunciations/sounds.

### Table 4. Accompanying adults’ (supervisors & parents) opinion of the “ELENA goes shopping” mobile game ($n = 7$)

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>The game makes children aware of the existence of foreign languages</td>
<td>3.14</td>
<td>1.48</td>
</tr>
<tr>
<td>I think the scenario raises children’s interest in a foreign language</td>
<td>2.57</td>
<td>0.62</td>
</tr>
<tr>
<td>I think the scenario helps children recognize foreign pronunciations/sounds</td>
<td>2.71</td>
<td>1.24</td>
</tr>
<tr>
<td>The game helps children to learn new vocabulary of a foreign language</td>
<td>3.29</td>
<td>1.57</td>
</tr>
<tr>
<td>Children can learn the basics of another language autonomously (without help) with the game</td>
<td>3.14</td>
<td>.48</td>
</tr>
<tr>
<td>The game motivates children to learn another language</td>
<td>3.29</td>
<td>.57</td>
</tr>
<tr>
<td>The game makes early language learning more interesting for children</td>
<td>3.43</td>
<td>.29</td>
</tr>
</tbody>
</table>

Children’s perspective – After playing the game, children mentioned in the interview that they have learned various things, besides German, like: shopping; the location of products in the supermarket; the similarity of German to Dutch; some German words; handling a smartphone; and the ingredients of pancakes and how to make them. The significant vocabulary increase after playing the game for around 25 minutes was 1 to 2 words. On average, the children could recall an extra 1.08 words in the post-play interview ($M = 1.08$, $SE = 1.99$), $t(25) = 3.89, p < .01$.

Remarkably, some children could not recall words from the 10-word list, but could recall other German words that were activated by playing the game. However, this effect was on average smaller, though significant ($M = 0.54$, $SE = 1.46$), $t(25) = 2.27, p < .05$.

Almost all children could play the game autonomously. Some children stated difficulty in re-finding the task they were doing, after accidentally moving to another activity. They then received help from adults with retrieving the right activity. They also stated that they sometimes could not hear the instructions, due to earplugs falling out or because other children were talking. Most of the received support named by children referred to other elements of the activity than the actual game, e.g., help with finding the ingredients in the supermarket or with reaching up to shelves.
All children participating in the pilot enjoyed playing the game. Highlights were making pictures, the movie with the song, and searching for the products on the shelves. The idea of new questions “coming in” after finishing the previous activity was also mentioned as fun. They especially liked that they could play the game and shop the ingredients autonomously. Some of them explicitly stated that they enjoyed this way of learning another language. All children interviewed would like to play more of these types of games, stating that it allows them to do things quicker than at school, at their own pace. They also liked that it was different from normal school. They enjoyed being active outside the classroom in another environment, playing individually (doing things yourself!) or together with a friend. Doing things instead of sitting and listening was mentioned as making learning less boring.

One child’s suggestion for the game was to integrate a time limit, within which the game must be completed. Another suggestion was the possibility to create teams yourself, and play against other teams, without adult guidance.

Based on the feedback from this pilot, we changed the user face interaction, in collaboration with a graphical designer. We made it possible to switch between activities and stressed the sequence by numbering them, so that children could more easily retrieve an activity if they lost it. Figure 5 shows some of the changes in the game, based on the feedback received during this pilot.

Figure 5. Version of mobile game before (left) and after (right) pilot feedback
We did not integrate the “team” suggestion for the game, as its objective is that it is played individually, while adults are doing their shopping. We also did not include the ‘time counter’ option, as it would probably increase the chance of children running around the supermarket.

Conclusion and discussion

The current design research study evaluated the feasibility of the “ELENA goes shopping” mobile game to support early language learning (pronunciation, vocabulary) in a real-life and non-formal context and to motivate, interest and involve children and their adult companions in early second language learning. We also evaluated the usability of the game for young children (aged 4-8).

We can conclude that the scenario successfully supported acquaintance of young children (aged 6 and older) with a neighboring (geographically proximate) language and motivated them to autonomously learn a language, with support from their adult companions where necessary. All children enjoyed the game and would like to play comparable games to learn things in context. They not only perceived that they learned another language, but could actually recall more words right after playing the game, with activation of extra words. They additionally self-reported learning other things related to the context of the game, such as locating things in a supermarket and becoming aware of pancakes’ ingredients. Children greatly appreciated their autonomy while playing, although the game simultaneously succeeded in involving adults in the children’s language learning activities. Experts and adults were also positive regarding the game’s capacity to motivate children for language learning, and found the game generally “playable” for kids.

This study shows that mobile contextualized language learning game scenarios offer the potential to extend and enhance second language learning time, by making it more varied, for example, even for very young (“early”) second language learners. Although mobile assisted language learning (MALL) has been used before to support learning vocabulary and to allow learners to take part in activities that relate directly to their (changing) locations (Duman, Orhon & Gedik, 2015; Holden & Sykes, 2011; Wang, Liu & Hwang, 2017), these learning scenarios were previously mainly targeted at older learners. This study shows that young children, accompanied by adults, can also benefit from this approach. Additionally, although digital games have already been used to foster language learning (Sykes & Reinhardt, 2013), this study shows that mobile games for early second language learning, with adult involvement, are already autonomously “playable” by young children. They can enhance young children’s interest in languages, in line with overall findings of MALL positively affecting motivation of (older) language learners (Wang, Liu & Hwang, 2017).

Notwithstanding the positive results of this design research study, we see several limitations and possible improvements for future studies. This is a case study and results cannot, therefore, be automatically generalized to other settings. Additionally, this study administered a vocabulary test right after the game. It would be interesting to check retention of words after 2 weeks, for example, and compare results versus a non-contextualized version of the game. Practically, headphones instead of earplugs could prevent some of the surrounding noise problems reported by children, though this largely depends on the context (not hearing could be unsafe in some situations). In addition, approaches to further connect and interrelate this type of non-formal learning activity with formal learning activities in ‘seamless learning experiences’ across contexts needs further and future exploration.

Acknowledgments

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References


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**Appendix**

**Appendices A-F are available at:** http://hdl.handle.net/1820/9802
Application of a Gamified Interactive Response System to Enhance the Intrinsic and Extrinsic Motivation, Student Engagement, and Attention of English Learners

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ABSTRACT
This study combined the gamification element and an interactive response system (IRS) in the development of a gamified IRS, and examined its effects on the intrinsic and extrinsic motivation, engagement, and attention of junior high school students when learning English. The quasi-experimental research method comprised the scales for measuring intrinsic and extrinsic motivation, student engagement, and attention, as well as an open-ended questionnaire to collect quantitative and qualitative data for analysis. The study involved 144 seventh-grade students who were divided into three groups to learn English using different polling tools. The results indicated that when the gamified IRS was used for polling activities in the classroom, the fun, interactive, competitive, and novel nature of the system helped improve the students’ levels of intrinsic motivation, overall engagement, emotional engagement, and focused attention. The use of clickers for polling leads to significant intrinsic motivation compared to using small whiteboards. This study suggests integrating the gamification element with classroom teaching to make English classes more interesting and attractive to learners. In addition, tools that are highly interactive, challenging, and competitive make students pay more attention in the classroom, and so are more helpful to them when learning English.

Keywords
Gamification, IRS, Intrinsic and extrinsic motivation, Student engagement, Attention

Introduction
In recent years, interactive response systems (IRSs) have gradually become a common tool for teachers’ use in the classroom. Some past studies have pointed out that IRSs have a positive effect on learning and can effectively trigger students’ learning motivation (Trees & Jackson, 2007), promote deeper engagement and classroom participation (Chien, Chang, & Chang, 2016; Sun, Martinez, & Seli, 2014), maintain students’ attention, and improve learning outcomes (Kay & LeSage, 2009; Sun, 2014). At the same time, other studies have highlighted the inadequacies of IRSs. For example, Aljaloud, Gromik, Billingsley, and Kwan (2015) found that sometimes, students would still participate and provide answers despite not having fully understood the topic. From the teachers’ perspective, additional time costs are incurred because they have to prepare questions on the topic in advance (Kay & LeSage, 2009). A factor frequently raised in studies related to IRSs is peer interaction (Chien et al., 2016). The finding was that peer discussions and interactions led to deeper understanding of knowledge and stronger learning motivation on the part of the students (Kay & LeSage, 2009). As such, in this study, we wanted to establish an IRS that could address the aforementioned inadequacies, enhance teacher-student and peer-to-peer interactions, and give students more autonomy for independent decision-making. The aim was to improve students’ concentration and focus in the classroom, thereby creating a positive effect on their learning motivation, engagement, and attention.

Gamified learning has been the focus in the educational field over the past few years. It emphasizes that the integration of the gamification element in non-game domains is to stimulate students’ motivation and interest (de-Marcos, Garcia-Lopez, & Garcia-Cabot, 2016; Deterding, Dixon, Khaled, & Nacke, 2011; Dichev, Dicheva, Angelova, & Agre, 2014). The purpose is for learning to be student centric so that learning becomes interesting and highly interactive. In his study on the integration of gamification with instant feedback systems, Wang (2015) found that the competitiveness of games helped students maintain attention during classes. However, the study only integrated the competitive mechanisms of gamification in the instant feedback system—it lacked the enriching elements of gamification, and the system did not include features to allow students to express themselves. In this study, we argue that when it comes to instant feedback systems, a design that has diverse gamification elements and interaction mechanisms as features can break out of the unidirectional communication of teachers asking and students answering, thereby promoting teacher-student and student-student interactions. Since gamification, with its mechanism and diverse elements, can promote both students’ learning interest and classroom interactions, we wanted to combine it with an IRS and examine the resultant effect on students’ learning.
Although due emphasis has been placed on the learning of English in Taiwan, classroom teaching on the subject nowadays is still unidirectional, with the teacher basically adopting the style of verbal instruction. The motivation for junior and senior high school students to learn English remains low, despite the availability of various English-related extracurricular activities (Shih, 2016). Past studies have shown that students’ intrinsic motivation for learning gradually decreases with age as they advance from elementary to high school (Gottfried, Marcoulides, Gottfried, & Oliver, 2009). Junior high school is a good time for students to develop a strong motivation for learning English, which will be helpful in sustaining their commitment to learning in the future. So far, the majority of studies on the application of IRSs have been limited to college classes (Aljaloud et al., 2015), with a relative lack of literature on their application in junior high schools and other stages of the education process. As such, this study aimed to develop a gamified IRS for application to the learning of English in junior high school classrooms and to examine whether the use of such a system can enhance students’ intrinsic and extrinsic motivation, engagement, and attention.

In conclusion, many studies have confirmed that an instant feedback system has positive effects on learning motivation, learning engagement, attention, and learning performance (Aljaloud et al., 2015; Chien et al., 2016). On the other hand, gamified learning can increase student interest in learning while at the same time promoting learning motivation (de-Marcos et al., 2016; Dichev et al., 2014). Wang (2015) applied the gamified element of competition to an instant feedback system and, using the conventional question and answer feedback system functionality, discovered that the system could help students maintain their attention while learning. However, we believe that making a high degree of interactivity the core of gamified learning would help to design a more interactive and instantaneous instant feedback system. Through the use of gamified elements and interaction mechanisms, a learning environment that helps students become more engaged and motivated can be created. Therefore, the goal of this study is to explore the effect that a gamified instant feedback system for English learning has on intrinsic and extrinsic motivation, learning engagement, and attention.

**Literature review**

**Gamified IRS**

IRSs have often been used to investigate students’ current level of knowledge and to assess their learning situations (Stowell, 2015). These systems have an interesting and attractive mode of operation, and can create a pleasant and positive classroom atmosphere (Johnson & Lillis, 2010). However, many past studies have pointed out the shortcomings of IRSs (Aljaloud et al., 2015; Kay & LeSage, 2009), or have found that the tool was more effective when combined with other teaching strategies such as peer interactions (Chien et al., 2016). Since gamified learning can stimulate students’ interest and promote classroom interactions, we decided to combine it with an IRS in the hope that the advantages of both methods could enhance students’ learning outcomes. It should be noted that gamified learning is not simply the use of the game format to present learning content. Rather, it is using the gamification element to stimulate students’ learning motivation and interest (de-Marcos et al., 2016; Dichev et al., 2014). According to Malone and Lepper (1987), the main features of learning games include challenge, fantasy, curiosity, and control. A game is a challenge because it has a specific goal. Indeterminate results, produced through hidden clues and different levels of difficulty and randomness, trigger the players’ competitive spirit. It is a fantasy because it contains events that do not exist in reality. It focuses on piquing the players’ sensory and cognitive curiosities. During the game, players experience independent decision-making and the giving of instructions. In this study, we used the aforementioned four features of the game mechanism (Malone & Lepper, 1987) as the core elements in designing the interface of the gamified IRS. In so doing, the gamification mechanism was used to enhance students’ learning motivation and attention when they took the initiative to participate in activities involving interactive responses.

Recent studies have combined interactive feedback systems with gamification designs and applied them in the field of education. Wang (2015) had previously used the gamified IRS named Kahoot! as a research tool and found that the competitiveness of the game effectively helped students pay attention in class. Kahoot! applies the polling format to competitions among large and small groups, and has functions such as sound effects and countdown timers for the games. However, teacher-student interactions remain unidirectional, with the teacher setting the questions and the students answering them. This study wanted to promote greater levels of student participation in the classroom through the introduction of other game functions, such as having the students submit options for multiple-choice questions and make bets on the correct answer. Thus, it was important to develop a new type of gamified IRS and test its effectiveness.
Effect of IRSs on intrinsic and extrinsic motivation

Intrinsic motivation refers to a particular person having the interest to participate in an activity, and deriving inner pleasure from doing so. However, it is extrinsic motivation if the person participates in the activity because he/she is attracted by external factors (e.g., getting good grades, doing schoolwork to get rewards and special privileges) rather than the activity itself (Ryan & Deci, 2000a). Students were found to be more proactive and focused when they undertook tasks with intrinsic value (Wigfield & Eccles, 2000). They were also able to gain a more in-depth understanding of the content and concepts of the teaching materials, and the information learned was retained for a longer period (Vansteenkiste, Lens, & Deci, 2006). Extrinsic motivation is especially important when students lack personal interest; the use of extrinsic incentives to increase participation can help promote interest in learning (Hidi & Harackiewicz, 2000). Intrinsic motivation plays an essential motivating role in personal development, adaptation, and the learning process (Ryan & Deci, 2000b). However, the English learning motivation of Taiwanese junior and senior high school students tends to be low (Shih, 2016), so this study included intrinsic and extrinsic motivation in the scope of exploration.

Past studies have shown that teachers can use IRSs to make lessons richer and more interesting. This would stimulate the interest of students to learn, increase teacher-student interaction, and make the classroom atmosphere more harmonious (Chien et al., 2016). Past studies have shown that choice affects intrinsic motivation (Ryan & Deci, 2000b). Students who can choose their own goals, tasks, and problems have a higher intrinsic motivation to complete their activities (Schunk, Meece, & Pintrich, 2012). The interactivity of instant feedback systems provides students with the opportunity to choose classes by polling, which helps to enhance learning motivation. Additionally, the competitive effect brought about by the games and the friendly interactions among peers can make students more interested in the lesson, leading to stronger learning motivation and improved learning outcomes (Burguillo, 2010). Lepper and Hodell (1989, as cited in Schunk et al., 2012) discovered that the four main sources of intrinsic motivation were challenge, curiosity, control, and fantasy. These coincided with the four elements that a gamified mechanism should have. It then follows that the combination of an IRS with the gamification element can enhance students’ intrinsic interest, which would in turn increase learning motivation. Therefore, this study wanted to explore whether a gamified IRS could significantly increase students’ intrinsic and extrinsic motivation.

Effect of IRSs on student engagement

Student engagement refers to their level of participation in teaching activities (Sun & Rueda, 2012). When they are engaged in learning activities, there will be continued participation and exhibition of more positive emotions (Skinner & Belmont, 1993). Using past scholars’ definition of student engagement as the basis, Fredricks, Blumenfeld, and Paris (2004) divided engagement into three types: behavioral, emotional, and cognitive. Behavioral engagement refers to students being actively involved in learning tasks, complying with classroom rules, and being involved in school activities. Emotional engagement refers to students’ emotional responses to the class or to their peers and teachers (Hu, Ching, & Chao, 2012). Cognitive engagement emphasizes the cognitive and psychological efforts made, which includes the emotional state during the learning process and learning strategies employed (Fredricks et al., 2004).

Many past studies have verified that classroom usage of IRSs improved student engagement (Chien et al., 2016; Sun et al., 2014; Trees & Jackson, 2007). By promoting teacher-student interaction, the instant feedback system helps to enhance students’ learning engagement. The research of Sun et al. (2014) found that online polling can effectively increase cognitive and emotional engagement. Thus, the instant feedback system can foster teacher-student and student-student exchanges and promote cooperation and discussions. Not only can it help students understand the teaching content, but it can also improve students’ classroom participation (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013). At the same time, gamification, which combines games and learning content, was also found to have an effect on student engagement. It can effectively enhance student engagement and participation. Sun and Rueda (2012) also pointed out that emotional engagement is promoted when elements that students are interested in have been added to the course. A game that is challenging can attract students to participate in the learning process (Hung, Sun, & Yu, 2015; Wang & Chen, 2010). Goehle (2013) used a gamified online learning platform to design an incentive mechanism for take-home assignments and found that students expressed that when they spent time and effort to master the concepts and repeatedly tried to complete difficult tasks, receiving a reward gave them a sense of accomplishment. Thus, gamified learning has a certain degree of influence on behavioral, emotional, and cognitive engagement. To sum up, both IRSs and gamification have positive effects on increasing student engagement. Hence, this study combined the two methods to make students more engaged in the learning process.
Effect of IRSs on attention

Attention refers to the concentrating and focusing of one’s consciousness (James, 2007). Sohlberg and Mateer (1987) used past literature related to attention therapy as the basis of their study, and proposed that attention can be divided into five levels: selective, divided, sustained, focused, and alternating. When there is focused attention, a person will have visual, auditory, tactile, or other responses to definite objects, meaning that he/she is able to respond to changes in the surrounding environment. When learners cannot concentrate on learning, the success rate of the learning task is significantly reduced (Foulsham, Farley, & Kingstone, 2013). Hence, the type of attention being investigated and measured in this study was focused attention. In the past, many scholars applied IRSs in the classroom to enhance students’ attention during the learning process, and obtained significantly positive results (Kay & LeSage, 2009; Sun, 2014; Sun, Chen, Yeh, Cheng, & Lin, 2018a; Sun et al., 2018b). Games are also helpful in attracting players’ attention (de-Marcos et al., 2016). As such, when this study applied an actual gamified IRS to the classroom, the research scope was its effect on focused attention to understand whether students’ attention could be made more focused.

In summary, current studies have confirmed that instant feedback systems and gamified learning yield benefits in terms of learning motivation, learning engagement, and attention. When past studies integrated game elements into instant feedback systems, they did not divert from the conventional one-way interaction of the question-and-answer method (Wang, 2015). Based on these results, this study attempted to integrate enriching game mechanisms into an instant feedback system in the hope of creating a learning environment that can effectively improve learning motivation, engagement, and attention. The goal of this study is to explore the effect that a gamified instant feedback system for English learning has on intrinsic and extrinsic motivation, learning engagement, and attention. The research model of the study is shown in Figure 1.

Intrinsic and Extrinsic Motivation
- Behavioral engagement
- Emotional engagement
- Cognitive engagement

Figure 1. Research model

Research methods

Participants

The research was conducted in spring 2017 and involved two teachers and a total of 144 seventh-grade students in six English classes from a public junior high school located in northern Taiwan. All classes were organized using normal class grouping. After eliminating the invalid samples (for not filling in the questionnaire properly or for being absent from class), 118 valid samples remained. There was an equal distribution between the two genders, with the average age being 13.03 years (SD = 0.47).

The six classes were equally divided into three groups: one control and two experimental groups. The control group had a valid sample of N = 43 (24 males, 19 females). Its participants underwent the traditional teaching and polling mode using a small whiteboard. Experimental Group A (valid sample N = 39, 19 males, 20 females) used a general IRS with clickers, which are commonly seen in classrooms. Each participant had a clicker for polling. Experimental Group B (valid sample N = 36, 16 males, 20 females) used a gamified IRS that was proposed and developed for this study, called the Interactive, Feedback-based In-class Teaching System 3 (iFIT3). Each participant was given either a tablet or a mobile phone for polling.
Methods and instructional design

The experimental process of this study is shown in Figure 2. Four sessions were held within 2 weeks. During Session 1, the experimental content was explained to the participants, and notices to inform parents of the experiment were issued. The students were then given 15 minutes to complete the pre-test form for measuring learning motivation. The course content was then taught. Sessions 2–3 focused on the teaching of the course content. Three sets of materials form Unit 8, “How Much Pork Do We Need?” of the first-year junior high school textbook of a particular publisher. The teaching content teaches learners to distinguish between countable and uncountable nouns and the difference in the usage of “how many” and “how much.” Teaching activities arranged by the teacher include listening to the dialogue on the CD, listening to the answer, reading along, grammar explanations, sentence forming, and cloze tests. During each session, at least five questions requiring interactive responses from the students were posed.

The polling situations in the classrooms for the three groups are shown in Figure 3. Participants in the control group and Experimental Group A wrote their answers on the small whiteboard or used the clickers, respectively. Those in Experimental Group B used the iFIT3 to bet on possible answers using game tokens. Alternatively, some students posed questions to the teacher while their peers submitted options for the multiple-choice questions. There was also a leaderboard function, which encouraged friendly competition among students. The screenshots of the various system functions of iFIT3 are shown in Figures 4–6.
The design of the game functions is shown in Table 1. Gamification elements were added to the polling process, such as background sound effects and countdown timers. The iFIT3 function developed in this study used the four game elements of challenge, fantasy, curiosity, and control (Malone & Lepper, 1987) as the core design concepts. The operating system language of the iFIT3 system is Mandarin, which is the native language of the learners, to avoid issues when operating the system, while the learning content is in English. During the last 15 minutes of Session 3, the participants in all three groups were asked to complete post-test forms for measuring their intrinsic and extrinsic motivation, student engagement, and focused attention. Since intrinsic and extrinsic motivation can be measured through an individual’s attitude and intentions on the rating scale for motivation, surveys were conducted before and after the experiment to evaluate the learning intent of students regarding
English lessons. Engagement and attention were measured through the assessment of the learning experience; it had to be conducted after the conclusion of the English class so that students would be able to recall the experiences and feelings that were the results of the class taken. For Session 4, each student was asked to complete an open-ended questionnaire after the class was concluded.

![Figure 6. iFIT3 system screen: post-polling results and the leaderboard](image)

**Table 1.** Functional design of the iFIT3 and design focus of the corresponding gamified elements

<table>
<thead>
<tr>
<th>Game functions</th>
<th>Design focus for gamification</th>
<th>Design ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make bets (using game tokens)</td>
<td>Challenge; Control</td>
<td>By moving from single answers to the option to bet, students have more flexible choices, and the interest and uncertainty can be increased, which in turn makes the game more challenging.</td>
</tr>
<tr>
<td>Game points; Leaderboard</td>
<td>Challenge; Fantasy</td>
<td>By applying fantasy elements to designing virtual game points and leaderboards, the competitiveness for ranking on the leaderboard prompts students to challenge themselves while playing the game.</td>
</tr>
<tr>
<td>Countdown timers; Sound effects</td>
<td>Challenge; Fantasy; Curiosity</td>
<td>By using time limits and sound effects to create the in-game atmosphere, the game can trigger students’ curiosity and increase the thrill and challenge of the game.</td>
</tr>
<tr>
<td>Submit options for multiple-choice questions; Make bets on options provided by peers</td>
<td>Control</td>
<td>By giving students a high degree of autonomy in learning, they can freely provide answers, and their bets would not be limited to options that the teacher(s) has provided.</td>
</tr>
</tbody>
</table>

**Instruments**

The scale for measuring intrinsic and extrinsic motivation was adapted from the Motivated Strategies for Learning Questionnaire (MSLQ) compiled by Pintrich, Smith, Garcia, and McKeachie (1991). The original scale was revised to a 6-point Likert scale. There were eight questions in total, with four questions for each construct. An example of a question on intrinsic motivation is, “In English class, I prefer content that challenges me in order to learn new things.” An example of a question on extrinsic motivation is, “One of the things I am most
satisfied with now is that I have good grades in English class.” In terms of reliability of the post-test scores, the Cronbach’s alpha value for the scale was .94, while the reliability of the constructs had scores of .89–.94. Overall, the internal consistency was good (Nunnally & Bernstein, 1994). Further, validity review of the scale was done by experts with educational backgrounds.

The scale for measuring student engagement was translated and adapted from the scale compiled by Fredricks, Blumenfeld, Friedel, and Paris (2005), with reference to that of Sun et al. (2014). The modified version was a 6-point Likert scale. There were five, six, and eight questions on behavioral, emotional, and cognitive engagement, respectively. An example of a question on behavioral engagement is, “I will follow the rules of this English class.” An example of a question on emotional engagement is, “I like to participate in this English class.” An example of a question on cognitive engagement is, “I will check whether my answer is wrong.” In terms of reliability of the post-test scores, the Cronbach’s alpha value for the scale was .95, while the reliability of the constructs had scores of .70–.95, indicating that there was good overall internal consistency (Nunnally & Bernstein, 1994). Similarly, the validity review of the scale was done by experts with educational backgrounds.

The scale for measuring focused attention was translated and adapted from the scale for measuring fun during Internet and multimedia learning experiences, which was proposed by Lin, Gregor, and Ewing (2008). Questions on the construct of focused attention from the scale were used as the measuring tools in this study. The original scale was revised to a 6-point Likert scale with a total of four questions. An example of a question on focused attention is, “This class lets me focus entirely on learning.” In terms of the reliability of the post-test scores, the Cronbach’s alpha value for the overall scale was .96, indicating good internal consistency in terms of reliability (Nunnally & Bernstein, 1994). Experts with educational backgrounds reviewed the validity of the scale.

The open-ended questionnaire was designed by the researcher. Its main purpose was to understand students’ experiences of using the various tools and to serve as qualitative information to provide additional information to supplement the quantified results. The questions included whether the students liked the teaching method after having attended the course, the differences they found between this and previous English classes, whether the system challenged them and stimulated their curiosity for learning English, and how the polling tools that they had used could be improved. The content of the open-ended questionnaires can be found at http://iltm.nctu.edu.tw/additional_info.

### Research results

#### Analysis of results for intrinsic and extrinsic motivation

For intrinsic motivation, the effect of interaction between the covariates and variables was not significant ($F = 2.13$, $p = .12$) and neither was the homogeneity hypothesis test result for intra-group variance ($F = .95$, $p = .39$). The results of the ANCOVA analysis are shown in Table 2. The adjusted mean post-test values for the control group and Experimental Groups A and B were 15.04, 17.14, and 16.68, respectively. This meant that for intrinsic motivation, the post-test results of students who had undergone the three different teaching methods were significantly different ($F = 6.33$, $p < .05$). Post-hoc comparisons revealed that the respective values for both experimental groups were significantly different from that of the control group.

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>$F$</th>
<th>$p$</th>
<th>Partial $\eta^2$</th>
<th>Post-hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>1309.83</td>
<td>1</td>
<td>1309.83</td>
<td>164.57</td>
<td>&lt; .001</td>
<td>59.1%</td>
<td></td>
</tr>
<tr>
<td>Inter-group</td>
<td>100.80</td>
<td>2</td>
<td>50.40</td>
<td>6.33</td>
<td>.002</td>
<td>10%</td>
<td>A &gt; C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B &gt; C</td>
</tr>
<tr>
<td>Intra-group</td>
<td>907.36</td>
<td>114</td>
<td></td>
<td>7.96</td>
<td>.001</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>2318</td>
<td>117</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* A and B = Experimental Groups A and B, respectively; C = control group.

For extrinsic motivation, the effect of interaction between the covariates and variables was not significant ($F = 1.842$, $p = .163$) and neither was the homogeneity hypothesis test result for intra-group variance ($F = .33$, $p = .72$). The results of the ANCOVA analysis are shown in Table 3. The adjusted mean values for the control group and Experimental Groups A and B were 15.78, 17.18, and 16.68, respectively, indicating that the post-test results of students who had undergone the three different teaching methods were not significantly different in terms of extrinsic motivation ($F = 1.34$, $p = .27$).
Table 3. Summary of covariance analysis for extrinsic motivation

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>Partial η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>792.06</td>
<td>1</td>
<td>792.06</td>
<td>52.33</td>
<td>&lt; .001</td>
<td>31.5%</td>
</tr>
<tr>
<td>Inter-group</td>
<td>40.45</td>
<td>2</td>
<td>20.23</td>
<td>1.34</td>
<td>.27</td>
<td>2.3%</td>
</tr>
<tr>
<td>Intra-group</td>
<td>1725.45</td>
<td>114</td>
<td>15.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>2557.96</td>
<td>117</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis of results for student engagement

The analytical results for overall student engagement are shown in Table 4. The mean values for the three groups were 70.73 (SD = 17.14), 75.56 (SD = 21.77), and 84.45 (SD = 14.81), respectively. Levene’s test for homogeneity hypothesis of variance was established ($F = 1.49, p = .23$). The effect of the inter-group factor was significant ($F = 5.66, p < .05$), showing that students using the various types of polling tools had significantly different post-test scores for overall student engagement. The results of post-hoc comparisons indicated that the students in Experimental Group B scored significantly better than those in the control group for overall student engagement.

Table 4. Summary of single-factor variance analysis for overall student engagement

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>Partial η²</th>
<th>Post-hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-group</td>
<td>3740.48</td>
<td>2</td>
<td>1870.24</td>
<td>5.66</td>
<td>.01</td>
<td>8.96%</td>
<td>B &gt; C</td>
</tr>
<tr>
<td>Intra-group</td>
<td>38028.23</td>
<td>115</td>
<td>330.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>41768.70</td>
<td>117</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. A and B = Experimental Groups A and B, respectively; C = control group.

Further analysis was conducted of the three constructs of behavioral, emotional, and cognitive engagement, with the results shown in Table 5. In terms of emotional engagement, the mean value for Experimental Group B ($M = 29.70, SD = 5.91$) was significantly higher than for both the control group ($M = 22.49, SD = 6.78$) and Experimental Group A ($M = 25.15, SD = 8.24$). Compared to students who used the general IRS or traditional polling method, those who used the gamified IRS had a significantly higher level of emotional engagement.

Table 5. Summary of variance analysis for the various constructs of student engagement

<table>
<thead>
<tr>
<th>Construct</th>
<th>F</th>
<th>p</th>
<th>Post-hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral engagement</td>
<td>2.89</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>Emotional engagement</td>
<td>10.33</td>
<td>&lt; .001</td>
<td>B &gt; C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>B &gt; A</td>
</tr>
<tr>
<td>Cognitive engagement</td>
<td>2.28</td>
<td>.107</td>
<td></td>
</tr>
</tbody>
</table>

Note. A and B = Experimental Groups A and B, respectively; C = control group.

Analysis of results for attention

The analytical results for attention are shown in Table 6. The mean values for the three groups were 14.48 (SD = 4.61), 16.54 (SD = 5.46), and 17.97 (SD = 4.61), respectively. Levene’s test for homogeneity hypothesis of variance was established ($F = 5.1, p = .61$). The effect of the inter-group factor was also significant ($F = 5.08, p < .05$). This showed that for students using various types of polling tools, their post-test scores for attention were significantly different. In addition, the results of post-hoc comparison revealed that students in Experimental Group B scored significantly better on attention than those in the control group.

Table 6. Summary of single-factor variance analysis for attention

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>Partial η²</th>
<th>Post-hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-group</td>
<td>244.81</td>
<td>2</td>
<td>122.40</td>
<td>5.08</td>
<td>.008</td>
<td>8.12%</td>
<td>B &gt; C</td>
</tr>
<tr>
<td>Intra-group</td>
<td>2771.16</td>
<td>115</td>
<td>24.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>3015.96</td>
<td>117</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. A and B = Experimental Groups A and B, respectively; C = control group.
Discussion

Students who used either the general or gamified IRSs for classroom polling had significantly greater intrinsic motivation for learning English than those who used the whiteboards. This could be because the operating methods of the IRSs were attractive to the students and created a pleasant classroom atmosphere (Johnson & Lillis, 2010). Following this, the teachers were able to plan richer and more interesting course content to stimulate the students’ interest in learning and to promote classroom interactions (Chien et al., 2016). Intrinsc motivation to learn might be triggered when students experience fun during the process (Ryan & Deci, 2000a; Ryan & Deci, 2000b). The qualitative data indicated that, to the students, both general and gamified IRSs were novel and interesting tools to use. Their comments were as follows:

“But because answers could be selected using the clickers, and everyone could make their own choices.” (Student 1, Experimental Group A)

“It was more fun to poll with the clickers.” (Student 2, Experimental Group A)

“The learning process felt very easy and relaxed.” (Student 1, Experimental Group B)

In addition, the IRSs and gamification element did not result in any significant difference in terms of extrinsic motivation. Past studies have found that extrinsic motivation is particularly important when students do not have any personal interest in the topic (Hidi & Harackiewicz, 2000). The qualitative data showed that for the control group, 56.3% of the students felt that using the whiteboard made them more motivated to learn and that the process was interesting. This study indicated that regardless of the polling tool used (small whiteboards, clickers, or iFIT3), the design of the polling activity itself was inherently interesting to the students. We speculate that this is because the three types of polling strongly stimulated the students’ intrinsic motivation; it can also be seen from the open-ended questionnaire that the students found the use of the new learning tools to be very interesting. Therefore, the polling method of this study may be less related to extrinsic motivation, which led to this experiment not finding a significant improvement due to the effect of extrinsic motivation.

The study also found that classroom usage of gamified IRS can significantly enhance student engagement. It was also ascertained that the provision of the gamification element was effective in facilitating emotional engagement. Students’ opinions revealed that 91.3% of them liked classes that made use of the gamified IRS. The following qualitative data from the open-ended questionnaire corroborated these results:

“But it was challenging.” (Student 2, Experimental Group B)

“It was the interactivity that made it fun.” (Student 3, Experimental Group B)

“It was more enjoyable, and it was competitive.” (Student 4, Experimental Group B)

Additionally, 76.1% of the students confirmed that they felt a stronger sense of participation in the class because they were able to contribute their own answers and had the option to bet on answers for the multiple-choice questions. From a comparison of the quantitative results and the information from the open-ended questionnaire, it was found that the functional design of the gamified IRS could promote classroom interaction and increase student engagement during classroom learning. This study also confirmed the findings of past scholars: that the provision of IRSs could definitely enhance student engagement (Chien et al., 2016; Sun et al., 2014; Trees & Jackson, 2007). This study further found from some students’ opinions that a challenging game can arouse students’ interest and promote their participation and interaction in class (Hung et al., 2015; Wang & Chen, 2010). After analyzing the three constructs of engagement, it was determined that when the gamification element (which the students were interested in) was included in the course, students’ emotional engagement increased (Sun & Rueda, 2012). In summary, the iFIT3 can be put to actual use in the classroom to effectively increase student engagement when learning English.

For the aspect of attention, students who used the gamified IRS for classroom polling performed better than those who used the small whiteboards. According to the results of the open-ended questionnaire, 13% of the students in Experimental Group B stated that they were more attentive in class because the questions and options for game betting appeared in the content that the teacher taught. The following qualitative data from the open-ended questionnaire corroborated these results:

“I paid attention in class because I wanted to win more tokens and be at the top of the leaderboard.” (Student 5, Experimental Group B)

“I was very attentive because all the quiz questions involved information taught during the class.” (Student 6, Experimental Group B)
This qualitative finding was consistent with the research finding of Wang (2015), specifically that the competitive element of the gamified IRS can effectively sustain students’ attention in class. During the teaching activities, some of the students really felt a sense of competition brought about by the gamified IRS. The competitive spirit of the game in turn made them pay more attention during the classroom teaching preceding the polling activity. This study further confirmed that the attention of students who used the gamified IRS was more focused compared to those in the control group, who used small whiteboards without any competitive element of gaming or polling functions. When this finding is applied to English classes (i.e., teachers create an interesting classroom atmosphere with a spirit of healthy competition), students’ level of focused attention will be elevated.

To sum up, this study verified that the use of novel IRSs and teaching methods can effectively increase students’ interest in learning and their intrinsic motivation, emotional engagement and attention. Students’ interest in the class definitely contributed more to the learning process. The results of this study show that general interactive feedback systems and gamified instant feedback systems only differ regarding emotional engagement. With the features of stimulating students’ interest and enhancing the classroom interactions, both general interactive feedback systems and gamified instant feedback systems can effectively increase students’ intrinsic motivation. Lastly, compared to small whiteboards, using gamified instant feedback systems can better help students engage in and concentrate on the learning process.

Conclusion, limitations, and implications

The aim of this study was to combine the IRS with the gamification element and then put it to actual use in the classroom to examine the system’s effects on intrinsic and extrinsic motivation, engagement, and attention of junior high school students when learning English. The results showed that the proposed gamified IRS could effectively stimulate their interest and intrinsic motivation during English class. There were also positive effects on their levels of emotional engagement and focused attention during class. This study proposes that gamified IRS is a teaching tool that can promote learning motivation. Based on the findings, this study recommends that using an instant feedback system can be beneficial for enhancing the intrinsic motivation for learning English, while a gamified instant feedback system can further enhance emotional engagement and provide students with more satisfying and exciting learning experiences. Further, when tools that are highly interactive, challenging, and competitive (such as the iFIT3) are used, the students will be more focused during the class, which will in turn benefit their learning of English.

It should be noted that this study faced some limitations. Since the entire experiment lasted only 2 weeks, it could not be determined whether long-term usage of the tools would reduce students’ sense of novelty (leading to the onset of boredom). Another issue was whether there would be any negative effect on students (for example, increased anxiety) if they were immersed in the competitive gaming atmosphere over a long period of time. In terms of equipment, there must also be sufficient mobile devices for every student in class. These various environmental factors should be noted and attended to prior to implementation.

Lastly, for future studies, other types of IRSs combining the gamification element or questioning should be developed, which would introduce diverse gamified IRSs. In this way, the novelty of the tool would be maintained. Separately, the gamification element can be combined with other teaching tools (such as gamified e-books or class management platforms) or incorporated into existing teaching strategies. This would further expand the advantages of gamified learning.

Acknowledgements

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Reference


A Flipped Contextual Game-Based Learning Approach to Enhancing EFL Students’ English Business Writing Performance and Reflective Behaviors

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ABSTRACT

English business writing is an important and challenging course for English as Foreign Language (EFL) students since it is not only related to English writing skills, but also to business knowledge. Context-game-based learning seems to be a good approach to situating students in a meaningful and interesting practicing environment, which could improve their learning motivation and interest. However, without interacting with the teacher and peers, the effectiveness of game-based learning could be limited. In this study, a flipped contextual game-based learning approach was proposed to cope with this problem; moreover, a mixed methods research approach was used to analyze the writing performance, writing errors, and reflective content of the students who learned with the proposed approach and those learning with conventional contextual game-based learning. The experimental results revealed that the flipped contextual game-based instruction was able to enhance the students’ English writing performance. It was also found that those students with the flipped learning approach had fewer writing errors than those learning with the conventional approach. Moreover, by analyzing the students’ reflective content, the benefits and challenges of flipping the classroom are reported. These findings could be valuable references for those who intend to conduct effective flipped contextual game-based learning with learning management systems to motivate students’ game-based learning and to improve their language learning performance.

Keywords

Contextual game-based learning, Flipped learning, Mixed methods, ESP writing classroom

Introduction

English is the most popular international language in the world (Hsieh, Wu, & Marek, 2017; Liu & Chu, 2010), and more and more people have been studying exhaustively in an attempt to master English skills. Compared to native language learners, there are few opportunities for English as a foreign/second language (EFL) learners to drill and practice their language skills (Liu & Chu, 2010; Shadiev, Hwang, Huang, & Liu, 2016), and they usually lack an authentic learning environment (Hwang & Chen, 2013; Hwang, Shih, Ma, Shadiev, & Chen, 2016; Liu & Chu, 2010). When learning in contexts related to real life, it would be easier for EFL learners to understand the meanings of the learning materials (i.e., words, sentences, or texts) (Hwang et al., 2016), and, if provided with more chances to practice in this environment, they are likely to learn better (Hwang & Chen, 2013).

However, it is not easy to secure real-life learning contexts for EFL learners; for example, Lan (2015) found that many EFL learners are too shy to use English in the real world. Educational digital games could solve this issue, as they are regarded as an effective way of engaging students in a study in situated learning environments (Sung, Hwang, & Yen, 2015), partly due to their facilitation of EFL learners’ motivation. Moreover, research indicates that digital educational games could provide authentic contexts for language or EFL learners to drill and practice their language skills (Liu & Chu, 2010; Shadiev, Hwang, Huang, & Liu, 2016), and they usually lack an authentic learning environment (Hwang & Chen, 2013; Hwang et al., 2016; Sung, Hwang, Lin, & Hong, 2017). To date, incorporating contextual educational games into language education has expanded (Butler, 2015). An increasing number of researchers have reported that the contextual game-based learning approach is beneficial to EFL learners’ learning performance (Hwang & Chen, 2013; Liu & Chu, 2010), but mostly this approach has been conducted to facilitate students’ vocabulary learning (e.g., Butler, 2015), listening, speaking (Liu & Chu, 2010; Reinders & Wattana, 2014), and reading (Sung et al., 2017), with few studies having aimed to help students practice their writing skills (Allen, Crossley, Snow, & McNamara, 2014), not to mention their business writing skills.

Business writing is a critical professional communication skill in the business world. To master this critical skill, students must gain knowledge of business and trade processes, writing business letters, and so on. However, this knowledge is far removed from university students’ daily life, so understanding such de-contextualized learning content could be difficult, and could even decrease students’ learning motivation and fail to engage them in meaningful learning. Given that contextual educational games could provide a situated learning environment for better learning (Sung et al., 2015), it would be useful to incorporate contextual game-based learning into instructional activities for English business writing.
On the other hand, some researchers doubt the effectiveness of digital educational games. For instance, Bolliger, Mills, White, and Kohyama (2015) reported that some university students from Japan were concerned that games may not be an effective method for English language learning. Although contextual educational games could improve EFL students’ learning motivation and engagement, and reduce their learning anxiety, it is still necessary to design learning tasks to take advantage of the educational affordances of contextual games. Allen et al. (2014) also stated that, compared to instructing L1 writing, there is less effective guidance from educators to support L2 students’ writing. Moreover, compared to ordinary English writing, business writing is more challenging because its learning content is less relevant to daily life. Therefore, it is necessary to develop effective learning strategies to integrate contextual game-based learning into L2 business writing activities.

The flipped classroom is an innovative instructional approach which reverses the traditional teaching and learning pedagogy (Hwang, Lai, & Wang, 2015; Lai & Hwang, 2016); that is, students study the learning materials prepared by teachers before the class, and do exercises or participate in discussion or other activities in the class with the teacher’s guidance and support (Bergmann & Sams, 2015). Several previous studies have reported the benefits of such an approach; that is, teachers can have more opportunities to guide students to apply what they have learned to practical applications and provide required supports to individual students in the class (Hsieh et al., 2017; Kong, 2014; Thai, De Wever, & Valcke, 2017). For example, Thai et al. (2017) conducted a flipped classroom setting to help undergraduate students in a course on Invertebrates, and found that the better improvement in learning performance was contributed to by the students being given more time to process the learning content in the online learning activities. Such a learning approach that enables students to have more practice with peers and the teacher is quite suitable for English courses for EFL students since teacher-supported practice and peer interactions are important for language learning. Therefore, several researchers have attempted to conduct flipped classrooms for foreign language learning (Basal, 2015; Hung, 2015; Sung, 2015).

Therefore, in this study, a flipped contextual game-based learning approach was proposed to enable students to have more practice and peer-interaction time in the class with support from the teacher during the game-based learning process. An experiment was conducted at the university level in the northern part of Taiwan, with one undergraduate flipped classroom. This study aimed to investigate the participants’ learning performance, writing errors, and reflective content. The following research questions guided the study:

- Do students who learn with the flipped contextual game-based learning approach have significantly better English business writing performance than those who learned with the contextual game-based learning approach?
- What are the differences between the English business writing errors made by the students learning via the two different game-based learning approaches?
- What are the differences between the reflective content of the students who learned with the flipped contextual game-based learning approach and those who learned with the contextual game-based learning strategy in terms of usefulness, satisfaction, motivation, and negative flow presence?

Literature review

Contextual game for English learning

Traditional education assumes typically that knowledge is abstract, decontextualized, and independent of the situation (Brown, Collins, & Duguid, 1989; Herrington & Oliver, 2000). When confronted with obscure, meaningless learning materials, it is difficult for students to assimilate knowledge. While contextual learning (or situated learning) highlights active cognitive processes and social interactions in authentic learning contexts (Brown et al., 1989), researchers have advocated that school instruction should help students learn concepts and knowledge by way of experiencing realistic situations (Zheng, 2010). The contextual learning perspective has been applied widely and has also been found to be beneficial for students’ development in many aspects, such as the acquisition of knowledge (Franciosi, 2017), problem-solving skills (Huang, Lubin, & Ge, 2011), higher-order thinking (Herrington & Oliver, 1999), project performance (Zheng, 2010), and collaboration (Taylor, 2003).

During the past decade, the application of educational games has grown rapidly in diverse school settings and various disciplines (Hwang & Wu, 2012), and digital game-based learning has frequently been adopted as a pedagogically innovative learning approach to facilitate EFL learners’ study (Cornillie, Thorne, & Desmet, 2012). With the advancements in digital game technologies, and further exploration of integrating digital game-based learning with diverse learning theories or methods (e.g., Situated learning), the contextual game-based learning approach has proved to be promising for learning, and at the same time, many researchers have begun to explore its educational value in language instruction. For instance, Lan, Fang, Legault, and Li (2015) found that
a virtual gamification environment could provide rich contextual cues to reinforce learners’ perceptions of language input, and was favorable for the learning of Mandarin Chinese as a second language. Hwang et al. (2016) designed game-based learning activities integrated with meaningful learning materials from daily life to help senior high school students master listening and speaking skills; Reinders and Wattana (2014) engaged Thai EFL learners in a university language course by playing an online contextual game, and improved their willingness to communicate in English; Hwang, Hsu, Lai, and Hsueh (2017) designed a problem-based game for ninth-grade students’ English listening, and found that their learning performance, motivation, and engagement all improved. Moreover, their learning anxiety also decreased. Franciosi (2017) helped Japanese university students in EFL classes improve their vocabulary acquisition by learning in an online simulation game.

To sum up, contextual game-based learning could improve language learners’ learning confidence, decrease their learning anxiety, facilitate deep information processing, strengthen social communication, and provide meaningful, authentic activities to help learners connect contexts and cognition, but it is necessary to take into consideration how to use contextual educational games to effectively facilitate language learning. In a study conducted by Prosko, Roscoe, and McNamara (2014) to enhance German university students’ ability to implement writing strategies in an English course, the game-based practice did not outperform the conventional practice; the researchers concluded that without proper instructional support, educational games might not have the expected effect. Furthermore, the studies exploring the benefits of applying contextual educational games to L2 writing are rare (Prosko et al., 2014), especially to L2 business writing. Therefore, this study aimed to improve university students’ learning performance, learning perceptions, and learning behaviors of game-play based on a flipped contextual game-based learning approach.

**Flipped classrooms in English language teaching**

According to Bergman and Sams (2012), the flipped classroom is an instructional strategy that reverses the traditional lecture by delivering content to students via instructional videos before the class; in the meantime, it moves traditional after-class homework into the classroom, such that students are engaging in practicing or doing exercises with support from the teacher and peers. That is, the teacher has more opportunities to help struggling students deal with homework problems or practice (Findlay-Thompson & Mombourquette, 2014). In addition to doing homework or practice exercises, in-class flipped learning activities may vary in many ways, such as using technologies, in-depth discussions, peer evaluation, project-based learning, and game-based learning or gamification, which is one of the learning strategies recommended by researchers (Hwang et al., 2015; Lai & Hwang, 2016).

In English instruction, writing is a critical part of English language teaching and is often assigned as homework (Bergmann & Sams, 2015). In traditional writing classrooms, teachers sometimes limit the class time spent on the actual writing because the writing skills needed should be explained so that the students can improve those skills in class before the writing practice (Cockrum, 2014). Therefore, lacking sufficient practical opportunities for students in class is regarded as one crucial reason for unsuccessful learning achievement. Over the past decade in higher education, flipped classrooms have attempted to overcome these challenges by allocating more class time for active learning (Engin, 2014; Kim, Khera, & Getman, 2014; Sung, 2015), enabling the teacher to directly engage students in the writing process by flipping the instructional method (Bergmann & Sams, 2015).

Previous studies have detailed the design of flipped classrooms and discussed the advantages and implementations for flipping the class, which have made a difference in English language teaching. For example, Engin (2014) designed a project and leveraged the students’ interest and experience of writing practice in the flipped classroom using a digital video tutorial followed by a model, research topic, and writing an assignment. The student-created videos promoted their language learning and encouraged more focus on writing form and promoting accuracy in English. Sung (2015) conducted a case study on a flipped classroom in an EFL (English as a Foreign Language) content course. The results showed that the flipped teaching and learning would create good momentum for change in current English language teaching, despite the limitations of test-oriented teaching, the prior learning experiences of different learners, and their different levels of English proficiency.

Although flipped classrooms are seen as an effective pedagogy for curriculum renewal and developing a student-centered learning approach to enhance students’ learning performance and their critical and independent thinking, Findlay-Thompson and Mombourquette (2014) examined the results of flipped teaching for a Business course, and found that the proper implantation of the flipped classroom is the main factor in engaging students’ participation and improving the effectiveness of the learning process. O’Flaherty and Phillips (2015) also
indicated the increasing pressure for Higher Education institutions to transform and adopt effective and proper flipped classrooms. Their findings evidenced that there is no single model for the flipped classroom, which may involve several components in a successful flipped classroom, such as pre-recorded videos, awareness of students’ understanding, and higher order learning during class time. Learning outcomes and students’ engagement is essential for a successful flipped classroom. Therefore, in this study, we not only adopted a flipped classroom to help students improve their engagement, interactions, or practice time in a writing classroom, but also implemented a contextual video game with flipped learning in the writing context.

**Method**

In this study, we attempted to investigate the impacts of flipping the contextual game-based learning on students’ English business writing performance, writing errors, and reflective behaviors. A mixed methods study was conducted to capitalize on both the quantitative and qualitative methods (Kim et al., 2014).

**Flipped contextual game-based learning**

In this study, a contextual educational game for flipped learning in an English business writing course was developed utilizing RPG Maker VX from Enterbrain Incorporated. As shown in Figure 1, the story-based learning module is an essential part of the game, which is embedded with a game rules module designed by the course teacher based on business trade cycles or rules in real life (as seen in Figure 2). When students are engaged in playing the story-based learning activities, they imperceptibly experience the business trade rules, process, and culture. They could also have opportunities to learn knowledge about business trade, practicing sentences, and practicing business writing structure in a practice module, and may visit the library to get help in the knowledge library module. On the other hand, teachers could manage the game rules module, knowledge library module, and practice module via the Teacher Interface module.

In the game, students role-play a brave and obedient daughter of a famous professor to earn money to build a beautiful castle for her father. As the story unfolds, the daughter and her brothers experience the complicated business trading process and imperceptibly perceive the knowledge and culture of business trade. At the same time, the daughter could also get plenty of opportunities to practice by interacting with the NPC (Non-Player Character) of the story. For example, she could learn how to inquire, quote, and bargain (see Figure 3), how to identify appropriate sentences to fit the specific context (see Figure 4), and she could practice how to write an inquiry business letter in different trading contexts (see Figure 5). It is worth mentioning that the story was narrated in Mandarin in order to decrease students’ external cognitive load and to better acquire the business trade knowledge (including all trade cycles). On the other hand, in the practice module, the questions and answer items were presented in English, aiming to practice the learned knowledge (e.g., practice business correspondence grammar, writing a business letter) in the target language.
While students learn with the contextual game in the flipped classroom, they could access instructional learning materials, such as online video lectures, guiding questions, and written summaries provided by the course instructor, to help them more intentionally and meaningfully engage in the learning activities before class.

Figure 2. The cycle of business trade

Figure 3. Learning how to inquire, quote, and bargain
Participants

The study adopted a quasi-experimental design in which two English writing classes of EFL students were assigned to an experimental group and a control group. A total of 68 students were enrolled in the two classes, which were taught by the same instructor. The experimental group of 35 students adopted the flipped contextual game-based learning approach, while the control group with 33 students adopted the contextual game-based learning approach. The students in these two classes were undergraduates who had already passed the placement test set by the Language Center at the University and had a similar level of English proficiency; that is, their test scores were above 550, which, according to the official TOEIC information, means that they could understand the main points of clear standard input on familiar matters regularly encountered in work, school, and leisure. The students’ ages ranged from 18 to 22.

Figure 4. How to identify an appropriate sentence to fit the specific business context

Figure 5. How to write business sentences in different trading contexts
Data collection

We collected data from diverse sources including students’ essays, participation, reflections, and online learning behavior. The level of the English writing tests was determined by the English instructors in the Language Center at the University, and two English experts decided the writing topics and then assigned similar topics for the pre- and post-test, indicating that the level of difficulty of the two writing tests was the same. Within the semester, the students’ two English business letters were uploaded to the 1know learning platform for the experimental group and uploaded to the Moodle system for the control group.

Students’ online data and reflection

To understand the evolving status of the flipped contextual game-based classroom, at the beginning of the semester, the students in the experimental group joined the learning management platform, the 1know learning system. We collected each of the student’s business letters, online participation, before-class learning status, and responses to the reflection document to gain a more in-depth understanding of their performance, perceptions, and reflective content. These data were gathered automatically by the learning management platform when the students completed the online tasks or uploaded the assignments. After conducting the post-test, both groups of students were required to submit their reflections on how they experienced the semester-long contextual game-based learning approach. Their reflections were then categorized into four dimensions (i.e., the usefulness, satisfaction, motivation, and negative flow presences) based on the pre-defined coding scheme.

The rubric of English business writing performance

A rubric of English business writing performance modified from the Texas Education Agency (2006) was administered. Table 1 shows the rubric, which consists of four dimensions (i.e., organization, content, appearance, and language use) with a total score of 120 points, 30 points for each dimension. These four dimensions measure how students accurately use a correct business letter format, how well they state the purpose of the letter, how well they explain the facts to support the main idea, whether their tone is appropriate for the intended audience, whether they could type and use correct spacing, font, and format, and whether they could accurately use punctuation and grammar. First, organization refers to using the correct business letter format such as heading, greeting, introduction, body, closure, signature, enclosure, and copy. Second, content means that the students could write the business letter clearly and state the purpose. For example, they could deliver appropriate explanations to support the main idea, and their letters are easy to follow. Third, appearance refers to the letter being typed with correct spacing, font, and format. Finally, language usage means punctuation, grammar, spelling, and errors. By analyzing and investigating these four dimensions of the students’ business writing letters, the instructors could easily understand the learners’ writing errors and mistakes in general and improve the quality of the students’ letter writing as well as the pedagogical methods of the English business writing course in the future.

Open-ended questionnaire

An open-ended questionnaire consisting of two guidance items was used to collect the students’ feedback regarding their perceptions of the learning approaches. The first question is “How confident, motivated, and anxious do you feel about English writing after the learning activities?” The second question is “What do you feel about the digital game in terms of usability, satisfaction, and so on?”

| Table 1. The rubric of English business writing performance (Texas Education Agency, 2006) |
|---------------------------------|--------------|-----------------|-----------------|--------------|
| Criteria                       | 4– Exemplary | 3– Accomplished | 2– Developing | 1– Beginning |
| Organization                   | Accurately uses correct business letter format (heading, greeting, introduction, body, closure, signature, enclosure, and copy) | Mostly uses correct business letter format (heading, greeting, introduction, body, closure, signature, enclosure, and copy) | Some noticeable errors in use of correct business letter format (heading, greeting, introduction, body, closure, signature, enclosure, and copy) | Several noticeable errors in use of correct business letter format (heading, greeting, introduction, body, closure, signature, enclosure, and copy) |
To explore the students’ reflective patterns in the two groups, two researchers investigated the reflective documents. The analysis of the reflections referred to the following four areas: (a) the usefulness of the contextual game-based learning approach in the writing classroom; (b) the students’ satisfaction with the contextual game in the writing classroom; (c) the motivation to engage in the contextual game-based learning; and (d) the students’ negative flow during the learning process. Two experts who had years of experience in content analysis were invited to confirm the suitability of the codes and the corresponding definitions, and the accuracy of the coding result based on the coding example, as shown in Table 2. For those codes which were not agreed upon, there was a discussion, and the final categorization was a result of a full agreement between the researchers and experts.

Coding scheme for assessing students’ reflective content

To explore the students’ reflective patterns in the two groups, two researchers investigated the reflective documents. The analysis of the reflections referred to the following four areas: (a) the usefulness of the contextual game-based learning approach in the writing classroom; (b) the students’ satisfaction with the contextual game in the writing classroom; (c) the motivation to engage in the contextual game-based learning; and (d) the students’ negative flow during the learning process. Two experts who had years of experience in content analysis were invited to confirm the suitability of the codes and the corresponding definitions, and the accuracy of the coding result based on the coding example, as shown in Table 2. For those codes which were not agreed upon, there was a discussion, and the final categorization was a result of a full agreement between the researchers and experts.

Table 2. Codes of students’ reflection content

<table>
<thead>
<tr>
<th>Categories of codes</th>
<th>Definition</th>
<th>Example</th>
</tr>
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<tbody>
<tr>
<td>Usefulness Presence</td>
<td>Students’ reflection on the usefulness of the contextual game in the writing classroom</td>
<td>“After playing the game, I found it useful for understanding the contextual business trade and examples, and sentences in the letters.”</td>
</tr>
<tr>
<td>Satisfaction Presence</td>
<td>Students’ satisfaction with the contextual game and gaming activity in the writing classroom</td>
<td>“Although this is my first time playing this kind of RPG game, I felt satisfied with the gaming activity. I would like to save the game and play it during the out-of-class time.”</td>
</tr>
<tr>
<td>Motivation Presence</td>
<td>Students’ motivation or interest were raised by the contextual game and gaming activity in the writing classroom</td>
<td>“I hope to play more educational games like this, and this did motivate me to learn English. The game is fascinating.”</td>
</tr>
<tr>
<td>Negative Flow Presence</td>
<td>Students found it difficult to participate in the gaming activity or to play the contextual game in the writing classroom.</td>
<td>“I do not like the game, so I was anxious about playing this game in the writing class. I did not know how to answer the questions in the game either.”</td>
</tr>
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</table>

Experiment procedure

The experimental treatment occurred in two regular business writing courses in the fall 2016 term taught by the same instructor. The courses aimed to help the students understand the knowledge, behaviors, and processes of business trade, and to facilitate their mastery of formal business letter structures and writing.
Figure 6 shows the experimental procedure. In the first week, the students took a pre-test of Inquiry Business letter writing. In the following 8 weeks, the experimental group students were scheduled to watch instructional videos in English introducing the basic knowledge of business trade, play the contextual game to experience the business trade procedure, and complete corresponding learning sheets before the class. As a consequence, the exercises and homework were scheduled to be done in the class with the assistance of the teachers and their peers. That is, by moving the lectures to the before-class time using the instructional videos, the teacher did not need to give lectures to the experimental group students in the class, and hence had time to guide them to do the homework or exercises and interact with them in the class.

On the other hand, the students in the control group learned with the conventional game-based learning approach; that is, they received the lectures with the same content as the instructional videos for the experimental group, played the same game, and completed the learning sheets in the class. Moreover, they were asked to do the exercises and homework after the class.

In the second to last week of the experiment, the participants took a post-test on writing an Inquiry Business letter. Finally, in the last week, the instructor administered the open-ended questionnaire to collect the feedback from the students regarding their perceptions of the learning approaches.

### Results

#### Analysis of English business writing performance

The students’ English business writing pre-test and post-test were evaluated by two teachers who had years of experience teaching English writing courses. The Pearson Correlation values of the tests were 0.77 ($p < .01$) and 0.82 ($p < 0.01$), respectively. In order to examine the effect of the flipped contextual game-based learning approach on business writing performance, compared to the conventional game-based learning approach, a one-way analysis of covariance (ANCOVA) was utilized with the pre-test scores as a covariate, the learning approaches as an independent variable, and the post-test scores as a dependent variable.

After testing that the assumption of homogeneity of slopes was met with $F = 0.117$ ($p > .05$), it was reasonable to conduct further analysis with ANCOVA. As indicated in Table 3, there was a statistically significant difference between the two groups with $F = 38.50$ ($p < .001$, $\eta^2 = 0.372$). Moreover, the adjusted mean of the experimental group was 96.56 with a standard deviation error of 1.06, which was higher than the adjusted mean of the control group with 86.07 (Std. error =1.09). It was inferable that the flipped contextual game-based learning approach outperformed the conventional game-based learning approach regarding facilitating undergraduate students’ business writing. Furthermore, according to Cohen (1988), the effect size, partial eta squared ($\eta^2$) with a value of
In order to double check the effectiveness of the proposed approach, in the 6th week of the experiment, a Business article writing test was conducted, in which 27 students in the experimental group and 20 students in the control group completed the test, while the other students failed to submit their articles in time. Two experienced English instructors examined the errors made in the participants’ business writing letters together based on the four dimensions. Table 4 shows the detailed counts of error conditions and error percentages for both groups. According to the rubric demonstrated in Table 1, the writing errors were categorized into four types; the errors in the letters of the experimental group students were as follows: organization with seven total error occurrences, including no heading and no closure; content with 19 errors, including repetitive words, spelling errors, and grammatical errors. On the other hand, the writing errors in the control group were as follows: organization with three total error occurrences, including incorrect spacing; content with 84 errors, including repetitive words, unusual word pairs, overused words, possibly confused words, possibly confused adjectives, and weak adjectives; appearance with 88 errors, including incorrect spacing, upper and lower case letter errors, sentence fragments; and language usage with 193 errors, including articles, punctuation errors, spelling errors, grammatical errors, preposition errors, missing verbs, missing subjects, incorrect verbs, and possibly confused words. To sum up, “language usage” was the most frequent writing error pattern, with an occurrence of 47.0% for the experimental group and 52.5% for the control group. Meanwhile, there was 39.9% “appearance” for the experimental group, 23.9% for the control group; 9.6% “content” for the experimental group, 22.8% for the control group; 3.5% “organization” for the experimental group, and 0.8% for the control group.

Meanwhile, an ANCOVA test was performed for the two voluntary groups with pretest scores as the covariant, the learning approaches as an independent variable, and the post-test scores, measured after the experiment, as a dependent variable. It was found that the experimental group (voluntary) significantly outperformed the control group (voluntary) with $F = 27.24 (p < 0.001, \eta^2 = 0.382)$, and the adjusted Mean was 97.64 ($SE = 1.05$) and 87.83 ($SE = 1.28$), respectively. This finding reaffirmed the effectiveness of the proposed approach.
**Analysis of students’ reflective content**

Table 5 shows several examples of the reflective content of the two groups. It was found that 37.5% of the experimental group and 40.0% of the control group had “usefulness” presence; 71.8% of the experimental group and 66.6% of the control group students had “satisfaction” presence; 59.3% of the experimental group and 36.6% of the control group students had “motivation” presence; and 37.5% of the experimental group and 30% of the control group students had “negative flow” presence. It seems that more students learning with the flipped classroom gave positive feedback regarding satisfaction and motivation, while at the same time having more negative flow than those learning with the conventional approach. This shows the benefits and challenges of learning in flipped classrooms.

<table>
<thead>
<tr>
<th>Learning experience of the game</th>
<th>Flipped contextual game-based learning</th>
<th>Contextual game-based learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usefulness Presence</td>
<td>“After playing the game, I found it useful for understanding the contextual business trade and example sentences in the letters.”</td>
<td>“This RPG game with English business letters is useful and the learning goal, content and speed of the tasks are appropriate and related to the course.”</td>
</tr>
<tr>
<td></td>
<td>“Not only did I better understand the business trade process through the game, but I also learned some business phrases and sentences. And I think the game is useful.”</td>
<td>“The tools, skills, content and platform of the game are well-designed, and would I like to play more games like this.”</td>
</tr>
<tr>
<td></td>
<td>“The game is useful and easy to play. I learned the business process in the context via the game, as well as how to write an inquiry letter in the gaming process.”</td>
<td>“I am impressed by this game. The game with language learning such as English business vocabulary, phrases, and sentences is useful.”</td>
</tr>
<tr>
<td>Satisfaction Presence</td>
<td>“Although this is my first time playing this kind of RPG game, I felt satisfied with the gaming activity. I would like to save the game and play it during the out-of-class time.”</td>
<td>“The characters and story are fascinating in the game, and this is the first time I played this kind of the game in an English business writing classroom. I felt satisfied with the gaming activity and this is very meaningful.”</td>
</tr>
<tr>
<td></td>
<td>“The story-based context encouraged me to learn. I was not bored at all when the English business phrases were situated in the game. Although my English is not good, I like to play this game and learn English.”</td>
<td>“I would like more series of game-based learning like this and I think this gaming activity is successful.”</td>
</tr>
<tr>
<td></td>
<td>“Game-based language learning is fun and meaningful. I did absorb the English business knowledge through the game. And I think the English business writing course with the game is great and successful”</td>
<td>“The experience of playing a game like this is special, and using an educational game instead of the teacher-centered teaching model makes me satisfied.”</td>
</tr>
<tr>
<td>Motivation Presence</td>
<td>“I hope to play a more educational game like this, and this did motivate me to learn English. The game is fascinating.”</td>
<td>“I found this game interesting. It contains English business writing skills and story-based context. It’s great to transform games into learning resources.”</td>
</tr>
<tr>
<td></td>
<td>“My motivation for the game was high and the game was fun and served to illustrate the writing materials in this, as well as enhance learning.”</td>
<td>“I enjoyed playing the game and improving my English business competence at the same time. This game motivated me to learn better.”</td>
</tr>
<tr>
<td></td>
<td>“I realized that the game can motivate me to learn, through the flipped classroom and story-based situational game.”</td>
<td>“The game with learning resources can enhance my motivation.”</td>
</tr>
<tr>
<td>Negative Flow Presence</td>
<td>“I do not like the game, so I was anxious about playing this game in the writing class. I did know how to answer the questions in the game either.”</td>
<td>“I couldn’t find the hints to move forward when playing the game, and I didn’t know how to complete the learning tasks in the game.”</td>
</tr>
</tbody>
</table>
I was not feeling well on that day, so I didn’t play the game. I don’t know why.”

“The reference on the bookshelves in the library should be more diverse; it is a little bit dull now.”

“I think the facilities in the computer-assisted language classroom need to be improved, such as the mouse and the air-conditioner.”

**Discussion and conclusions**

In this study, a flipped contextual game-based learning classroom was developed, and a mixed methods approach was employed to explore the learning differences between the experimental group and the control group.

**English business writing performance**

The analysis results indicate that the flipped contextual game-based learning approach was effective in the English business writing classroom in terms of improving the students’ business writing outcomes. These points can also gain support from the literature. For example, Chik (2014) and Hwang et al. (2016) indicated that contextual game-based language learning demonstrated significant potential for language classrooms from the aspects of enhancing learner performance, autonomy, and community. In addition, Blau and Shamir-Inbal (2017) and Engin (2014) indicated that flipping a conventional learning approach could further promote students’ learning performance by enabling them to practice more during the class time with peer interactions and assistance from the teacher rather than practicing alone after the class.

**English business writing errors**

In terms of writing errors, it was found that the students learning with the flipped contextual game-based learning approach made fewer writing errors than those who learned with the contextual game-based learning approach. This is consistent with the finding and implications regarding the students’ writing performance; that is, engaging students in more practice and interactions with the teacher and peers in the class is helpful in terms of improving their writing outcomes.

**Reflective content**

In terms of the reflective content, Figure 7 summarizes the multi-dimensional findings from the students’ feedback regarding the impacts of “flipping” the digital game-based learning for English writing. First, for the usefulness aspect, the students generally thought that the learning approach was “fun and meaningful, more interesting, improving learning performance, and promoting participation.” Second, from the aspect of motivation presence, the students considered that the game was enjoyable, and the gaming activity had successfully transformed the gaming content into learning resources. Third, from the aspect of usefulness presence, the students indicated that the contextual game provided the learning inputs of English business letters, story-based context, and an easy-to-use platform. On the other hand, from the aspect of negative flow presence, they pointed out room for improving the learning approach; for example, some students felt anxious during the gaming process since they were unable to find the required information in the game, and hence they considered that the gaming tasks were too difficult.

To sum up, the flipped contextual game-based learning approach offers an effective environment in which students can better understand the contexts and knowledge of business trade as well as having more in-class time for practicing English business writing. On the other hand, there are several limitations to the present study. First, although the gaming approach played the main role of delivering knowledge to the students, and the learning management systems were only used to provide supplementary learning materials and collect students’ homework, the use of different systems (e.g., 1know and Moodle) in the two groups might have affected the students’ learning perceptions. Second, the proposed flipped gaming approach was only applied to a business English writing course in a university; the findings might not be able to represent the effectiveness of the same approach for other courses and subjects.
For future research, it would be worth investigating the impacts of flipped contextual-gaming on other language learning courses. It would also be interesting to measure the impacts of the approach from various aspects, such as the collaborative or communicative relationships between students and teachers, students’ higher-order thinking, self-efficacy, and learning anxiety. Moreover, investigation of students’ gaming behaviors as well as their interactive behaviors in the classroom and online could be valuable. Further research can also probe how the newly-developed contextual game can be transformed into a mobile language application, and how to use different learning content to promote low participation students’ involvement for better learning. Finally, further investigations into contextual game-based language learning in the writing classroom can provide a holistic picture of English language teaching development.

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Chinese Character Composition Game with the Augment Paper

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ABSTRACT
This paper discusses the design of a digital Chinese character composition game with the paper-interface named as ARC (Augmented Reality-based Chinese Characters) and its implementation in a Singapore primary school. The ARC game is designed to help beginning Chinese as second language (L2) learners to develop Chinese orthographic knowledge and improve quality of collaboration. Underlying sociocultural perspectives of learning, it seeks to enable learners to complete the game collaboratively in classrooms, and in this process to build a deep understanding of linguistic knowledge in solving in-situ language-related problems that emerge in language use. The results of a quasi-experiment indicate that ARC is an effective system for improving Chinese character learning performance and collaborative learning quality. It suggests that the augmented paper, enabling natural interactions, allow more and potentially young students to engage with educational content and collaboration. The problematizing scaffold should be embedded in the design game to elicit more opportunities for collaborative dialogue.

Keywords
Game-based language learning, Chinese character learning, Second language learning, Collaborative learning, Tangible interfaces

Introduction

With the development of technology and the evolution of new generation literacy, trends in educational research indicate an increasing interest in effects of digital game-based learning in various domains (Cornillie, Thorne, & Desmet, 2012; Godwin-Jones, 2014; Qian & Clark, 2016). Language learning is no exception. Contextual game-based language learning tends to positively influence language learning (Lan, 2015). Yet there is a dearth of more empirical evidence concerning how to well design the educational game to support active learning. Moreover, some researchers point out possible negative effects of digital games on learning. For example, students or players are distracted by the lavish entertainment factor and pay little attention to learning content (Kim, Park, & Baek, 2009). It is therefore highlighted the necessity of integrating instructional or pedagogical strategies into the educational game design (Hwang, Hsu, Lai, & Hsueh, 2017; Kim et al., 2009). Curriculum fit, readiness of teachers and students, and appropriateness of content should be taken into account when designers develop a game for specific educational purpose or bring digital games into the classroom (De Grove, Bourgonjon, & Van Looy, 2012; Godwin-Jones, 2014).

This study introduces a Chinese character composition game for second language (L2) learning called ARC (Augmented Reality-based Chinese Characters). It is designed by our research team in line with new Chinese language curriculum for Singapore primary 1 and 2 students. It is concerned with Chinese character learning for Chinese character recognition is a major hurdle for non-native learners. Chinese, as a kind of logographic language, is distinctive from English and other alphabetic languages. In Chinese, distinguishable types of strokes combine in different ways to form components (some of them are radicals) that are the fundamental elements to construct characters. Innovations in language education have been targeted towards ways of enhancing learners’ structural understanding of the logographic system beyond rote learning and mechanical practice (Lam et al., 2001). The effectiveness of using technological tools on improving learning and teaching of Chinese character has been reported (Zhan & Cheng, 2014). The instantiation of logistical use ranges from web-based reading tasks with glossing support to online personal vocabulary learning games or applications. Meanwhile, collaboration is a commonly used game design element for engaging player in social interactions, and it is also a frequently targeted game design element regarding 21st century skill development. However, little is known regarding how games should be designed for collaborative Chinese character or vocabulary learning, and how games may influence student collaborative learning skill development (Qian & Clark, 2016). ARC is designed as a table-top game with tangible paper interfaces for enabling collaborative L2 learning in classrooms.

The ARC system has been using in two primary schools in Singapore over five months. In this paper, we will first introduce the theoretical and pedagogical foundations of the game design and installation. After that, a quasi-experiment conducted in one primary school will be presented to demonstrate the effect of the gameplay on Chinese character learning and collaborative learning. The study aims at not only contributing to the research literature in Chinese character teaching for L2 learners but also shedding light on game-based language learning design for young participants.
Theoretical underpinnings and practical approaches

Contextual game-based language learning

Educational game or game-based learning refers to a learning environment where game content and gameplay help enhance knowledge creation and skills acquisition, and where game activities involve problem solving spaces and challenges that provide learners with a sense of achievement (Qian & Clark, 2016). Many advantages of the educational game have been evidenced in empirical studies (e.g., Hwang, Shih, Ma, Shadiev, & Chen, 2016; Yang, Quadir, & Chen, 2015; Zheng, Wagner, Young, & Brewer, 2009). Compared with traditional instruction, the educational game can help offer more engaging learning environments. (Barab et al., 2009; Steinkuehler, 2006). The level of students’ participation increases in such a learning environment for it makes learning fun and relaxing, and it, in turn, increases students’ learning outcomes (Erhel & Jamet, 2013; Sandberg et al., 2014).

From the sociocultural views of learning, language learning is viewed as a semiotic process attributable to participation in social activities, rather than internal mental processes solely by the individual (Lantolf & Thorne, 2006). Digital game environments can help provide rich and vivid contexts, which extend the traditional classroom, help students realize the importance of learning content by connecting it to real scenarios, and encourage more communication and meaningful interactions (Hwang, Chiu, & Chen, 2015; Thorne, Black, & Sykes, 2009). 3D virtual context, for example, has been evidenced to be beneficial for students’ foreign language learning as it immerses students in a brand-new world to use the target language with less anxiety and frustration (Lan, 2015). The portability of mobile devices and the popularisation of augmented reality (AR) technology also have been proposed to bring students compelling language learning experiences, by creating a stronger connection between the digital content and the real contextual environment (Bacca, Baldiris, Fabregat, Graf, & Kinshuk, 2014).

Augmented paper for language learning

AR as one kind of technologies that combine or supplement real-world objects with virtual objects has been widely developed for education (Bacca et al., 2014; Cuendet et al., 2013). Bacca et al. (2014) summarized in their review paper that research on AR has demonstrated its advantages for increasing students’ motivation, learning gains, interaction, and collaboration. AR is used in language learning because of the possibility of combining augmented information with contextual information to provide new experiences in language learning. Over the years, an increasing number of studies has been published suggesting possible mode for integrating AR techniques in subject learning (e.g., Bujak et al., 2013; Wang, 2017), and the use of this technique in classrooms is on the rise (e.g., Wojciechowski & Cellary, 2013). However, the possibilities that AR can benefit to learning remain to be discovered. Its effect depends on what we can imagine and devise as pedagogical applications (Cabero & Barroso, 2016).

This study focuses on the augmented paper-based Chinese character learning. The paper interface is emphasized because the paper-based tabletop not only uses paper as a document with digital capabilities for augmenting its content but also keeps paper’s intrinsic properties, e.g., tangibility, manoeuvrability, and flexibility (Prieto et al., 2014). Various arguments have been put forward for why manipulatives (defined as physical objects that can be touched or moved by students to reinforce a concept) may support learning. For instance, they provide an additional channel for conveying information, increase flexibility, empower students to process and organize information at their own pace, facilitate abstraction and improve memory through physical action (Manches et al., 2010; McNeil & Jarvin, 2007). On this basis, Bujak et al. (2013) further elaborated that augmented objects can offer immediate kinaesthetic feedback, while virtual objects include additional information built right into them, and in this way to help memory encoding.

Collaborative language learning

ARC is designed for enabling collaborative learning in classrooms. Vygotsky’s sociocultural theory implies that collaborative learning provides the foundation upon which all learning is built (Stahl, Koschmann, & Suthers, 2015). Analyzing and modelling interaction by which learning takes place are essentially emphasized in collaborative learning research. In collaborative language learning, however, language is not only the learning content but also the learning medium. Therefore, this makes it challenging to analyze how a group of students engage in thinking together about a problem or task, how they produce knowledge artifacts (e.g., in verbal,
textual, or graphic form) that integrate their different perspectives on the topic, and how they represent the shared group products that they have negotiated and made a consensus to construct. This may be the reason why many studies on pair/group work in language classrooms are focused on examining learners’ attitudes to pair/group work in general, rather than exploring the nature of the collaboration process or the role of technology when students participate in a jointly intellectual activity (Wen, Looi & Chen, 2015; Storch, 2005; Shehadeh, 2011).

In this study, the concept of collaborative dialogue is adopted to help examining the effect of collaborative language learning process. Swain (2000) argued that not all dialogue was equally conducive to cognitive and linguistic development. Collaborative dialogue emerged from learners’ interactions when learners were engaged in a problem-solving activity as the kind of interaction that could potentially lead to the co-construction of linguistic knowledge (Gutiérrez, 2008). In Swain’s words, “collaborative dialogue is where language use and language learning can co-occur. It is language use mediating language learning. It is cognitive activity and social activity” (2000, p. 97). Together with the concept of collaborative dialogue, language related episodes (LREs) were postulated as a unit of analysis for investigating learner-learner interaction. LREs referred to any part of a conversation where language learners “talk about the language they are producing, question their language, use, or correct themselves or others” (Swain and Lapkin, 1998, p. 326). It has been extensively used as unit of analysis for investigating language learner-learner interactions in which L2 learners used language to shape linguistic knowledge by talking about, questioning, or reflecting on the linguistic properties of the target language (e.g., Dobao, 2012; McDonough & Sunitham, 2009; Swain & Deters, 2007; Wen et al., 2015).

**Chinese character composition game: ARC**

Undergirded by the belief in the merits of contextual learning in L2 and augmented paper for learning, ARC game was designed to provide multimedia and multimodal contexts for L2 learning and, it was designed for collaborative learning to create authentic contexts for L2 use. Concerning specific Chinese character learning strategies, the radical-derived Chinese character learning approach was adopted to guide all the system-based activity design.

![Figure 1. ARC setting within a small group](image)

Research has shown that knowledge of radicals plays a vital role in enhancing character learning achievement not only for young school children but also for adult L2 learners (e.g., Jiang & Cohen, 2012; Shen & Ke, 2007; Su & Kim, 2014; Taft & Chung, 1999; Wang, Liu, & Perfetti, 2004). With limited vocabulary, it may not be easy for beginning learners to realize the importance of character’s radicals. Yet some studies have tested the beginning Chinese learners’ sensitivity to the structures of Chinese characters. They found that the development of semantic radical awareness helped Chinese learners guess the meaning of unknown or unfamiliar characters and revise what has been learned while learning the new (Huang, 2003; Shen & Ke, 2007; Wang, Perfetti, & Liu, 2003). Therefore, in the radical-derived character learning approach, every ARC-based activity was designed to help the student recognize radicals, structures and compound Chinese characters. A total of six sorts of activities
was designed, and three kinds of paper cards were prepared for students to complete these activities. They are structure cards, radical cards and component cards (see Figure 1). Based on the new Chinese language curriculum of Singapore, the designed ARC game covers approximately 50% compound Chinese characters and over 70% radicals that students need to recognize in Primary 1 and 2.

To “augment” cards, near-field communication (NFC) readers were used in our system. Like RFID, NFC has advantages of cost-effectiveness and stability of data communication. Every single card was attached to an NFC tag. With this technology, when many cards are on the table at the same time, card information will not be read without mutual interference. Once students tape a card on the NFC reader, its related information will be identified and represented on the iPad screen immediately. In an ARC classroom, students are divided into small groups to play the game together. They are encouraged to exchange cards to complete the activity collaboratively. On the basis of the literature, we assume that students will communicate and exchange ideas a lot with one another. Thus, they would have a good understanding of the target character.

Figure 2a shows one kind of the activities, “filling characters in a sentence,” as an example. In such activity, a sentence and its corresponding picture are displayed on iPad screen to provide students with the contextual information of the target character. The typical workflow of the activity is shown in Figure 2b. Within a group, students need to discuss the missing Chinese character. After making a consensus, they pick up the structure card for the Chinese character first, and then selected its corresponding radical and compound sequentially. During this entire process, whenever the group cannot make a decision or have no idea about how to continue, they can seek help from the system using the hint card.

![Figure 2](image)

(a) Task example  (b) Activity workflow

*Figure 2. An example of “filling characters in a sentence” and its activity workflow*

After the target Chinese character having been constructed successfully, the group members can use accessory cards to select any exploratory task that they would like to follow (see Figure 3). We also prepare a card named as “Finish.” With it, students of different groups can decide by themselves when to finish the current task and start the next character. In the first few lessons, we suggest that the teacher hold the finish card. In other word, students could not enter the next task without the teacher’s permission. After students have some awareness of collaboration, they can keep the card by themselves.

![Figure 3](image)

*Figure 3. Self-directed work pace*

Also, in Figure 3, if a group of students is uncertain about the pronunciation or the usage scenario of the character composed, they can use the “Pin Yin” card or the “Word & sentence” card to learn how the character should be pronounced, or how the character could be used in a concrete scenario. Whilst for those students familiar with the characters, they can autonomously choose one or more pink color cards to generate their
group artifacts related to the target Chinese character. The card “Let talk”, for example, can be used, when students would like to draw a picture of scenario and verbally make a relevant sentence with the given Chinese character. Figure 4 demonstrates one group of students is working on the “Let talk” activity in the classroom.

![Figure 4. A group working on an exploratory task](Image)

(a) Group work scenario  
(b) The generated group artifacts

Research design

A quasi-experimental design was adopted in this study. Multiple data sources were collected and triangulated to examine the affordances of the ARC system and their effects on students’ learning.

Participants

The participants of this study were grade one students (aged between 7 to 8 years) from a government primary school in Singapore. Forty-nine students from two classes were involved in our study. The overall Chinese language proficiency of these two classes was not high. English was the family language for most students in the classes. During the experimental period, these two classes were taught by the same teacher, Mr A, who was a tech-savvy. He was a computer science engineer, and then came to teach in this school three years ago. Both classes received an equivalent amount of instructional time and participated in the similar activities, but the experimental class used ARC game system ($N = 24$), and the control class did not ($N = 25$).

Procedure and settings

This study is situated in an ongoing 2-year project about designing and developing the ARC game, and its implementation in primary schools. The ARC game is designed to help students to review the Chinese characters they learnt, and it includes four sections for primary 1. To keep consistent with school syllabus, our school-based intervention spanned approximately five months, from April 2017 to September 2017. The intervention procedure related to the two classes is detailed in Figure 5.

At the beginning, all the students spent 10 minutes to complete a pre-test for testing their Chinese orthographic knowledge. One technical training session (20 minutes) was conducted by our researchers to the experimental class. In the experimental period, each class received an equivalent amount of instructional time and participated in the similar activity design. In both classroom environments, 3 to 4 students were heterogeneously grouped by the teacher and sat together. After the intervention, a 10-minute post-test was delivered to all the participants. We conducted a focus group discussion to get students’ feedback about the learning experience as well. Four students per class were randomly selected to participate in the focus group discussion to share with us their attitudes towards playfulness, collaboration, and the game design (20 mins per group).

Additionally, a one-hour professional development session was conducted to Mr A before ARC lesson to help him being familiar with the system and its design principles. Semi-structured post-interview was administered to get his reflections on teaching and feedback about using ARC. Besides, after each lesson, our research team had a quick post-lesson discussion with Mr A, exchanging ideas with him and improving the activity enactment in both classes.
Data sources and analysis

Data about the learning outcome and processes were collected and triangulated to examine the ARC affordances and effects. All the data sources are listed in Table 1.

<table>
<thead>
<tr>
<th>Data sources</th>
<th>Purpose</th>
<th>Language learning performance</th>
<th>Collaborative learning</th>
<th>Technological affordances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-and post-test results</td>
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<td>Field notes</td>
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<td>Videos and transcripts of group work</td>
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<td>Students’ focus group discussion</td>
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<td>Teacher’s post-interview</td>
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Concentrating on the learning outcome, pre-test and post-test were designed to measure students’ Chinese orthographic knowledge. A positive relation between children’s orthographic awareness and Chinese character recognition has been widely acknowledged (Chen, Allport, & Marshall, 1996; Chen et al., 2013; Jin, 2007). The tests were developed by our research team, referencing a series of tests created by Hung and Fang (2006) and the test created by Chen et al. (2013). We modified the original tests by considering the students’ Chinese language proficiency, and the tests were validated by a primary school master teacher. Forty questions were included in the test with a total score of 40. The gain analysis was used to examine students’ learning performance.

In each class, a video-camera was set up at the back of the classroom to record the class process. Meanwhile, two other video cameras were set to record two small groups in each class. The video data of face-to-face group interactions were the main data sources for this study. The video data-based analysis of this study consists of two steps. First, we analysed and assessed small group collaboration by the rubric developed by Meier et al. (2007). They proposed 9 dimensions to capture the main characteristics of collaboration, and each dimension was rated on a 5-point scale (1 = lowest; 5 = highest) and the sum of these formed the final collaboration score of each group. In our coding, however, we only included 8 dimensions and excluded the dimension about technical coordination, since it was not suitable for assessing the quality of collaborative processes happened in the control class (see Appendix 1). Two trained researchers assessed the recorded data using the rubric for a total of 7 lessons in both the experimental and control classes (see Appendix 2). The first lesson of the control class was not included because the class grouping had a change after the first lesson. The inter-rater reliability of $r$ was 0.79.

Second, the data about small group interactions were transcribed verbatim and coded in terms of the concept of collaborative dialogue and the analytical unit of LREs. We described the occurrence of LREs when L2 learners were participated in group activities to examine students’ language learning process in both classes. The qualitative analysis of the video data and field notes helped to explain when the interactions took place or why they did not happen.
Meanwhile, the focus group discussions and the teacher’s post-interview were conducted to address how the participants perceived the learning and teaching experience using ARC and without using ARC. To make sure the reliability of the data analysis, during the entire coding process, two experienced researchers examined the data, completed the coding independently, and then collaborated and built a consensus on their coding.

Results

Language learning outcome

The learning gain per student was computed by subtracting the post-test score by the pre-test score. The results showed that the ARC class students gained mean = 8.61 (n = 23, SD = 5.92) scores from the learning while the control class students gained mean = -5.43 (n = 22, SD = 4.12) (see Figure 6). The independent t-test revealed that the ARC class students made significant improvement compared with the control class students (t = 9.19, p < .01). The learning gain of the control class showed negative. This might be caused by the inconsistency of difficulty level of the tests. The pre-test was designed with a low difficulty level as it was for students who just started primary school. The overall results indicated that students learnt Chinese characters with the ARC game made an obvious improvement in orthographic knowledge and awareness.

![Figure 6. Learning gains](image)

Collaborative learning process

The histograms in Figure 7 show the mean score of the quality of collaborative learning of each dimension for the ARC and control classes. They indicated that groups in the ARC class outperformed than in the control class in most dimensions. Regarding the score of the dimension of time management, however, groups in the control class performed better than in the ARC class. According to the class observation, sometimes students in the ARC class spent too much time on the tasks they interested in, especially those exploratory tasks that required students to generate their group artifacts. We designed the ARC game to provide students with sufficient autonomy that every single group could learn at own pace. Nevertheless, we also noticed that the time management competency of the students at this young age was still weak, let alone in the game-based environment.

No difference was found between the two classes in the score of task division. Based on the observation, we reasoned that it might be due to the difficulty of the activity. Students were able to complete the task without splitting the task. Yet it was worth noticing that students in the ARC class did better than the control class in the dimensions of sustainable mutual understanding, dialogue/action management, research consensus, and reciprocal interaction.

Taking time into consideration, we aggregated the numerical scores of all 8 dimensions to obtain a single score to each lesson and displayed them in Figure 8. At the beginning of the intervention, there was no much difference between the two classes. Then the quality of collaborative learning of the ARC class constantly improved. As we observed, compared with the control class, the game playing in the ARC class was less dominated by one or two students whose language proficiency were comparatively high. At the first ARC lesson, we observed many students scrambled for playing the game. Students continually tapped the cards without discussing with others, but soon they realized that this way of playing affected their group’s leaderboard ranking.
Students at this age were particularly concerned about badge displayed in games. In the following ARC lessons, we observed that they began to learn to discuss with others before using the cards. More dialogues about action management could be observed in the ARC class. However, the change of interaction modes in the control class was not obvious.

![Image](Figure 7. The comparison of the score in each dimension between the two classes)

The score retrogression of the control class in the last lesson might be caused by the type of game design. In the control class, students did the tasks without the hints or immediate feedback provided by the system, and thus most often they needed to seek help from the textbook or the teacher when they got stuck. The activity of the last lesson was about word puzzle, in which few hints could be found from the textbook. Maybe because of that, students in the control class were less engaged. On the contrary, with the hints and contextual animation simulation, students in the ARC class were well engaged in the word puzzle game.

![Image](Figure 8. The quality of collaborative learning in each lesson)

Besides, though an obvious increment of the collaborative learning score was detected in the ARC class, we had to point out that there was still room for improvement in students’ collaborative learning (see Figure 8). Even at the end, the aggregated score of all the dimensions was only 25.75, which was about 64% of the full score 40. Except for the factors of age and activity design, the characteristics of L2 learning might affect students’ collaborative learning performance as well. As shown in the video data, even though a majority of students in the ARC class were consistently engaged in the activity, not much collaborative dialogue (LREs) took place without teachers’ intervention.

**Language-related episodes**

The time of each lesson of both the ARC and control classes was approximately 60 minutes. As shown in Table 2, in the ARC class, the average time the teacher provided for student group work was about 44.0 minutes (SD = 1.99). Less time of activities was provided for students in the control class and more deviation among the lessons was found (M = 33.94, SD = 2.39). According to our classroom observation, the teacher spent less time on introducing the rules of the activities and it was easier for him to provide feedback to students’ work at the class level in the ARC class.
Table 2. Activity time distribution and LREs frequency

<table>
<thead>
<tr>
<th>Class</th>
<th>Activity Time</th>
<th>Group</th>
<th>LREs Frequency</th>
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<td>L1</td>
<td>L2</td>
<td>L3</td>
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<td>41.14</td>
<td>44:35</td>
<td>45:55</td>
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<tr>
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<td>A</td>
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<td></td>
<td>B</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Experimental</td>
<td>36.59</td>
<td>32:05</td>
<td>33:19</td>
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The average number of LREs observed in the ARC class was 5.38 (SD = 1.41), and it was 2.50 (SD = 1.05) in the control class. Though LREs happened more frequently in the ARC class than the control class, generally speaking, they did not happen frequently during group work process. In other words, even though the ARC game was designed for collaborative learning, the students talked little about the language they were producing, they seldom questioned their language use or corrected themselves or others. The LREs in the ARC class were more observed when students were selecting radical cards or generating own group artifacts, for instance, in the process of writing the target Chinese character or making oral sentences. An increasing number of the LREs could be observed when students were choosing radical cards to compose characters. It suggested that the students became more aware of their physical actions with the manipulatives.

Feedbacks from the teacher and students

All the students in the focus group said that they enjoyed playing the ARC game and learning Chinese language in this approach. Yet not everyone participated in the pen and paper-based activities felt satisfied. One of the reasons for dislike given by the students was that they were required to do too many works in the activities. Half of the students from the control class said they preferred to have a lecture rather than do the activities by themselves. One of the students from the control class, who preferred to do the activities, said we could play games in the class like this. In other words, without the feature of a digital game, the similar activity design per se was unable to attract students adequately. All the students played the ARC expressed that they liked the pictures and animations embedded in the game, and they believed that the multimedia could help them to understand tasks or texts. It was worth noting that all the interviewed students from the ARC class said they preferred playing with the paper-interface to using iPads directly. Yet constrained by their ages, these interviewees could not explain the reason behind it.

With regard to collaborative learning awareness, all the students from the ARC class expressed that they liked to play the game with group members together. Two students said in this way, they could get help from others when they had no idea about how to continue the game. On the contrary, all the students from the control class said they preferred to learning individually rather than in a group. One boy from the control class said that in the group activities, all other members learnt from him, but he learnt nothing from others.

In the post-interview, the teacher also provided us with quite positive feedback about the ARC game. According to him, ARC helped students to be more engaged in learning, and the adoption of the paper interface provided all the participant with an equal opportunity to join the game. He explained that he noticed some students who usually could not follow teacher’s instruction in the traditional class, but still tried to play the game via picking up cards and trying them on the card reader. He highlighted that since ARC game could provide students timely feedback, it was easier for teachers to facilitate collaborative learning in the ARC class than in the non-ARC class. The teacher stated that though students at this age were not very good at group work, there were obvious improvements of the students’ collaborative learning competency after the ARC game playing.

Discussion and conclusion

This study demonstrated a work in progress of how a Chinese character composition game with the paper-interface was designed and implemented in a primary school. The study not only substantiated AR potential as a carrier of educational content but also appropriated it to the pedagogical need of Chinese character learning. Though AR technology has been improving, more studies related to the development and usability of AR application are still needed (Akçayır & Akçayır, 2017). The study evidenced that the use of ARC was not difficult for young students and the tangible paper interface could help increase the game playfulness.
From the experimental results, it was evidenced that playing ARC game helped to improve Chinese orthographic knowledge and collaborative learning competency for L2 beginning learners. Regarding the quasi-experimental design, we needed to state that we looked forward the improvement of the control class as well since radical-driven strategy and active learning approach used in the control class had been proven to be effective (Shen & Xu, 2014). Meanwhile, we assumed that the teacher’s user experience of ARC might also help him to enact collaborative learning activities in the control class. In the control classroom, however, even though the teacher enacted the activities smoothly and managed the classroom well, the students seemed to need a longer time to develop interaction awareness and cultivate collaboration culture. The effect of ARC on learning was examined through investigating the user’s content knowledge improvement and collaborative learning development. These two aspects were taken into account as collaboration occurs when learners are involved with social interactions, which would result in improved learning capabilities (Lave & Wenger, 1991).

ARC experiences leveraged situated cognition, by allowing users to connect to the virtual educational content and communicating with peers using their own language. The results supported the views of many scholars in the field of game-based language learning, that interactive multimedia create contextual learning environments can effectively help language learners construct knowledge (Chen & Lin, 2016). Moreover, the empirical data suggested that augmented papers, enabling natural interactions, allowed more and potentially young students to engage with educational content and collaboration. The tangible interface, together with the badge mechanism, required more coordination during the game play and resulted in the improvement of collaboration.

The practical significance of this study was that it suggested an effective approach to improving L2 learners’ Chinese orthographic knowledge. It contributed to existing studies on making use of technology to enhance contextual game-based L2 learning. It also extended this work to suggest that beyond representing contextual information, the appropriation of tools for collaborative learning can help promote language use context where users would build a deep understanding of linguistic knowledge. “Contextualized learning is learning that is directly connected to the real-world context in which it occurs” (Leighton & Crompton, 2017, p. 286). The game like ARC with augmented paper can help to engage students in interact with the surroundings around them and triggers more social interaction and communication.

Nevertheless, in the context of L2 learning, it also appeared that not many in-situ language-related problem solving or discussion emerged spontaneously in language use. In this study, it was only observed that a growing number of LREs regarding the semantic meaning of the radicals emerged in composing Chinese characters. It suggested that the students learnt to evaluate the radicals selected and thought about ways to compose characters. In other words, they were gradually able to reflect on their actions of manipulatives. Nevertheless, they seldom discussed the meaning or the context in which the target character could be used without the teacher’s intervention. These students showed more concentration on whether the character was correctly composed or not. After that, they paid little attention to the feedback information provided by the game, such as the multimedia contextual information about how to the generated character could be used. Therefore, future game design needs to pay more attention to scaffolds that may problematize the subject matter by causing students to pay more attention to critical ideas and connection between new contextual information and existing knowledge of the Chinese character. The type of problematizing scaffold may create opportunities for deeper processing and more productive learning (Reiser, 2004).

Some limitations of this study should be dealt with in the future. The qualitative rating scheme was used to generate a quantitative manure, but it still had the limitation of requiring human judgement. The findings were drawn based on the ARC implementation in a primary one class. Further multiple studies and relevant work will be planned and conducted in the collaborative schools. As the data gets richer, the following studies will further explore the correlation between students’ system-based learning trajectories and their learning outcomes and place more emphasis on investigating how the manipulatives could be designed and used to encourage students to reflect on their experiences in the game play. The findings will have a broad range of possible implementations for gamed-based language learning. Beyond simplified Chinese, the similar design can also be tested and implemented to traditional Chinese learning. Beyond Chinese character learning, the augmented paper can be adopted in more gamed design to convey contextual information and elicit social interactions.

Acknowledgements

This present research is supported by the Ministry of education, Singapore Ring-Fenced Fund (RFF). I would like to thank ARC team members Mei Wan Ng, Yee Au Su, Lucy Sim and Yanyan Wang who helped collecting and analysing data. I also would like to thank our collaborative school teachers.
References


Appendix 1

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<thead>
<tr>
<th>Dimension</th>
<th>Elaboration</th>
<th>Examples in this study</th>
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<tbody>
<tr>
<td>1. Sustaining mutual understanding</td>
<td>Speakers make their contributions understandable for one another.</td>
<td>A: “Yah, this should be ‘拍’. It is relevant to hands”</td>
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<td></td>
<td></td>
<td>B: “I know. I know it is radical ‘扌’.”</td>
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<td></td>
<td></td>
<td>A: “Yes!”</td>
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<td>2. Dialogue/action management</td>
<td>A smooth “flow” of communication is maintained in which little time is lost due to overlaps in speech or confusion about whose turn it is to talk or do the activity.</td>
<td>A: “Later I do the second, can?”</td>
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<td>B: “Can!”</td>
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<td></td>
<td></td>
<td>C: “Everybody can write,”</td>
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<td>3. Information pooling</td>
<td>Students try to gather as many solution-relevant pieces of information as possible.</td>
<td>Students work together to make a sentence using the target character.</td>
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<td>4. Reaching consensus</td>
<td>Decisions for alternatives on the way to a solution after a critical discussion.</td>
<td>A: “We write with pens. It is a pen.”</td>
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<td>B: “No. We are not eating with pens. It is not a pen.”</td>
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<td></td>
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<td>A: “Then what is it? Chopsticks?”</td>
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<td>B: “No lah, we don’t write using Chopsticks. …”</td>
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<td>B: “Table! It is a table! We eat and write on a table. It is the Chinese character ‘桌’.”</td>
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<td>5. Task division</td>
<td>The task is divided into subtasks.</td>
<td>“I draw the picture and then you say the sentence.”</td>
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<td>6. Time management</td>
<td>Students monitor the remaining time throughout their cooperation.</td>
<td>“Hurry up! We just finished one character.”</td>
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<td>7. Reciprocal interaction</td>
<td>Students treat one another with respect and encourage one another to contribute their opinions and perspectives.</td>
<td>“BH, do you want to write?”</td>
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<td></td>
<td></td>
<td>“Do you want to play?”</td>
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<td>8. Individual task orientation</td>
<td>Each student actively engages in finding a good solution to the problem, thus bringing his or her knowledge and skill to bear.</td>
<td>Looking for clues in the textbook</td>
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<td></td>
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<td>Exploring answers with radical or component cards</td>
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Appendix 2

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The Effects of Competitive Gaming Scenarios and Personalized Assistance Strategies on English Vocabulary Learning

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1Corresponding author

ABSTRACT

English vocabulary is the foundation of English learning. According to information processing theory, recitation helps learners remember and understand English terminology. However, this type of exercise may lead to boredom, anxiety, difficulty concentrating, and other negative effects. This study proposes the integration of competitive gaming with personalized assistance as a means of reducing anxiety and enhancing the degree of immersion, as well as raising the overall effectiveness of the lesson. The board game Monopoly was used as the basis for the design of a vocabulary-focused competitive game. Personalized assistance was provided to help learners study and review new English vocabulary words in an attempt to improve their memorization. A total of 120 students were recruited to serve as participants in the study. Each was randomly assigned to one of four different groups to take part in select English vocabulary activities. The results show that the integration of a competitive gaming scenario with a personalized assistance strategy helped students improve their vocabulary acquisition.

Keywords

English vocabulary learning, Competitive gaming scenario, Personalized assistance strategy, Flow theory, English anxiety

Introduction

Globalization has led to English becoming an international language (Zhang et al., 2017). Vocabulary, pronunciation, and grammar constitute the three primary elements of language, with the accumulation of vocabulary arguably being the most essential. Wilkins (1972) asserted that people are unlikely to successfully express any message without using the appropriate words. The collection and comprehension of words are closely related to overall English ability (Hwang & Wang, 2016). Thus, vocabulary is a focal point when learning English. Those who do not have a sufficient vocabulary cannot effectively understand or communicate. Having a sufficient English vocabulary means storing enough words in long-term memory to achieve a cumulative effect. Atkinson and Shiffrin (1968) used information processing theory to show that learners turn external information and knowledge into long-term memory in three stages: sensory collection, short-term memory, and long-term memory. This process places information or knowledge at the focus of external sensory reception. Thinking processes are initiated after the formation of short-term memory. Next, learners repeatedly review the data, resulting in the formation of long-term memories. Repetitive exercises target the commission of English vocabulary to long-term memory. The repetitive recitation method asks students to memorize English vocabulary by understanding the word itself alongside the word in the mother tongue (Banikowski & Mehring, 1999). However, some have argued that such mechanical and repetitive recitations are likely to lead to boredom, anxiety, distraction, and other negative effects (Mak, 2011; Wu & Huang, 2017).

The current research considered flow theory, also known as immersion theory, a notion first proposed by Csikszentmihalyi (1975). This model describes an empirical flow pattern that causes individuals to become fully involved in the learning process. People who are fully engaged in what they are doing are free from distraction. When learners encounter challenges involving multiple skills and tasks, flow theory explains that the result is the experience of pressure, and even anxiety; however, learners can enter a “heart state” to improve their concentration. Flow theory suggests that concentration is an essential factor, substantially influencing the immersion experience. Studies have indicated that an examinee’s degree of focus is significantly related to working memory, which operates when the individual learns to be biased towards a particular memory type; this, in turn, affects learning outcomes (Rensink, 2002). It is worthwhile to note that a reduction in anxiety and increase in the degree of immersion have been shown to improve learners’ ability to increase their English vocabulary.

Many studies have indicated that game-based learning can effectively enhance learning motivation, promote educational outcomes, and even reduce anxiety (Young & Wang, 2014). Such games can feature text, voice,
video, or other multimedia features (Prensky, 2001) and be fun, challenging, and ultimately satisfying. Together, these aspects trigger learners’ sense of competition and desire for cooperative behaviour in order to obtain rewards. At the same time, flow theory shows that when skills and challenges are properly balanced, students enjoy a higher degree of focus, excitement, and fulfilment, and their level of anxiety is reduced. Because games have established rules and allow students to pursue challenging goals, they facilitate learners entering an immersive state (Kinzie & Joseph, 2008).

When teaching English vocabulary, it is important to determine how different learners can achieve a balance between the challenges they face and their skill level. The current research suggests that achieving this balance depends on the student accessing different auxiliary resources such as personal assistance. Much of the literature has argued that effective individualized learning successfully employs educational resources such that students receive what they need, when they need it (Buckley & Doyle, 2017; Gogoulou et al., 2007). Thus, a personalized assistance strategy would provide the mechanisms and processes required to complete academic tasks in game-like educational scenarios. This would help students meet their goals, achieve proper balance, and further improve their learning experiences and outcomes. Therefore, the research questions driving this study were as follows:

- Could competitive gaming and personalized assistance enhance learning efficiency related to English vocabulary?
- Could competitive gaming and personalized assistance reduce anxiety related to the acquisition of English vocabulary?
- Could competitive gaming and personalized assistance enhance English language learners’ degree of immersion?

**Literature review**

**Anxiety state**

Anxiety related to foreign language learning is usually attributed to the inability to use second-language skills. Sarason (1984) argued that anxiety resulting from learning a foreign language was a form of social concern that could be explored across three dimensions: cognition, affectation, and behaviour. Horwitz, Horwitz, and Cope (1986) defined anxiety related to foreign language acquisition as follows: in the process of learning a language, this type of anxiety is a subjective tension, apprehension, and worry that will further affect the autonomic nervous response (p. 125). MacIntyre and Gardner (1991) classified anxiety as either trait-based, emotional, or situational unease. Trait anxiety refers to when an individual experiences a stable and long-term state of anxiousness. Emotional anxiety results from an individual's tentative state of worry. Situational anxiety describes a particular situation or environment that causes tension, disruption, and a generally uneasy feeling.

Many studies have suggested that anxiety related to learning a foreign language affects learning outcomes (Mican & Medina, 2017; Yanxia, 2017). Elkhafaifi (2005) indicated that anxiety-ridden students tended to underestimate their ability, which in turn led to lower scores and overall performance. Other studies have shown that emotion is closely related to cognitive ability and overall learning, and positive emotions relevant to learning reinforce this process. Conversely, negative emotions such as anxiety and frustration are not conducive to learning (Hwang et al., 2017; Meyer & Turner, 2006). At the same time, the literature has also suggested that anxiety is an important factor in and has a significant influence on educational outcomes when learning English as a second language (Mak, 2011). Melchor-Couto (2017) found that students in states of high anxiety and/or who suffer from low self-confidence tend to exhibit negative results. In summary, the quality of second language acquisition stems from the learning environment and is related to external factors such as nervousness; the amount of disturbance, uneasiness, or other negative emotions; and other undesirable influences.

**Immersion state**

Flow theory, also known as immersion theory, was proposed by Csikszentmihalyi (1975) to describe the flow pattern within which individuals become fully involved with, focused on, and subsumed by a particular activity. Individuals become wholly engaged with the immediate activity, and lose elements related to their perception of the outside world. The result is a selfless state of mind, otherwise known as “flow.” This flow experience can be enjoyable and even fun; the entire body and mind participate in the activity, allowing the individual to gain a sense of satisfaction without relying on other elements to enhance the experience. The state of mind itself is the reward. Flow theory includes four facets: control, concentration, curiosity, and intrinsic interest (Beard, 2015;
Csikszentmihalyi, 1975). These four sub-constructs can be used to measure learners’ flow state when they engage in the learning process.

Skill level and amount of challenge are two additional critical factors in the flow state, because the various different combinations of skills and challenges can produce a wide variety of mental conditions. Only when skills and challenges reach a balance do students achieve the most desirable level of flow. If a student’s level of skill allows them to easily surpass the challenge, then the activity will make them feel bored. When the challenge is greater than their level of skill, they may feel anxious. Much of the literature has pointed out that a balance is essential to learning while in the flow state (Cakmak et al., 2015; Challco et al., 2016).

**Game-based learning scenario**

Many studies have determined that applying educational games to language learning can positively impact academic outcomes and promote students’ motivation and interest (Boyle et al., 2016; Oga-Baldwin et al., 2017). Cristea and Fărcașiu (2015) investigated learning outcomes related to English vocabulary activities, finding that English vocabulary games are one of the most effective learning practices available. Thus, interesting game-based learning is likely to lower anxiety, promote concentration, and improve academic outcomes.

Yip and Kwan (2006) explained that studying vocabulary is often perceived as boring, since students must practice memorizing large bodies of relatively disconnected words. To address this situation, the researchers employed online vocabulary games as a tool to guide students’ absorption of English vocabulary. Their study showed that online games did help achieve the designated learning outcomes and promoted longer memory retention in participants. Ashraf, Motlagh, and Salami (2014) also found that using online games could help students acquire English vocabulary by creating a pleasant environment in which learners are eager to compete and/or cooperate. Though there may also be negative effects, games were determined to generally promote a sound cycle of competitiveness.

**Personalized assistance strategy**

Learning strategies are clear steps or plans developed in an effort to solve educational problems or reach academic goals. They are often applied to the domains of memory, cognition, and emotion (Maranges, Schmeichel, & Baumeister, 2017). Strategies for learning English are employed to assist students with memorizing and absorbing related English knowledge in terms of skills, steps, and actions. They are intended to have a positive influence, helping students to gain, retain, and organize knowledge and ultimately make language learning more relaxing, joyful, and efficient (Oxford, 1990). The advantage of personalized learning is that it helps optimize students’ learning processes and assists them in gaining knowledge more effectively. Wu et al. (2014) proposed the development of a ubiquitous personalized English reading system by using RFID technology. This system provided learners with highly realistic scenarios when reading English articles, in part by analysing their current location. This study defined personalized assistance as the provision of scaffolded support to adjust the proportion of questions of different difficulty levels to students’ personal learning progress, thus facilitating their learning performance.

**System design**

**Design of the competitive gaming scenario**

This study developed a game similar to Monopoly, which served as the competitive activity used to test our theory. Since Monopoly is a well-known board game, this ensured that learners would be likely to understand our game’s rules and reduced the possibility of it affecting the research design. The interface was mainly composed of vocabulary tests, movement rolls, travel, and card areas (see Figure 1). The functions of each area are described below.

**Vocabulary**

In the game, when a learner receives a token, they are allowed to click the dice icon. This causes them to receive six fill-in-the-blank type questions. Three English education experts were asked to discuss this process and eight
college students took this test. Subsequently, it was decided that 15 seconds was the most suitable amount of time to answer the questions. When the learner finishes answering, the system counts the correct number of answers. This determines the number of forward spaces in the learner’s roll. Although the game allows learners to control their amount of progress, it does differ from traditional Monopoly. It is only once the learner is familiar with the content and feels highly confident that they are allowed to control their fate and the distance of their roll. This design helps learners master the material. While they wait for their token, they are allowed to review the six questions they have already answered (see Figure 2).

![Figure 1. Game interface of English vocabulary](image1)

![Figure 2. Review interface of English vocabulary](image2)

**Role**

Monopoly is a competitive game played by groups of four people; only one person can operate the game at a time. In our game, the right side of the screen becoming larger indicated that it was the player’s turn to proceed. Learners clicked the dice icon to initiate their turn and play the game. In the beginning, each player had $10,000. The amount of the capital increased or decreased in response to specific in-game behaviours. When the game ended, the total amount of the capital determined the victory.

**Travel**

The game allowed players to move forward along the lattice, according to their number of correct answers. When the game piece landed in a space occupied by no one, the player was able to choose whether or not to buy
the land. If they landed in a space they already owned, they could choose to build a house or upgrade an existing building. Of course, when purchasing a property, building a house, or upgrading an existing structure, the player needed to have and spend the corresponding amount of money. If a player landed on a space occupied with another’s assets, they had to pay a fine based on the category and level of that space.

*Special effect cards*

In order to increase the amount of fun and encourage more interactive group competition, this study designed seven types of special effect cards. These cards allowed for faster upgrading, house destruction, freezing, grabbing, double forward moves, stolen houses, and tax review. Each learner could keep up to four special effect cards and use a maximum of one per round. When the learner answered more than three questions correctly or coincidentally landed on a lattice space with a special effect card, the system randomly gave the player a special effect card. This rewarded students answering questions correctly.

*Design of the personalized assistance strategy*

The well-known German psychologist Hermann Ebbinghaus (1913) proposed an overlearning approach to education, meaning for a person to master a certain body of knowledge, they must practice to the point of mastery. This learning approach echoes information processing theory, which argues that the making of new knowledge involves the consolidation of old knowledge. A good teaching strategy transfers data from learning materials to learners’ long-term memory; therefore, in the process of learning, students not only absorb new knowledge, but also review existing knowledge. Thus, we must pay special attention to the ratio of new to old knowledge. Too much new knowledge can easily lead to cognitive overload, while too much old knowledge may make learners feel bored.

This study created a test bank with 70% unknown or unfamiliar and 30% familiar English vocabulary items, to make adjustments for learning outcomes. Every student had their own vocabulary dataset, and each item was marked as learned or not learned. The system provided questions regarding both unknown and known items, with 70% being unfamiliar and 30% being familiar. This gave students more opportunities to be tested on learning content they did not know. At the same time, they could also review content they had already mastered. Based on the results of each test, the personalized assistance strategy made immediate adjustments. When answered incorrectly, the items were categorized as questions the learners did not know. In the next round’s test, the system gained more accurate information based on these knowns and unknowns, ultimately helping learners achieve their goals.

*Research methods*

This study proposed the integration of competitive games with personalized assistance to explore whether the two together would have significant effects on anxiety, immersion, and learning outcomes. The research model can be found in Figure 3.

A two-way ANOVA design was used to conduct this study and answer the three research questions. The main results and interactive effects of the competitive gaming scenario and personalized assistance strategy on the
degree of immersion, level of anxiety, and resulting learning outcomes were all examined. This research developed four types of sub-learning systems, including: general (GenTE), personalized (PerTE), game-based (GamTE), and game-based and personalized (G&PTE) test bank exercises.

GenTE randomly selected questions from the question bank and provided answers for the students to review but employed no competitive gaming or personalized strategy. PerTE was based on the learners’ answers, giving them tailored questions but not requiring them to participate in the competitive game. GamTE positioned four learners in a competitive game, but the tested vocabulary was randomly given (i.e., no personalized assistance). Among these sub-learning systems, G&PTE was the only plan integrating the competitive game with a bespoke learning program. The main content was English vocabulary for students of English as a foreign language. Twenty English vocabulary lists were selected from the intermediate to high levels of the General English Proficiency Test (GEPT) given by the Language Training and Testing Center of Taiwan.

The purpose of this research was to test vocabulary learning outcomes. Therefore, we selected unfamiliar vocabulary items after discussing this topic with experts in the field. In this way, the study was able to avoid the research results being affected by learners’ background knowledge. The design used repetitive recitation to access students’ long-term memory, in accordance with information processing theory. The materials covered English vocabulary, KK phonetics, parts of speech, English with Chinese sentence examples, and pronunciation. The vocabulary lists and sentences were based on a “winter” or “coldness” context. A total of 20 English vocabulary were designated for the experiment. All the vocabulary used Yahoo’s dictionary and VoiceTube as references; professional experts were employed to make any revisions and ensure accuracy. This study recruited 120 volunteers, all university students ranging in age from 19 to 26; in total, there were 62 males and 58 females. The learners were randomly assigned to four different groups of 30 students each. The procedures followed in this experiment are shown in Figure 4.

<table>
<thead>
<tr>
<th>Experimental explanation</th>
<th>5 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Watching English vocabulary videos</td>
<td>7 minutes</td>
</tr>
<tr>
<td>General test bank exercises</td>
<td></td>
</tr>
<tr>
<td>Personalized test bank exercises</td>
<td></td>
</tr>
<tr>
<td>Game-based test bank exercises</td>
<td></td>
</tr>
<tr>
<td>Game-based with personalized test bank exercises</td>
<td></td>
</tr>
<tr>
<td>Post-test and questionnaire</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Delayed post-test</td>
<td>10 minutes</td>
</tr>
<tr>
<td>1 week later</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. Procedure of the experiment

This study was based on the premise that anxiety from English instruction could be generated by either of two elements: the learning scenario or the learning task. Therefore, two anxiety scales were used to measure the anxiety levels of the participants. The first questionnaire was calibrated according to the situation-trait anxiety scale proposed by Spielberger, Gorsuch, and Lushene (1970). This scale is divided into two parts: situational and trait anxieties. The situational anxiety scale defines anxiety stemming from a learner’s sensations at a given time, a short-term emotional response triggered by a particular situation. Therefore, situation anxiety was adopted as an element in this study. There were 20 questions in the test item, and the questionnaire was translated by three experts. The content of its semantic expression was consistent with the experts’ validation and internal reliability (Cronbach’s α = 0.92), meaning that the items in the questionnaire had a good level of reliability (Nunnally, 1978; Spielberger, 1983).

The English reading anxiety scale proposed by Saito, Garza, and Horwitz (1999) was originally a measure of the anxiety generated by learners reading English articles, but this study modified the scale to measure the anxiety experienced in the process of reading English words. The original test items were comprised of 20 statements;
among them were the following: “I usually translate word for word when reading English,” and “When I see strange English letters and symbols, I can hardly remember what I read.” After discussing all of the items with experts, it was concluded that these two did not fit with the rest of the anxiety test for reading English vocabulary. Thus, we deleted these two questions; the result was that there was a total of 18 items on the questionnaire. For the content of the scale, the translations of the items, modifications, and deletions were accomplished with the assistance of three experts; the result achieved validity. After testing, the internal reliability (Cronbach’s α) was 0.86, meaning that the questionnaire items could be considered reliable and well designed (Nunnally, 1978).

The immersion questionnaire for this study and its four constructs were developed by Webster, Trevino, and Ryan (1993); the constructs included the degrees of concentration, control, curiosity, and inner interest. There were 12 questions, and each construct had three sub-questions. The purpose of the immersion scale was to measure the learners’ immersion experience within the learning process. The translation of the items in the scale was reviewed by three experts to determine if it was consistent with the experts’ understanding, and thus to establish validity.

Results

Analysis of learning outcomes

The first table lists the descriptive statistics for the results of the pre-test, post-test, and delayed post-test. A one-way ANOVA was used to identify significant differences in the pre-test scores among the four different groups. The pre-test had 20 items, each worth 5 points, with a maximum possible score of 100. After the analysis, it was determined that no significant differences existed among the various groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Delayed post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>GenTE</td>
<td>30</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>GamTE</td>
<td>30</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>PerTE</td>
<td>30</td>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>G&amp;PTE</td>
<td>30</td>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>120</td>
<td>70</td>
</tr>
</tbody>
</table>

Note. GenTE: general test bank exercises; GamTE: game-based test bank exercises; PerTE: personalized test bank exercises; and G&PTE: game-based with personalized test bank exercises.

This study used the progress scores from the pre-test and post-test as the learning outcomes. Then, a two-way ANOVA was conducted to measure the main interactive effects of the competitive game and personalized assistance, as shown in Table 2. It was found that the personalized assistance strategy had the main effect on the post-test. Moreover, both it and the competitive gaming scenario had significant interaction effects. In other words, personalized assistance alone had a positive impact on learning outcomes; the improvement in learning outcomes could not be achieved if students only interacted with the competitive game. However, when both were offered, the interactive effect of these two factors facilitated an improvement in learning performance that was superior to when personalized support alone was received.

Table 2. Results of two-way ANOVA on post-test

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAS</td>
<td>11900.208</td>
<td>1</td>
<td>11900.208</td>
<td>27.404</td>
<td>.000***</td>
</tr>
<tr>
<td>CGS</td>
<td>1235.208</td>
<td>1</td>
<td>1235.208</td>
<td>2.844</td>
<td>.094</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>5950.208</td>
<td>1</td>
<td>5950.208</td>
<td>13.702</td>
<td>.000***</td>
</tr>
<tr>
<td>Error</td>
<td>50372.500</td>
<td>116</td>
<td>434.246</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>373975.000</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. p < .05, "p < .01, ""p < .001; PAS: Personalized Assistance Strategy, CGS: Competitive Gaming Scenario. All of the following two-way ANOVA notes are the same as this table.

In order to determine if the participants’ learning outcomes would change as time went on, a delayed post-test was also conducted. One week after finishing the primary experiment, we administered an additional English vocabulary test. The content of the test was the same as on the post-test, and the results were very similar to those of the initial post-test (see Table 3). The personalized assistance strategy’s primary effect was on the post-
test, and there was an interactive effect from the personalized assistance and competitive game. From these results, we concluded that personalized assistance did indeed enhance long-term English vocabulary learning. In addition, it produced an interactive effect on the delayed post-test, when accompanied by the competitive gaming scenario. This shows that the combination of the two elements reflected certain aspects of information processing theory. Learners were not only able to transfer information or knowledge into their short-term memories, but also successfully make the transition to long-term memory.

Table 3. Results of two-way ANOVA on delayed post-test

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAS</td>
<td>3404.583</td>
<td>1</td>
<td>3404.583</td>
<td>5.456</td>
<td>.023</td>
</tr>
<tr>
<td>CGS</td>
<td>1740.616</td>
<td>1</td>
<td>1740.616</td>
<td>2.789</td>
<td>.100</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>3255.821</td>
<td>1</td>
<td>3255.821</td>
<td>5.218</td>
<td>.026</td>
</tr>
<tr>
<td>Error</td>
<td>41183.643</td>
<td>66</td>
<td>623.995</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>179150.000</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *p < .05.

Analysis of anxiety scale

The study also investigated whether competitive gaming and personalized assistance influenced anxiety levels in English vocabulary learning. To explore these factors, we used the game developed for this research and two English reading anxiety scales. Three experts were called upon to assist with the translation and deletion of scale items to ensure that the content of the scale was comprised of consistent semantic expressions. Using a two-way ANOVA, the survey adopted a five-point scale. Descriptive statistics of the results for the four groups can be found in Table 4.

Table 4. Descriptive statistics of anxiety scale

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Situation anxiety</th>
<th>English reading anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>GenTE</td>
<td>30</td>
<td>56.97</td>
<td>11.14</td>
</tr>
<tr>
<td>GamTE</td>
<td>30</td>
<td>52.5</td>
<td>12.599</td>
</tr>
<tr>
<td>PerTE</td>
<td>30</td>
<td>54.7</td>
<td>11.914</td>
</tr>
<tr>
<td>G&amp;PTE</td>
<td>30</td>
<td>48.8</td>
<td>13.942</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>53.24</td>
<td>12.65</td>
</tr>
</tbody>
</table>

The competitive gaming scenario indicated a significant difference on both the situational and English reading anxiety scales, as shown in Tables 5 and 6, respectively. There was no interaction between the competitive gaming scenario and personalized assistance strategy. These results show that competitive gaming can be used to help learners reduce their situational and English reading anxiety levels.

Table 5. Results of two-way ANOVA on situation anxiety

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAS</td>
<td>267.008</td>
<td>1</td>
<td>267.008</td>
<td>1.725</td>
<td>.330</td>
</tr>
<tr>
<td>CGS</td>
<td>806.008</td>
<td>1</td>
<td>806.008</td>
<td>5.207</td>
<td>.022</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>15.408</td>
<td>1</td>
<td>15.408</td>
<td>0.100</td>
<td>.753</td>
</tr>
<tr>
<td>Error</td>
<td>179555.567</td>
<td>116</td>
<td>154.789</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>359205.000</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *p < .05.

Table 6. Results of two-way ANOVA on English reading anxiety

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAS</td>
<td>112.133</td>
<td>1</td>
<td>112.133</td>
<td>0.959</td>
<td>.330</td>
</tr>
<tr>
<td>CGS</td>
<td>634.800</td>
<td>1</td>
<td>634.800</td>
<td>5.427</td>
<td>.022</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>132.300</td>
<td>1</td>
<td>132.300</td>
<td>1.131</td>
<td>.290</td>
</tr>
<tr>
<td>Error</td>
<td>13368.733</td>
<td>116</td>
<td>116.972</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>320276.000</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *p < .05.
Analysis of the immersion scale

This research used an immersion scale with the following four facets: concentration, degree of control, curiosity, and inner interest. With the construct of concentration, there was no interaction between the personalized assistance strategy and competitive gaming scenario among any of the four groups. However, the degree of control displayed significant interactions among the four groups for both the competitive gaming scenario and personalized assistance strategy. Nevertheless, the two elements did not display any interaction. The results of the analysis of the curiosity construct showed a significant difference among the four groups in the competitive gaming scenario, but no significant difference with the element of personalized assistance. Neither was there an interaction with curiosity by either of these two factors. The results of the analysis of the inner interest construct showed that there were significant differences with the competitive gaming scenario and personalized assistance strategy among the four groups. However, there was no interaction between these two elements. All relevant statistical descriptions can be found in Tables 7 to 11.

Table 7. Descriptive statistics of immersion scale

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Concentration</th>
<th>Control</th>
<th>Curiosity</th>
<th>Inner interest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>GenTE</td>
<td>30</td>
<td>9.2</td>
<td>2.772</td>
<td>8.47</td>
<td>2.063</td>
</tr>
<tr>
<td>GamTE</td>
<td>30</td>
<td>9.7</td>
<td>2.693</td>
<td>10.20</td>
<td>2.235</td>
</tr>
<tr>
<td>PerTE</td>
<td>30</td>
<td>10.43</td>
<td>2.873</td>
<td>10.37</td>
<td>2.025</td>
</tr>
<tr>
<td>G&amp;PTE</td>
<td>30</td>
<td>9.43</td>
<td>2.967</td>
<td>11.03</td>
<td>2.059</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>9.69</td>
<td>2.831</td>
<td>10.02</td>
<td>2.279</td>
</tr>
</tbody>
</table>

Table 8. Results of two-way ANOVA on concentration

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAS</td>
<td>7.008</td>
<td>1</td>
<td>7.008</td>
<td>0.876</td>
<td>.351</td>
</tr>
<tr>
<td>CGS</td>
<td>1.875</td>
<td>1</td>
<td>1.875</td>
<td>0.234</td>
<td>.629</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>16.875</td>
<td>1</td>
<td>16.875</td>
<td>2.110</td>
<td>.149</td>
</tr>
<tr>
<td>Error</td>
<td>927.833</td>
<td>116</td>
<td>4.398</td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>320276.000</td>
<td>120</td>
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</table>

Table 9. Results of two-way ANOVA on control

<table>
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<tr>
<th>Source</th>
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<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
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<tbody>
<tr>
<td>PAS</td>
<td>56.033</td>
<td>1</td>
<td>56.033</td>
<td>12.740</td>
<td>.001 **</td>
</tr>
<tr>
<td>CGS</td>
<td>43.200</td>
<td>1</td>
<td>43.200</td>
<td>9.822</td>
<td>.002 **</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>8.533</td>
<td>1</td>
<td>8.533</td>
<td>1.940</td>
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</tr>
<tr>
<td>Error</td>
<td>510.200</td>
<td>116</td>
<td>4.398</td>
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<td></td>
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<tr>
<td>Total</td>
<td>12658.000</td>
<td>120</td>
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</table>

Note. **p < .01.

Table 10. Results of two-way ANOVA on curiosity

<table>
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<tr>
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<th>MS</th>
<th>F</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>PAS</td>
<td>26.133</td>
<td>1</td>
<td>26.133</td>
<td>3.529</td>
<td>.063</td>
</tr>
<tr>
<td>CGS</td>
<td>80.033</td>
<td>1</td>
<td>80.033</td>
<td>10.808</td>
<td>.001 **</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>1.200</td>
<td>1</td>
<td>1.200</td>
<td>0.162</td>
<td>.688</td>
</tr>
<tr>
<td>Error</td>
<td>859.000</td>
<td>116</td>
<td>4.398</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12064.000</td>
<td>120</td>
<td></td>
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</tr>
</tbody>
</table>

Note. **p < .01.

Table 11. Results of two-way ANOVA on inner interest

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>PAS</td>
<td>95.408</td>
<td>1</td>
<td>95.408</td>
<td>17.308</td>
<td>.000 ***</td>
</tr>
<tr>
<td>CGS</td>
<td>130.208</td>
<td>1</td>
<td>130.208</td>
<td>23.621</td>
<td>.000 ***</td>
</tr>
<tr>
<td>PAS*CGS</td>
<td>1.875</td>
<td>1</td>
<td>1.875</td>
<td>0.340</td>
<td>.561</td>
</tr>
<tr>
<td>Error</td>
<td>639.433</td>
<td>116</td>
<td>5.512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12927.000</td>
<td>120</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. ***p < .001.
Discussion

The effects of the competitive gaming scenario and personalized assistance strategy on learning outcomes related to English vocabulary

In this research, the amount of progress on the pre- and post-tests were regarded as the learning outcomes. Games can significantly improve a competitive environment and state of immersion (Chang et al., 2017). The main impetus for an immersed state is a balance of techniques and challenges. Some researchers have argued that techniques and challenges most easily reach a balanced result at a low-skill threshold and less challenging state. Thus, the balanced immersion state for the game-based test bank exercise group was developed using low-level techniques and challenges. Yet learners can become bored or disinterested, fail to become immersed, and eventually lose focus on an activity (Hamari & Koivisto, 2014). In our experiment, this led to no successful learning outcomes and a slow growth in English vocabulary skills; it did not drive the sound circle of skills and challenges or balance high skills.

This study suggests that instructors should effectively allocate learning resources when time is limited by optimizing the testing process. In our learning strategy, students had a 70% chance of testing English vocabulary that they did not already know and a 30% chance of encountering vocabulary with which they were already familiar. This analysis shows that a personalized assistance strategy can effectively help students acquire English vocabulary knowledge. Moreover, it was determined from the delayed measurement that such a strategy could have a long-term impact on learning outcomes. Russell (2001) analyzed a large number of studies and found that new information technology may not directly have a significant positive impact on learning outcomes, but “no significant difference” also has an important meaning. If we expect that new technologies have substantial effects on learning performance, we should pay more attention to the course design, students’ needs/responses, and individual differences. The findings of this study are consistent with Russell’s argument in which competitive games will not affect learning outcomes alone; however, the integration of personalized strategies into the game design does help learners enjoy the learning process and strengthen and maintain effectiveness.

The influence of the competitive game and personalized assistance on anxiety associated with learning English vocabulary

It was determined that competitive games could significantly reduce situational and English reading anxieties. According to game-scenario literature, games allow learners to pursue challenging goals by following established rules, thereby enticing them to become interested and immersed in the learning activity. Thus, the process can easily create a low-anxiety educational environment (Mavridis & Tsiatsos, 2017). The best results have been produced by group-based competitive games, rather than a personal gaming environment. An optimized learning process allocates the appropriate resources so that learners can more efficiently obtain required knowledge. Therefore, this study argues that personalized assistance strategies should be used along with competitive games to offer more useful forms of play.

The influence of the competitive gaming scenario and personalized assistance strategy on immersion associated with learning English vocabulary

Students tend to be focused on the learning process. Much of the literature has indicated that game theory is closely related to the immersion state. An immersed state is one in which an individual completely focuses on an activity. The main element necessary to yield a flow state is a balance between skill level and challenge. Game-based learning allows students to pursue challenging goals within established rules by using their personal skills. Thus, game-based learning should have a significant impact on immersion. The two-way ANOVA analysis showed that the personalized assistance strategy had a significant impact on controlling two facets: immersion level and intrinsic interest. This demonstrates that personalized assistance could help students improve within an established learning system and assist them in exerting a degree of control; it may also be an improvement over traditional methods in that it could generate a higher level of inner interest.

Conclusion

This research used an experimental design for data collection and analysis and verified the results of the experiment via a variety of statistical methods. There was a significant difference in terms of reducing anxiety
when using a competitive gaming scenario to learn English vocabulary. This study divided the measure into situational and English reading anxieties. The results showed a substantial reduction in both types of anxiety during the competitive game designed to teach English vocabulary. Further analysis of the situational anxiety component indicated that it mainly stemmed from facets of the positive state. Learners’ anxiety from reading English primarily emerged from the negative state. Therefore, this research suggests that using competitive games will reduce situational anxiety by improving the positive state, and also will directly reduce the negative state, thus diminishing English reading anxiety. Additionally, competitive gaming had a significant effect on English vocabulary acquisition by enhancing the amount of control, curiosity, and intrinsic interest. Kinzie and Joseph (2008) believed that games would offer challenges that could be achieved by following existing rules, so learners could immerse themselves and become more interested in the activity. According to the results of this study, it seems that competitive gaming did indeed improve the level of inner interest in the learning process.

According to information processing theory, converting English vocabulary into short-term memory requires a record of external senses, while converting short-term recollections into long-term memory entails a process of review. To improve learning outcomes by converting English vocabulary into long-term memory in a limited amount of time, study and practice periods had to be properly allocated between short and long-term memory. This research found that after the initial background knowledge was acquired, students needed to spend half of the original learning time reviewing: this strengthened the level of consolidation. This study designed a personal assistance strategy that used a 70% conversion of short-term memory for learning new knowledge, and 30% conversion of long-term memory for review. Due to our findings, we believe that this personalized assistance strategy will effectively improve learning outcomes in students of English vocabulary.

In conclusion, the competitive gaming scenario and personalized assistance strategy for learning English vocabulary significantly interacted to enhance learning effectiveness. It is clear that individualized assistance had a significant effect on learning and joining it with the competitive game further promoted this interaction. For students of English vocabulary, this study suggests that personalized assistance strategies will effectively improve English vocabulary skills, especially in competitive gaming scenarios. Moreover, it will increase students’ competitiveness with other learners. Ultimately, this should yield a sound circle in which all find a balance between high skill and challenge levels. Therefore, competitive gaming scenarios and personalized assistance strategies will together improve English vocabulary acquisition.

Acknowledgments

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References


Using Game-Based Learning with Kinect Technology in Foreign Language Education Course

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*Corresponding author

ABSTRACT

The present study investigates the effects of game-based language learning with Kinect technology on students’ self-efficacy beliefs and attitudes toward English. The study was conducted at a state university located in Central Turkey. Foreign language education is promoted in Turkey, yet because of several factors, among which weekly hours of teaching, and student motivation prevail, and students still cannot develop their language skills. The literature shows that these problems might be minimized making use of technological advancements effectively in the classroom. Therefore, game-based language learning, through which students carry out meaningful tasks based on real-life scenarios to develop their communication skills, is getting an increasing attention. In this study, a pre-test/post-test quasi-experimental study was conducted. Participants were the first-year students taking English as a compulsory course. In total, there were 62 participants. The instruments included two questionnaires measuring self-efficacy beliefs and attitude toward English. The results revealed that there was a significant positive increase in some sub-factors of attitude and self-efficacy scores of the students in the experimental group compared to the average scores of the students in the control group. The study explains why game-based learning activities with Kinect technology should be integrated into the foreign language courses.

Keywords

Foreign language education, Game-based learning, Kinect, Higher education

Introduction

In today’s globalizing world, individuals are encouraged to learn other languages so that they can improve themselves and keep pace with developments and changes around the world. Especially in Europe, there is an increasing effort in foreign language learning. However, it still remains a challenge to reach to the native-like level of proficiency. The literature shows that there are a number of factors playing a role in that, among which crowded classrooms, employing traditional methods, inappropriate assessments, lack of student motivation and equipment, lack of qualified language teachers, insufficient number of teaching hours, and focusing on receptive skills rather than productive skills seem to prevail (Erdem, 2016; Tevno, 2011).

In order to develop language skills, Çelebi (2006), for instance, suggested employing activities based on real-life scenarios in foreign language classrooms. The traditional methods, which heavily focus on developing grammar knowledge and reading, ignore other essential skills such as listening, speaking, and writing. However, language is ultimately used for communication in real life. Thus, the present foreign language education should be examined taking this key factor into consideration.

The strategic and geographical status of Turkey as a cultural and a physical bridge between Asia and Europe as well as its proximity to Middle East and Africa makes learning foreign languages particularly important (Kirkgöz, 2007). As a result of several education reforms in Turkey, today foreign language education starts at the second grade in primary school and continues at higher education level as illustrated in Table 1.

| Table 1. Weekly hours of foreign language teaching in Turkey |
|-----------------|-----------------|-----------------|-----------------|
|                  | Primary School  | Middle School   | High School     |
|                  | 1   2 3 4        | 5   6 7 8       | Prep** 9 10 11 12 |
| Second Language  | -   2 2 2        | 3   3 4 4       | 20   4 4 4 4     |
| Third Language   | -   - - -        | 2** 2** 2**     | 4    2 2 2 2     |

Note. *Compulsory; **Elective; ***Preparatory class.

Foreign language education is promoted by the government in Turkey starting at early ages, however, students still cannot reach to the desired level of proficiency. At the level of higher education, there are several state and private universities in which the medium of instruction is in English, and some universities offer a one-year intensive English language preparation (Alptekin & Tatar, 2011). However, a large number of universities offer only a compulsory foreign language course to the first-year students of their undergraduate programs. The
weekly hours of this course vary 2 to 4 at most, and that's why instructors cannot go beyond providing basic language knowledge. Eventually, many students graduate from universities without learning a foreign language.

There are several steps that should be taken to succeed in foreign language education, such as supporting teachers’ professional development (Andrade & Evans, 2012), and taking students’ interests, needs, and individual differences into consideration (Liu, 2012), extracurricular activities to support the development of foreign language skills (Tholin, 2008), using audio-visual aids and materials in the classroom effectively (Price, 2010; Boyraz, 2014), and appropriate assessment (Purpura, 2016). Foreign language curriculum should focus ultimately on the development of communicative capacity in a foreign language, student-centered learning, and the role of teacher should be identified as a facilitator of learning process (Kırkgöz, 2007; Wichadee, 2011). However, for students to perform successfully in learning tasks, their self-efficacy and attitudes towards English are also important (Zheng, Young, Brewer & Wagner, 2009). Learners’ self-efficacy beliefs and attitude are considered key factors in their motivation, action, and persistence (Bandura, 1977; Eshghinegad, 2016). Therefore, both are crucial determinants in predicting learners’ academic performance and achievement. Furthermore, self-efficacy beliefs and attitude explain why some learners could be more successful than others with similar - or even higher - capabilities and background (Kim, Wang, Ahn & Bong, 2015).

Self-efficacy beliefs and attitude arise from experiential and instrumental sources (Bandura, 1977; Ahmed, 2015). Thus, providing learners with more opportunities to use the language in the classroom environment will help them develop their self-efficacy beliefs and gain a positive attitude toward learning. Language education could be empowered by making use of technological advancements effectively in the classroom (Lai & Li, 2011). In this regard, game-based language learning, through which learners can carry out meaningful, situation-based tasks, is receiving more attention (Lisle, 2012). The literature suggests that game-based learning activities with Kinect technology might be utilized to provide an effective environment for speaking and role play simulations based on real-life scenarios (Chang, Sheldon, Si & Hand, 2012; Lien, Huang, Wang & Chen, 2012). However, there is still a need for understanding the effects of these activities on learners’ self-efficacy beliefs in and attitude toward learning foreign languages due to the lack of adequate research. The purpose of the present study is, thus, to develop game-based learning activities with Kinect technology in an English course at higher education level in Turkey, and investigate the effects of these activities on learners’ self-efficacy beliefs in and attitude toward learning English as a foreign language. The research questions are as follows:

- Is there any significant difference in the students’ attitude toward English between the experimental and control groups?
- Is there any significant difference in the students’ beliefs of self-efficacy in English between the experimental and control groups?

**Game-based language learning**

Games have an important place in language learning today with the advancement of technology. They enable learners to actively participate in activities, and to strengthen their affective reactions such as interest, motivation, and willingness to participate. Furthermore, games often focus on the communicative and functional aspects of language(s) (Gömlekzis, 2005; Öztürk-Yurtseven, 2016). They have positive effects on active participation, allows individuality and competition in learning, and provides opportunities to use language skills in diverse situations (Kartal, 2014). Thus, game-based learning is an alternative method which promotes an effective language learning environment as compared to traditional methods.

Learners’ motivation is increased by contextual learning and using authentic materials which provide interaction among learners (Öztürk-Yurtseven, 2016). According to Dale (1969), we learn the things we do better than we read or hear because we use more senses, and activities which allow more individualized learning and make learning easier and more permanent. Digital games, supported by audio-visual aids, enable learners to perform their fundamental language skills (e.g., reading, writing, and speaking) in situations similar to real-life scenarios. There have been an increasing number of studies on digital game-based learning (DGBL). Hwang and Wu (2012) analyzed the research status and trend of DGBL from 2001 to 2010. They found that the number of articles from many countries has significantly increased. Most of these studies are exclusively related to language education. To illustrate, Neville, Shelton, and McInnis (2009) explored the effect of using fictional games on learning foreign language vocabulary, developing reading skills, and learning a different culture. They observed that those who used fictional games had longer and more effective writings, and they were more successful in using words or groups of words than those exposed to traditional methods. In another study, Liu and Chu (2010) examined how ubiquitous games influenced learning English and learners’ motivation through a
context-aware learning environment. The researchers found that incorporating ubiquitous games into the program resulted in better learning outcomes and increased learners’ motivation. Games can enable learners to develop specific language skills. For instance, Turgut and Irgin (2009) studied young learners’ out of school learning and experiences with computer games. They observed that games promoted young learners’ language learning, and developed their vocabulary skills.

The literature, based on a recently growing body of research into the potential of massively multiplayer online role-playing, mobile and virtual reality games for teaching and learning English, however, suggests that there is still a need for further research on the effects of new and advanced technologies (Lin & Lan, 2015). For instance, Cheng, Yang and Andersen (2017) adapted a 3D language-learning game to virtual reality integrated with the Oculus Rift. They found a significant increase in learners’ sense of cultural involvement, but they couldn't observe any improvement in language learning. Cheng, Yang and Andersen (2017) also suggested that with the advancement of technology additional opportunities could feature real-life settings for language learning practice, and that further research was needed to understand the effects and potential of these games. Lee and Gerber (2013) reported a longitudinal study of observing English language development through massively multiplayer online gaming. They found that learners’ awareness of the language and attention to the language forms increased as they confronted many situations where they felt the need to know the language during the process of game play. The present study seeks to contribute to the relevant literature by investigating the effects of integrating game-based language learning activities with Kinect technology into the English course on learners’ self-efficacy beliefs and attitude.

**Kinect-based learning**

Kinect is a motion sensing input device consisting of four major components: an RGB camera, 3D depth sensors, a multi-array microphone, and built-in processing cores. Gestures or voice commands can be employed to operate any system developed with help of software development kit without a handheld remote or pedal controllers (Kinect for Windows, 2017). Even though they were used for interaction in game consoles at first because of their several advantages such as interactions with natural gestures and postures, Kinect cameras have drawn attention of many experts in different fields including advertisement, medicine, health, and especially education.

The literature suggests a number of reasons for using Kinect technology in educational environment. Boutsika (2014), for instance, listed these reasons as follows: (i) students do not need any equipment to control their action, (ii) every movement students perform is projected on the screen, (iii) students feel like they are really playing a game regardless of whether it is an open or closed environment, (iv) Kinect enables new moments to be naturally imbedded in students’ subconscious and similarly to be generalized to real-life settings. Today, it is possible to find the examples of Kinect implementations which have been adapted to educational environment through innovative methods. To illustrate, Cheong, Yap, Logeswaran & Chai (2012) used Kinect together with a multi-touch interactive whiteboard and a teaching station and designed a cost-effective technology. The results showed that the innovative environment supported with Kinect technology was more effective than standard computers since they were much easier to operate. Using a novel approach to produce video portfolios in the classroom, Lien et al. (2012) built a rich and context sensitive background in which students’ whole body movements were captured by Microsoft Kinect. The researchers asserted that learners’ performance is affected by a variety of learning styles, and this approach has a significant capacity to enhance learners’ sense of style, reflective and metacognitive skills.

In the recent years, the implementations of Kinect technology have also been in the field of language education. For instance, Urun, Aksoy and Comez (2017) explored the effectiveness of a Kinect-based game in a virtual language classroom. In this quasi-experimental study, they found a significant difference in the post-test scores in favour of the experimental group supported with Kinect-based learning environment. Kinect technology seem to be effective in increasing learners’ motivation. Pan (2017) analysed the effects of using the Kinect motion-sensing interactive system to enhance English learning. The results revealed that the motion-sensing interface of Kinect was not a key-factor affecting short-term or long-term learning retention, but Pan (2017) suggested using it especially for interactive operations to attract students’ attention in English vocabulary learning.

In brief, there have been several attempts to understand the contributions of Kinect technology. However, there is still a need for further research regarding how Kinect technology interacts with confounding factors in foreign language learning such as self-efficacy and attitude, both of which heavily influence academic performance and achievement. The present study developed game-based learning activities with Kinect technology and adapted it
to an English course at higher education level. The ultimate goal of the study was to investigate the effects of integrating these activities into the course on learners’ self-efficacy beliefs and attitude toward learning English.

**Self-efficacy and attitude**

Learners’ self-efficacy beliefs and attitude are crucial determinants in predicting their academic performance and achievement (Bandura, 1977; Başaran & Cabaroğlu, 2015; Zheng et al., 2009). Many researchers have focused on the relationship between self-efficacy and/or attitude and factors such as anxiety level, motivation, learners’ use of strategies, and persistence in learning (Doordinejad & Afshar, 2014; Kim et al., 2015; Raoofi, Tan, & Chan, 2012). Some others have explored the effect of learners’ self-efficacy beliefs and attitude on academic performance and achievement (Ayotola & Adedeyeji, 2009; Heidari, Izadi, & Ahmadian, 2012; Yurtseven, Alcı, & Karataş, 2014). Nonetheless, there are only a few in the field of foreign language education. Only recently have researchers been more interested in individual differences such as self-efficacy, and motivational orientations such as attitude.

Self-efficacy beliefs influence learners’ strategy use in foreign language learning (Wang & Li, 2010). To illustrate, having conducted a study with Chinese learners of English at university level, Wang and Li (2010) found that learners with high self-efficacy beliefs utilized three subcategories of reading strategies (i.e., metacognitive, social/affective, and cognitive strategies) more than those with low self-efficacy beliefs. There have been other studies demonstrating that learners’ self-efficacy beliefs are directly related to their academic performance and achievement. For instance, Doordinejad and Afshar (2014) investigated the relation between self-efficacy and overall academic achievement, and found that those with high self-efficacy beliefs in English had higher English scores. In addition to the effect of self-efficacy beliefs, the relevant literature has shown that motivational orientations such as attitude also influence academic performance and achievement (Gardner & Lambert, 1972; Yurtseven, Alcı, & Karataş, 2014). Learners’ attitude toward learning a foreign language can facilitate the process and influence learners’ actions (Gardner & Lambert, 1972). In a study conducted with high school students, for instance, Yurtseven, Alcı, and Karataş (2014) found that there was a mutual relationship between attitude and achievement. Accordingly, if learners develop a negative attitude, this might lead them to fail whereas if they experience achievement, this might help them develop a positive attitude toward learning. Furthermore, the literature has shown that attitude is also a powerful predictor of academic performance in English courses (Mustafa, 2015; Sardegna, Lee, & Kusey, 2018).

Many studies have explored the effects of self-efficacy and attitude on academic performance and achievement, but there is a lack of research answering the question of how to improve learners’ self-efficacy beliefs and help learners develop a positive attitude toward learning a foreign language. Self-efficacy beliefs are ultimately based on experience (Bandura, 1977), and instrumental reasons are considered primary sources of learners’ attitude (Mustafa, 2015). However, it is difficult for learners to find the opportunity to use the language. Therefore, it will be effective to incorporate alternative methods and techniques into foreign language classrooms. Game-based learning activities with Kinect technology, which provide learners with meaningful activities based on real-life scenarios, might be a powerful tool to enhance learners’ self-efficacy and develop a positive attitude toward foreign language learning.

**Method**

**Research design**

The present study used a pretest/posttest quasi-experimental design (Fraenkel & Wallen, 2003). The independent variable was the use of game-based learning activities with Kinect technology in the classroom. The dependent variables included the students’ self-efficacy beliefs and attitude toward English. Both the control and experimental group attended the English course. The former followed the traditional methods while the latter was supported with game-based learning activities (See Figure 1).
Participants

The participants were the first-year students enrolled in the Foreign Language course at a university in Turkey during the fall semester of 2016-2017. The students had been divided into two sections by the faculty, yet they were taught by the same instructor. The students had never been exposed to a course in which digital games were employed. Participants were distributed to experimental and control groups formed through simple random sampling method, in which participants had the same probability of being placed in the specified groups (Fraenkel & Wallen, 2003).

Table 2. Distribution of participants in the study by gender and groups

<table>
<thead>
<tr>
<th>Gender</th>
<th>Experimental group (%)</th>
<th>Control group (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19 (30.6%)</td>
<td>15 (24.2%)</td>
<td>34 (54.8%)</td>
</tr>
<tr>
<td>Female</td>
<td>13 (21.0%)</td>
<td>15 (24.2%)</td>
<td>28 (45.2%)</td>
</tr>
<tr>
<td>Level of English Proficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beginner</td>
<td>15 (46.0%)</td>
<td>16 (53.0%)</td>
<td>31 (50.0%)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>16 (50.0%)</td>
<td>13 (43.0%)</td>
<td>29 (47.0%)</td>
</tr>
<tr>
<td>Advanced</td>
<td>1 (4.0%)</td>
<td>1 (4.0%)</td>
<td>2 (3.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>32 (51.6%)</td>
<td>30 (48.4%)</td>
<td>62 (100.0%)</td>
</tr>
</tbody>
</table>

Note. E.G: Experimental group, C.G: Control group.

As seen in Table 2, there were 62 participants, 30 in the control group and 32 in the experimental group. Although the distribution of these participants by gender was close to each other, male participants (54.8%) were slightly more than female participants (45.2%). The students were studying at the department of Computer and Instructional Technology Education. Almost all participants think that their English proficiency was in a beginner and intermediate level.

Instruments

In this study, the instruments included two questionnaires that returned the quantitative data: English Self-Efficacy Scale (ESS) and Attitude toward English Scale (ATES).

ESS was used to measure students’ self-efficacy beliefs in English for four language skills developed by Hancı-Yanar, and Bümen (2012). The scale consisted of 34 items; 8 for reading, 10 for writing, 10 for listening and 6 for speaking. The example items of scale are as follows: “I can understand when I read an English text,” “I can write a good paragraph or composition,” “I can take the main idea of English speakers,” “I can meet my needs in daily life using English.” Previously, the Cronbach-Alpha reliability coefficient of the scale was found to be between 0.88 and 0.93. Likewise, the present study confirmed that it was between 0.80 and 0.95. Thus, it was a valid and reliable means of measuring the English self-efficacy beliefs, in the five-point Likert format ranging from 1 (Completely Disagree) to 5 (Completely Agree).

ATES was used to measure students’ attitude toward English under four sub-factors: learning, unwillingness, individual meaning, and importance. The example items of scale are as follows: “I like to practice English,” “I am curious to learn more English knowledge,” “I am not very willing to work hard in English,” “English is more important than other courses.” This scale was developed by Tuncer, Berkant, and Dogan (2015). It was a 5-point Likert-type scale, consisting of 19 items. The reliability of the scale was high, (i.e., 0.88). For the present study, the Cronbach-Alpha internal consistency coefficient was computed as 0.85. Both instruments were conducted in the participants’ native language, Turkish.
Setting and games

This study was designed to examine the effects of game-based learning activities with Kinect technology on students’ self-efficacy beliefs and attitude toward English. It was conducted in the Foreign Language course, one of the compulsory courses offered to the first-year students at university in Turkey. The aim of this course is to enable students to develop their foreign language skills (i.e., reading, speaking, listening and writing). At the end of this course, students are expected to acquire skills and knowledge in self-introduction, writing about everyday subjects, personal or daily conversation, and using appropriate patterns and definitions in the foreign language.

Game-based learning activities were integrated into the curriculum of this course. The purpose of these activities is to provide an environment in which students take an active role in the learning process, and interact with each other. The games were developed using two or three dimensional visuals, sound and sound effects with the Unity 3D after examining the characteristics, interests and needs of the learner group. Additionally, games were designed to interact with Kinect technology so that it could be applied in the classroom environment. Kinect camera technology is a manually controlled device, a device that commands the user’s gesture and speech by providing the natural user interface before the user perceives his body position, movements, voice, and so on (Kinect for Windows, 2017). Furthermore, games were developed in accordance with the possible scenarios based on the Erasmus mobility programs, which would offer meaningful activities to university students and provide the greatest benefit to language development. Erasmus is a European Union program that enables higher education institutions to cooperate with each other, produce common projects, and exchange students and staff (Erasmus, 2017). The games were played by groups of students including 4 or 5 members. Each game took approximately 15-20 minutes. The games consisted of three stages and a number of different tasks under these stages. Each task included a variety of dialogues in order to avoid the risk of memorization.

Win and travel

Students find themselves in a scenario in which they are an Erasmus exchange student abroad, and according to this scenario, they participate in a competition on foreign language knowledge. The points they gain in the competition are calculated as their budget which they will spend in a European tour for a week. The first stage consists of seven sub-tasks: introducing yourself, buying flight tickets, preparing luggage for flight, taking a taxi and airport voyage, talking to airport staff before boarding procedures, shopping (Duty Free), and post-landing processes. Both the purpose of “Win & Travel” section and a screenshot of implementation process can be seen in Figure 2.

Renting a house

The second stage, based on what Erasmus students need to do so that they can continue their life abroad, consists of four sub-tasks: choosing a roommate, choosing a flat, organizing furniture at home with a roommate, and shopping at the supermarket to meet the nutritional needs. Both the purpose of “Renting a House” section and a screenshot of implementation process can be seen in Figure 3.
Finding a part time job

The last stage, finding a part-time job and working part-time abroad, is composed of five sub-tasks: giving your information to the employment office, telephone interviews for job opportunity details, getting prepared to meet employers, interviewing with employers, deciding on a part time job to work, and first day at work. Both the purpose of “Finding a Part Time Job” section and a screenshot of implementation process can be seen in Figure 4.

In addition, there are additional tasks at each stage where students will collect points through physical activities and these points can be used in travel planning, home expenses or in completing the game. The first of these tasks (See Figure 5) is based on vocabulary knowledge, the second is based on recognizing countable and uncountable objects, and the last requires students to match the words presented in the foreign language (English) with their visuals or equivalents in the students’ native language (Turkish).

Data collection process

The study was conducted in the two sections of Foreign Language course in the fall semester of 2016-2017. Students participated in the study on voluntary basis. Pre-tests (ESS and ATEs surveys) were distributed to the students to collect the relevant data for this study in the first week of the course. Traditional methods (e.g., narration, question-answer and demonstration) were employed in the control group. In the experimental group, game-based learning activities described above were integrated into the curriculum. For instance, these activities were used in the 2nd and 3rd weeks, 5th and 6th weeks, and 11th and 12th weeks of the course period respectively in the classroom enriched with Kinect and smart board. Table 3 below illustrates the process of data collection.
### Table 3. Data collection process

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the Beginning of</td>
<td>Pre-Test (ESS and ATES Surveys)</td>
<td>Pre-Test (ESS and ATES Surveys)</td>
</tr>
<tr>
<td>the Course</td>
<td>(1st Week)</td>
<td>(1st Week)</td>
</tr>
<tr>
<td>During the</td>
<td>Traditional Teaching Methods (1st Week – 14th Week)</td>
<td>Traditional Teaching Methods (1st Week – 14th Week)</td>
</tr>
<tr>
<td>Course</td>
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<td>Game-Based Activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Game 1 - (2nd and 3rd Weeks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Game 2 - (5th and 6th Weeks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Game 3 - (11th and 12th Weeks)</td>
</tr>
<tr>
<td>At the End of</td>
<td>Post-Test (ESS and ATES Surveys)</td>
<td>Post-Test (ESS and ATES Surveys)</td>
</tr>
<tr>
<td>the Course</td>
<td>(14th Week)</td>
<td>(14th Week)</td>
</tr>
</tbody>
</table>

The classroom of the experimental group consisted of three basic parts as shown in Figure 6: Kinect, Smart board and Action Area. Action Area is defined as the area in which learners can perceive their own images and use their body language. Individual performances were observed in this area. More precisely, the students came to the area and participated in the activities in turn according to their tasks in each game directed by the instructor. At the end of the course, post-tests were conducted with both the experiment and the control group.

![Figure 6. Classroom environment](image)

### Data analysis

IBM SPSS Statistics 23.0 program was used for statistical analysis of the quantitative data. Data normality was checked using Kolmogorov-Smirnov (K-S). Different statistical tests were used depending on the type of data. Accordingly, for the paired comparison of different groups, independent samples t-test (i.e., parametric test) and Mann Whitney-U test (i.e., a non-parametric test) were run. Paired t-test (i.e., parametric test) and Wilcoxon Signed Rank test (i.e., a non-parametric test) was run for paired comparisons within the same group. The difference between the groups according to the relevant variables was tested at the significance level of $p < .05$.

### Findings

In this section, the findings from the pre-tests and post-tests of experimental and control group are presented. According to the normality tests, all data sets except the sub-item of ATES (i.e., individual meaning) are normally distributed among the sub-factors of the questionnaires. According to the Kurtosis, and Shapiro-Wilk’s W normality tests, non-parametric tests were applied for the sub-item of ATES (i.e., individual meaning, $p < .05$).
The results of students’ attitude toward English lesson

In order to answer the first research question, students’ attitude toward English lesson was examined in both groups. Independent samples $t$-test and Mann Whitney-U test results on pre-test scores of students in the experimental and control group for attitudes towards English course scale are presented in Table 4.

Table 4. Comparison of attitude toward English pre-test results of experiment and control groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>$N$</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>$SD$</th>
<th>$t$</th>
<th>$p$</th>
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<td></td>
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<td>0.86</td>
<td>-0.62</td>
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<td>4.8</td>
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<td></td>
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<td>MWU</td>
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<tr>
<td>Experiment</td>
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<tr>
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<td>0.88</td>
<td>MWU</td>
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As seen in Table 4, there was no statistically significant difference between the groups in terms of the learning ($t = -0.62, p > .05$), unwillingness ($t = 0.79, p > .05$), importance ($t = -0.54, p > .05$) and individual meaning ($U = 468, p > .05$). Accordingly, students’ attitudes toward English course in both groups were similar before the experiment. The attitude scale of the groups was compared with the independent samples $t$-test and Mann Whitney-U test for post-test scores and the results are given in Table 5.

Table 5. Comparison of attitude toward English post-test results of experiment and control groups

<table>
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<th>Groups</th>
<th>$N$</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>$SD$</th>
<th>$t$</th>
<th>$p$</th>
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</thead>
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<tr>
<td>Experiment</td>
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<td>0.40</td>
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<td>0.016*</td>
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<td>5.0</td>
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<tr>
<td>Individual Meaning</td>
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<td>MWU</td>
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<td>MWU</td>
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</tbody>
</table>

Note. *$p < .05$.

According to Table 5, there was no statistically significant difference between the groups in terms of the unwillingness, importance and individual meaning except learning ($t = 2.47, p < .05$). The means of learning sub-factor was 4.10 and 3.75 for the students in the experimental group and in the control group respectively. This difference was statistically significant ($p < .05$). Additionally, Table 6 below shows the paired $t$-test and Wilcoxon test results for pre-post test scores of the attitude scale for English course in the experimental group.

Table 6. Comparison of attitude toward English pre- and post-test results of experiment group

<table>
<thead>
<tr>
<th>Groups</th>
<th>$N$</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>$SD$</th>
<th>$t$</th>
<th>$p$</th>
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<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>32</td>
<td>3.34</td>
<td>1.00</td>
<td>5.00</td>
<td>0.87</td>
<td>-4.38</td>
<td>0.00*</td>
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<tr>
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<td>4.10</td>
<td>3.50</td>
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</tr>
<tr>
<td>Pre-test</td>
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<td>2.75</td>
<td>1.00</td>
<td>4.40</td>
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<td>2.91</td>
<td>0.007*</td>
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<td>1.50</td>
<td>5.00</td>
<td>0.89</td>
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</tbody>
</table>

Note. *$p < .05$.

A statistically significant difference was found between the mean scores of the learning ($t = -4.38, p < .05$) and unwillingness ($t = 2.91, p < .05$) sub-factors in the paired test results for the pre- and post-test scores averages of the attitude scale towards the English course in the experiment group. In other words, these findings indicated that the mean scores of the unwillingness factor decreased while the scores of the students in the experimental
group increased in favor of the post-test between the pre- and post-test measures of the mean of the learning factor. Table 7 shows the paired t-test and Wilcoxon test results for pre-post test scores of the attitude scale for English course in the control group. According to the results, there was no statistically significant difference between pre- and post-test results in terms of students’ attitude toward English in the control group.

Table 7. Comparison of attitude toward English pre and post-test results of control group

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>SD</th>
<th>t</th>
<th>p</th>
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<td></td>
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</tr>
<tr>
<td>Pre-test</td>
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<td>4.8</td>
<td>0.79</td>
<td>-1.58</td>
<td>0.13</td>
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<tr>
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<td>3.75</td>
<td>2.5</td>
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<td>5.0</td>
<td>1.0</td>
<td>-0.53</td>
<td>0.72</td>
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</table>

The results of students’ self-efficacy beliefs in English

In order to answer the second research question, students’ self-efficacy beliefs in English were examined in both groups. Independent samples t-test results on pre-test scores of students in the groups for self-efficacy beliefs in English course are presented in Table 8.

Table 8. Comparison of self-efficacy beliefs in English pre-test results of experiment and control groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>SD</th>
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<td>0.89</td>
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<td>2.23</td>
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<td>4.2</td>
<td>0.87</td>
<td>-0.13</td>
<td>0.89</td>
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<td>1.2</td>
<td>4.0</td>
<td>0.78</td>
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</tr>
</tbody>
</table>

As seen in Table 7, there was no statistically significant difference between the groups in terms of reading (t = -0.30, p > .05), writing (t = -0.69, p > .05), listening (t = 0.13, p > .05) and speaking (t = -0.13, p > .05). Accordingly, self-efficacy beliefs of students toward English in the groups were similar before the experiment. Additionally, the self-efficacy beliefs scale of the groups was compared with the independent samples t-test for post-test scores and the results are given in Table 9.

Table 9. Comparison of self-efficacy beliefs toward English post-test results of experiment and control groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>32</td>
<td>2.96</td>
<td>1.3</td>
<td>4.5</td>
<td>0.76</td>
<td>0.16</td>
<td>0.86</td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>2.93</td>
<td>2.1</td>
<td>4.5</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>32</td>
<td>2.49</td>
<td>1.0</td>
<td>4.5</td>
<td>0.81</td>
<td>-0.24</td>
<td>0.80</td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>2.54</td>
<td>1.5</td>
<td>3.3</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listening</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>32</td>
<td>2.99</td>
<td>2.1</td>
<td>4.0</td>
<td>0.55</td>
<td>1.98</td>
<td>0.06</td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>2.67</td>
<td>1.2</td>
<td>4.0</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>32</td>
<td>2.76</td>
<td>2.0</td>
<td>4.0</td>
<td>0.59</td>
<td>3.01</td>
<td>0.004**</td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>2.30</td>
<td>1.0</td>
<td>3.5</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. **p < .01.

There was no statistically significant difference between the groups in terms of reading, writing and listening, except speaking (t = 3.01, p < .05). The means of speaking sub-factor of students in the experimental group and in the control group was 2.76 and 2.30 respectively. This difference is statistically significant (p < .05). Table 10 shows the paired t-test results for pre-post test scores of the self-efficacy beliefs scale for English in the experimental group.
The ultimate goals of foreign language teaching include enabling students to acquire both productive (i.e., speaking and writing) and receptive language skills (i.e., listening and reading), to communicate in their foreign language effectively, and to develop willingness to learn and positive attitudes toward learning foreign languages (Güler, 2005). In order to achieve these goals, the literature suggests that there is a need for novel approaches (Goodwin & Kryratzis, 2012), and these approaches should be based on more “authentic” and “real” communication instead of “limited” (traditional) and “unnatural” interactions (Cook, 1997). The most effective way of having such authentic and real experiences could be easily found in an environment where the target language is spoken. However, this may not be possible for everyone due to different factors. In this sense, technological advancements can provide alternative ways to create opportunities for everyone to learn foreign languages more effectively. In the present study, realistic learning environments were built. For this purpose, Kinect-based games were developed, and the possible constraints were minimized. Game-based learning methodology supported by Kinect technology was employed in a foreign language course offered at higher education level. The preliminary goal of the study was to investigate the effects of this methodology on students’ self-efficacy beliefs and attitudes toward English.

This study developed a game-based environment for learning English by using Kinect and integrating motion-sensing activities for students to engage in situational interactive learning environment. According to the results, there was not a significant difference in the pre-test scores of the students in the experimental and control group, whereas there was a significant difference in their post-test scores. The results showed that both groups had similar self-efficacy beliefs and attitudes toward English before the experiment, but the students in the experiment group developed positive attitude toward learning English after using Kinect-based games in the classroom. In this regard, the results are also consistent with those of previous work (Çavuşoğlu-Deveci, Arslan Buyruk, Erdoğan & Yücel Toy, 2016; DeHaan, Reed & Kuwanda, 2010; Vandercruysse, Vandewaetere, Cornillie & Clarebout, 2013). To illustrate, Vandercruysse et al. (2011) investigated how students’ motivation, perceptions

---

**Table 10.** Comparison of self-efficacy beliefs in English pre- and post-test results of experiment group

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>Pre-test</td>
<td>32</td>
<td>2.66</td>
<td>1.00</td>
<td>4.30</td>
<td>0.76</td>
<td>-1.34</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>32</td>
<td>2.96</td>
<td>1.30</td>
<td>4.50</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>Writing</td>
<td>Pre-test</td>
<td>32</td>
<td>2.18</td>
<td>1.00</td>
<td>3.30</td>
<td>0.61</td>
<td>-1.39</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>32</td>
<td>2.49</td>
<td>1.00</td>
<td>4.50</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Listening</td>
<td>Pre-test</td>
<td>32</td>
<td>2.55</td>
<td>1.10</td>
<td>4.60</td>
<td>0.84</td>
<td>-2.28</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>32</td>
<td>2.99</td>
<td>2.10</td>
<td>4.00</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td>Pre-test</td>
<td>32</td>
<td>2.23</td>
<td>1.00</td>
<td>4.20</td>
<td>0.87</td>
<td>-2.60</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>32</td>
<td>2.74</td>
<td>2.00</td>
<td>4.00</td>
<td>0.59</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* *p < .05.

As seen in Table 10, a statistically significant difference was found between the mean scores of the listening (*t* = -2.28, *p* < .05) and speaking (*t* = -2.60 *p* < .05) sub-factors in the paired *t*-test results for the pre- and post-test scores averages of the self-efficacy beliefs in English in the experimental group. In other words, the scores of the students in the experimental group increased in favor of the post-test between the pre- and post-test measures of the mean of the listening and speaking factors.

Table 11 shows the paired *t*-test results for pre-post test scores of the self-efficacy beliefs scale for English course in the control group. Accordingly, there was no statistically significant difference between pre- and post-test results in terms of students’ self-efficacy beliefs in English in the control group despite a positive increase.

**Table 11.** Comparison of self-efficacy beliefs in English pre- and post-test results of control group

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>Pre-test</td>
<td>30</td>
<td>2.72</td>
<td>1.00</td>
<td>4.30</td>
<td>0.81</td>
<td>-1.06</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>30</td>
<td>2.93</td>
<td>2.10</td>
<td>4.50</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Writing</td>
<td>Pre-test</td>
<td>30</td>
<td>2.30</td>
<td>1.00</td>
<td>3.50</td>
<td>0.70</td>
<td>-1.41</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>30</td>
<td>2.54</td>
<td>1.50</td>
<td>3.30</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>Listening</td>
<td>Pre-test</td>
<td>30</td>
<td>2.52</td>
<td>1.10</td>
<td>4.60</td>
<td>0.72</td>
<td>-0.68</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>30</td>
<td>2.67</td>
<td>1.20</td>
<td>4.00</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td>Pre-test</td>
<td>30</td>
<td>2.26</td>
<td>1.00</td>
<td>4.00</td>
<td>0.78</td>
<td>-0.21</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>30</td>
<td>2.30</td>
<td>1.00</td>
<td>3.50</td>
<td>0.62</td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

The ultimate goals of foreign language teaching include enabling students to acquire both productive (i.e., speaking and writing) and receptive language skills (i.e., listening and reading), to communicate in their foreign language effectively, and to develop willingness to learn and positive attitudes toward learning foreign languages (Güler, 2005). In order to achieve these goals, the literature suggests that there is a need for novel approaches (Goodwin & Kryratzis, 2012), and these approaches should be based on more “authentic” and “real” communication instead of “limited” (traditional) and “unnatural” interactions (Cook, 1997). The most effective way of having such authentic and real experiences could be easily found in an environment where the target language is spoken. However, this may not be possible for everyone due to different factors. In this sense, technological advancements can provide alternative ways to create opportunities for everyone to learn foreign languages more effectively. In the present study, realistic learning environments were built. For this purpose, Kinect-based games were developed, and the possible constraints were minimized. Game-based learning methodology supported by Kinect technology was employed in a foreign language course offered at higher education level. The preliminary goal of the study was to investigate the effects of this methodology on students’ self-efficacy beliefs and attitudes toward English.

This study developed a game-based environment for learning English by using Kinect and integrating motion-sensing activities for students to engage in situational interactive learning environment. According to the results, there was not a significant difference in the pre-test scores of the students in the experimental and control group, whereas there was a significant difference in their post-test scores. The results showed that both groups had similar self-efficacy beliefs and attitudes toward English before the experiment, but the students in the experiment group developed positive attitude toward learning English after using Kinect-based games in the classroom. In this regard, the results are also consistent with those of previous work (Çavuşoğlu-Deveci, Arslan Buyruk, Erdoğan & Yücel Toy, 2016; DeHaan, Reed & Kuwanda, 2010; Vandercruysse, Vandewaetere, Cornillie & Clarebout, 2013). To illustrate, Vandercruysse et al. (2011) investigated how students’ motivation, perceptions
and learning outcomes changed with integrating games to a computer-based language learning environment. They reported that games ultimately increased students’ motivation, and the majority of students perceived the environment as a learning environment, even when they were instructed to play in a gaming environment. In another study, Shakroum, Wong and Fung (2018) investigated how gesture-based learning system with Kinect sensor (GBLS) impacts the learning outcomes. They found that GBLS’s features positively affect the students' intrinsic motivation. Additionally, the experimental group showed a significant difference between pre-test and post-test scores regarding learning and unwillingness factors on the attitude scale. The difference between the scores on importance and individual meaning factors, however, was non-significant. The results showed that the experimental group had significantly less unwillingness to learn English and a significant increase in their perception of their own learning while the importance of learning English for them did not change with the experiment. As Reinders and Wattana (2012) mentioned, game-based learning activities have several benefits such as lowering affective barriers and encouraging learners to interact within a target domain. These activities improve willingness to communicate and language acquisition. As Mubaslat (2012) stated, language games are not activities which aims to break the ice between students or to kill time. On the contrary, they have a positive effect on creating an interactive environment and improving academic performance and achievement.

Additionally, the pre-test and post-test scores of the scale on students’ self-efficacy beliefs were analysed. The analysis did not show a significant difference in the pre-test scores between the groups. However, the post-test scores following the experiment resulted in significant difference. More precisely, the groups had similar self-efficacy beliefs before the experiment, and Kinect-based games had positive effects on enhancing self-efficacy beliefs in the experimental group. The experimental group showed a significant difference in their self-efficacy beliefs on speaking and listening, yet the difference was not significant in their self-efficacy beliefs on reading and writing. The relevant literature presents a possible explanation for the significant difference observed in the experimental group. For instance, Al Hosni (2014) put forth that course-book and content-based teaching prevented the development of speaking skills, and increased students’ shyness. Similarly, grammar-based teaching is also regarded as an obstacle to the development of speaking and listening skills (Yolgaeli & Arıkan, 2011). The skills that are enhanced by the use of technology-based contextual games include speaking and listening skills, both of which university students would like to develop most (Boroujeni & Fard, 2013; Çavuşoğlu Deveci et al., 2016), yet educational institutions heavily provide content which is based on developing reading and writing whereas speaking and listening are usually limited (Boroujeni & Fard, 2013). The significant difference found in students' perceptions of the development of their speaking and listening skills shows that technology-based situational games can meet their needs and interests. In brief, game-based learning activities with Kinect technology have positive effects on learning outcomes (Shakroum, Wong & Fung, 2018; Urun, Aksoy & Comez, 2017) particularly the self-efficacy beliefs of students at higher education level in their speaking and listening skills.

**Conclusion and recommendations**

Game-based learning is getting an increasing attention in foreign language education as it encourages students to use the target language in a more creative and communicative environment. The relevant research shows that it has positive effects on learning quality and motivation, especially compared to traditional methods of teaching. Furthermore, learners display more positive attitude toward game-based learning (Hays, 2005; Vogel et al., 2006). The present study also revealed that integrating Kinect-based games into foreign language classrooms had positive effects on university students' attitudes and self-efficacy beliefs. In other words, these game-based language learning activities have positive effects on the learning process. Using such games in the classroom helps learners enhance their self-efficacy beliefs, particularly on speaking and listening skills.

Based on the results of this study, the following major recommendations can be offered for researchers and teachers to design language learning environments:

- Careful pedagogic planning of game-based learning activities is essential,
- Game-based learning activities can be designed for improving students’ attitudes and self-efficacy beliefs about language learning,
- Considering its advantages, especially motion sensing and voice recognition, Kinect cameras can be adapted to game based environments and language learning environments,
- Game-based learning activities with Kinect technology can be used to provide an environment for speaking and role play simulations based on real-life scenarios in classroom,
- Some potential limitations of this study also should be taken into consideration while discussing the results since the participants of this study were only first-year students taking English as a compulsory course. Future researchers should replicate the study with larger groups, groups of students from different
departments so that the results can be generalized, and investigating the role of gender, socioeconomic level, and the type of school students have graduated from will also contribute to understanding the case better.

Acknowledgments

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References


Lee, Y. J., & Gerber, H. (2013). It’s a WoW World: Second language acquisition and massively multiplayer online gaming. Multimedia-Assisted Language Learning, 16(2), 53-70


effects of prior knowledge in different fields such as language learning have been highlighted. However, there has been a lack of attention paid to the effects of prior knowledge in a contextual game-based language learning environment. To this end, this study developed an MMORPG-based educational game to facilitate English learning, aiming at investigating how students’ different levels of prior knowledge, in terms of their prior English ability and online gaming experience, affect their learning performance and anxiety. The results showed that the high English ability students significantly outperformed those with low English ability, the low online gaming experience students significantly outperformed those with high online gaming experience, and the low English ability students experienced significantly higher degrees of anxiety than those with high English ability. Furthermore, the results showed that prior English ability was positively correlated to learning performance but negatively correlated to anxiety, and anxiety was negatively correlated to learning performance. These findings suggest that a contextual game-based learning environment can be exploited as a useful tool to support language learning; however, the learning performance and anxiety created by the environment were affected to varying degrees by the levels of students’ prior knowledge.

Introduction

The widespread popularity of digital games has attracted increasingly serious attention from educators who have investigated their potential for education in recent years (Wu & Huang, 2017; Yang, Lin, & Liu, 2017). Previous research has demonstrated that digital games can provoke active learner involvement through exploration, experimentation, competition, and cooperation in contextual virtual learning environments (Lan, Fang, Legault, & Li, 2015). Learners’ immersion in such game-based simulated learning environments has been shown to be beneficial for learning (Shih, Jheng, & Tseng, 2015). The application of, and studies on, digital game-based learning (DGBL) have highlighted the great value of digital games for education, such as improving learning motivation (Chen, 2017), fostering creativity (Hsiao, Chang, Lin, & Hu, 2014), increasing engagement (Jabbar & Felicia, 2015), facilitating flow experience (Yang & Quadir, 2018), and enhancing learning performance (Yang, Quadir, & Chen, 2016). Therefore, DGBL has been proven to be an effective approach for enhancing learning.

Although there are potential positive effects of DGBL, not all learners benefit from its support due to the diversity of individual differences. Individual differences are factors that represent individuals, such as gender differences, cognitive styles, and prior knowledge, which may affect individual preferences and further impact learning performance (Yang & Chen, 2010). Prior knowledge is particularly important among various types of individual differences. As suggested by Ku, Chen, Wu, Lao, and Chan (2014), learners with different levels of prior knowledge benefit differently in terms of their mathematics confidence and performance. Previous studies have investigated the influence of prior knowledge in different fields such as language learning (Suh, Kim, & Kim, 2010) and geometry learning (Lee & Chen, 2014).

Unlike previous studies, which focused on a single variable, this study incorporated two types of prior knowledge, namely, prior English ability and online gaming experience. As suggested by Glick and Hohmann-Marriott (2007), English ability is linked strongly to academic performance. Tsai, Yu, and Hsiao (2012) showed that online gaming experience positively affects playing skill, which in turn positively affects learning performance. Therefore, prior English ability and online gaming experience play influential roles in DGBL. In addition, this study investigated the effects of the two types of prior knowledge not only on cognitive outcomes (i.e., learning performance) but also on the affective factor (i.e., anxiety). As suggested by Horwitz, Horwitz, and Cope (1986), anxiety may hinder learners’ communication with others, so it is a critical factor in language learning. This study therefore examined how learners’ prior knowledge, in terms of different levels of English ability and online gaming experience, affects their learning performance and anxiety in a contextual game-based learning environment.
English learning environment. Moreover, the relationships between English ability, online gaming experience, learning performance, and anxiety were also explored. Accordingly, the following research questions were examined:

- How does learners’ prior knowledge (in terms of levels of English ability and online gaming experience) affect their English learning performance in DGBL?
- How does learners’ prior knowledge (in terms of levels of English ability and online gaming experience) affect their anxiety of English learning in DGBL?
- What are the relationships between English ability, online gaming experience, learning performance, and anxiety?

**Literature review**

**Massively multipler online role-playing games (MMORPGs) in English learning**

Among different genres of digital games, MMORPGs have gradually become popular (Hou, 2012). With the main feature of online interactions with the gaming system and other players’ avatars, enabling collaborative exchanges of thoughts and emotions among other players, MMORPGs have been applied to educational contexts (Malliarakis, Saratzemi, & Xinogalos, 2017; Rama, Black, van Es, & Warschauer, 2012). The educational potential of MMORPGs has been examined in previous research, indicating that gameplay in MMORPGs is aligned with the possibility of developing the skills of decision-making, cooperation, problem-solving, and social interactions (Chang & Lin, 2014). Therefore, MMORPGs not only motivate players’ desire to complete more advanced tasks by purposefully developing their avatars’ skills, but have also become a path to learning (Sylvén & Sundqvist, 2012).

For learners studying English as a foreign language, the learning process is often considered to be boring as the teaching is mainly delivered in a teacher-centered mode, which might demotivate learning (Wu & Marek, 2010). To alleviate this problem, digital games provide an opportunity to engage students more effectively in learning (Hung, Young, & Lin, 2015). Particularly, MMORPGs play an important role in improving English communicative skills and reinforcing language acquisition due to the contextual 3D virtual learning environment (Lan, 2015). Learners’ language skills can be facilitated by immersion in such contextual game-based language learning environments (Lan, Kan, Sung, & Chang, 2016). Previous studies have shown that MMORPGs can be an effective tool for enhancing language learning (Suh et al., 2010; Zhang, Song, Liu, Tang, Chen, & Zhang, 2017). Moreover, MMORPGs allow learners to practice English holistically as the learning content and the four language skills—listening, speaking, reading, and writing—could be integrated into game narratives (Peterson, 2012). Thus, learners can become active participants in their learning experience (Sharpe, Beetham, De Freitas, & Conole, 2010).

**Digital games for learning performance**

When considering the possibilities of using digital games as an educational tool, quantifiable achievement or performance must be investigated to determine whether the educational approach is successful or not. Previous studies on using digital games seeking to explore this issue of learning performance have reported contradictory findings. On the one hand, an optimistic stance has been taken on the potential of digital games in education (Vandercruysse, Vandewaetere, & Clarebout, 2012). Digital games are considered as a new form of instructional tool with the great potential to effectively enhance learning performance (Kim & Ke, 2017). For example, Chen and Lin (2016) reported that students who learned with a digital game outperformed those who learned with traditional instruction. Sung, Hwang, and Yen (2015) showed that a contextual digital game improved students’ learning performance and problem-solving competences. On the other hand, several studies have found that digital games are not effective in all situations, indicating that the effectiveness of educational games is often based on improving learning motivation and positive social interactions rather than on knowledge acquisition (Gunter, Kenny, & Vick, 2008). For example, Miller and Robertson (2010) reported that no significant differences were found between a game-playing group and a traditional group. As suggested by Tsai et al. (2012), the effectiveness of knowledge acquisition in DGBL is influenced by students’ learning motivation, learning ability, and playing skill, and these factors are affected by their prior knowledge. Therefore, there is a need to examine how prior knowledge affects learning performance in DGBL.
Foreign language learning anxiety

Individuals’ anxiety should be taken into consideration when evaluating an educational game for foreign language learning (Hwang, Hsu, Lai, & Hsueh, 2017). As reported by Young (1992), various factors are associated with foreign language learning anxiety, such as motivation, cultural factors, and learners’ coping skills. Horwitz et al. (1986) classified foreign language learning anxiety as situation-specific anxiety related to the student’s negative emotional reactions to language learning. Therefore, foreign language anxiety refers to the apprehension experienced when a situation involves the use of a foreign language in which learners are not fully proficient (Gardner & MacIntyre, 1993). One of the most consistent findings in past research is that a higher level of language anxiety is associated with a lower level of language performance (Hewitt & Stephenson, 2012). For example, Yang, Lin, and Chen (2018) showed that high anxiety learners had worse learning performance than low anxiety learners. Thus, anxiety plays an influential role in foreign language learning. However, there has been a lack of attention paid to understanding the effects of prior knowledge on foreign language anxiety in DGBL. Therefore, there is a need to examine how prior knowledge affects learners’ anxiety while learning English in DGBL.

Methods

Participants

A total of 55 sixth-graders (26 boys and 29 girls) aged 12 on average in an elementary school in northern Taiwan participated in the study. The students were divided into the high English ability and low English ability groups based on their final English grade in the previous semester. Those who scored higher than the mean were labeled as having high English ability (N = 30), while those lower than the mean were considered as having low English ability (N = 25). Similarly, the students were also classified into the high online gaming experience and low online gaming experience groups based on the amount of time they spent playing online games. Those who belonged to the higher mean ratings were labeled as having high online gaming experience (N = 26), while those in the lower mean ratings were considered as having low online gaming experience (N = 29).

Instruments

To measure the students’ learning performance, an English achievement test was developed, composed of 25 multiple choice questions (MCQs) worth four points each for a total score of 100. The students took the achievement test before and after the gameplay. To ensure that they did not do the post-test blindly by recalling the sequence of questions used in the pre-test, the sequence in the post-test was different from that used for the pre-test. The Cronbach’s alpha value for the test questions was .928, indicating that the internal consistency of the test questions was acceptable.

The Foreign Language Classroom Anxiety Scale (FLCAS) proposed by MacIntyre (1992) was adopted in this study. The FLCAS consists of eight questions and was translated into Chinese to assess the students’ anxiety in learning English in DGBL. For each question, the students rated themselves on a 5-point Likert scale from strongly disagree (1) to strongly agree (5), with higher values indicating higher degrees of anxiety. The Cronbach’s alpha value for the FLCAS was .846, indicating that the internal consistency was acceptable.

Multiple interviews were also conducted with selected students to further understand their views on learning English via DGBL. The interviewed students were selected based on different levels of prior English ability and online gaming experience, resulting in four different groups. In total, eight students participated in the interviews, consisting of two students from each group. The interview questions were semi-structured with prompts whenever necessary to explore the students’ perceptions, opinions, and suggestions regarding learning English via DGBL. The questions concentrated on the following four aspects: the conditions of learning in the game; the design of the English language learning content the students learned via the game; problems experienced within the game and the solutions to the problems; and their interest in using a similar learning environment in the future.
The English learning online role-playing game (ELORPG)

An online role-playing game, ELORPG, was developed for English learning, inspired by the idea of using MMORPGs for education in the classroom context. The ELORPG was developed to better integrate both learning and gameplay elements. Therefore, the ELORPG covers most of the features of MMORPGs, such as battles, pets, and a contextual role-playing 3D environment. In addition, the design of the ELORPG utilizes learning strategies, such as role-playing and task-based learning, to develop a DGBL environment. The ELORPG aimed at engaging students in English learning by completing meaningful tasks. The students were assigned various tasks to answer questions, sell equipment, and fight the monster. A screenshot of the ELORPG is shown in Figure 1.

![Figure 1. A screenshot of the ELORPG](image)

The English learning content was integrated into the ELORPG in the form of tasks, for which the students were required to answer a series of questions. The tasks were classified into two types, learning tasks and review tasks (see Figure 2). The learning tasks contained learning content designed in the form of dialogue, in which words and sentences were highlighted with different colors to attract the students’ attention. A word card was also shown at the bottom of the dialogue with different words appearing randomly to encourage the students to learn more words. Once two learning tasks were completed, the students needed to perform a review task, which was designed as a series of questions to test whether they had understood the content in previous learning tasks. Upon successful completion of a task, they were rewarded with items that were able to make them more powerful such as weapons for fighting and leveling up. Such a design approach could encourage them to continue with the gameplay and immerse themselves in the contextual game-based learning environment, and to improve their knowledge of English words and sentence patterns.

![Figure 2. Learning content in a learning task (left) and a review task (right)](image)
Procedure

An experiment was conducted once a week for two weeks, consisting of three sessions. The first two sessions took about 90 minutes each, and the third session was about 120 minutes. Therefore, the total time of the three sessions was about 300 minutes. In the first session, the students firstly took the pre-test for 15 minutes. Then, they were given brief instructions on how to interact with the ELORPG for 10 minutes to ensure their understanding of the game operation. Subsequently, the students were asked to interact with the ELORPG for about 65 minutes. In the second session, the students continued to interact with the ELORPG for about 65 minutes. After the gameplay, the students took the post-test for 15 minutes and filled out the FLCAS which took approximately 10 minutes. In the third session, eight selected students were interviewed face-to-face, each taking approximately 15 minutes.

Data analysis

The data collected from the pre-test, post-test and FLCAS were coded for quantitative analysis. Descriptive statistical analysis included calculating the means and standard deviations. To assess the effects of the high and low English ability and the high and low online gaming experience students’ learning performance and anxiety, independent samples t tests were conducted. The independent variables were the students’ levels of prior English ability and online gaming experience, while the dependent variables were their learning performance and anxiety. In addition, Pearson Correlation Coefficient was also applied to investigate the relationship between the students’ prior English ability, online gaming experience, learning performance, and anxiety. Moreover, the students’ responses to the interviews were coded for qualitative analysis by comparing the differences between the students’ levels of prior English ability and online gaming experience.

Results

The effect of levels of English ability on learning performance

To examine whether the students’ levels of prior English ability affected their learning performance, an independent samples t test was employed. The results showed that there was a significant difference between the high English ability and low English ability students’ learning performance ($t(53) = -2.408, p = .020$) (see Table 1). More specifically, the high English ability students performed better than those with low English ability. The results indicated that there was considerable learning performance shown by the high English ability students, whereas the performance was not as substantial for the low English ability students when learning via the ELORPG.

Table 1. Different English ability levels on learning performance

<table>
<thead>
<tr>
<th>English ability levels</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>30</td>
<td>11.07</td>
<td>10.275</td>
<td>53</td>
<td>-2.408</td>
<td>.020</td>
</tr>
<tr>
<td>Low</td>
<td>25</td>
<td>3.36</td>
<td>13.450</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *p < .05.

The effect of levels of online gaming experience on learning performance

An independent samples t test was also employed to compare both the high online gaming experience and low online gaming experience students’ learning performance to examine if their levels of prior online gaming experience would affect their learning performance. The results showed that there was a significant difference between the high and low online gaming experience students’ learning performance ($t(53) = 2.190, p = .033$) (see Table 2). More specifically, the low online gaming experience students performed better than the high online gaming experience students. In other words, the low online gaming experience students’ test scores increased dramatically after gameplay, and the improvement was much higher than it was for the high online gaming experience students. The results indicated that there was considerable learning performance shown by the low online gaming experience students, whereas the performance was not as substantial for the high online gaming experience students when learning via the ELORPG.
**Table 2. Different gaming experience levels on learning performance**

<table>
<thead>
<tr>
<th>Gaming experience levels</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
<th>$df$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>26</td>
<td>3.85</td>
<td>11.838</td>
<td>53</td>
<td>2.190</td>
<td>.033</td>
</tr>
<tr>
<td>Low</td>
<td>29</td>
<td>10.90</td>
<td>11.995</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *$p < .05$.  

**The effect of levels of English ability on anxiety**

An independent samples $t$ test was employed to examine the effects of prior English ability levels on the students’ anxiety. The results showed that the difference between the high English ability and low English ability students on the anxiety dimension’s mean scores was significant ($t(53) = 2.627, p = .011$) (see Table 3). More specifically, compared to the high English ability students, the low English ability students’ anxiety was significantly higher. The results revealed that the low English ability students experienced higher degrees of anxiety than the high English ability students when learning via the ELORPG.

**Table 3. Different English ability levels on anxiety**

<table>
<thead>
<tr>
<th>English ability levels</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
<th>$df$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>30</td>
<td>1.76</td>
<td>.611</td>
<td>53</td>
<td>2.627</td>
<td>.011</td>
</tr>
<tr>
<td>Low</td>
<td>25</td>
<td>2.31</td>
<td>.912</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *$p < .05$.  

**The effect of levels of online gaming experience on anxiety**

An independent samples $t$ test was also employed to examine the effects of prior online gaming experience levels on the students’ anxiety. The results showed that the difference between the high online gaming experience and low online gaming experience students in the anxiety dimension’s mean scores was not significant ($t(53) = .368, p > .05$) (see Table 4). In other words, no significant difference existed between the high online gaming experience students and the low online gaming experience students’ anxiety. The results indicated that the high and low online gaming experience students experienced a similar degree of anxiety when learning via the ELORPG.

**Table 4. Different gaming experience levels on anxiety**

<table>
<thead>
<tr>
<th>Gaming experience levels</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
<th>$df$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>26</td>
<td>1.97</td>
<td>.880</td>
<td>53</td>
<td>.368</td>
<td>.714</td>
</tr>
<tr>
<td>Low</td>
<td>29</td>
<td>2.05</td>
<td>.741</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Correlations between English ability, online gaming experience, learning performance, and anxiety**

The results presented in the previous subsections showed that prior English ability and online gaming experience had influential effects on the students’ learning performance and anxiety in the ELORPG. It would also be interesting to see the relationships between these variables. Table 5 shows the results of the correlation between the students’ English ability, online gaming experience, learning performance, and anxiety. The results showed that the students’ prior English ability was significantly correlated to their learning performance ($r = .801, p = .000$) and their anxiety ($r = -.347, p = .009$). In other words, prior English ability had a significant relationship with both learning performance and anxiety, whereas the former had a positive correlation and the latter had a negative correlation. These results revealed that the greater the prior English ability, the better the learning performance they achieved and the lower anxiety they perceived in the ELORPG. In addition, a significant and negative correlation was found between the students’ learning performance and their anxiety ($r = -.445, p = .001$), indicating that the higher the anxiety, the worse the learning performance. Furthermore, the results showed that the students’ online gaming experience did not significantly correlate to their prior English ability, learning performance, and anxiety. In other words, the students’ online gaming experience was not associated with their prior English ability, learning performance, and anxiety.
Table 5. Correlations between English ability, online gaming experience, learning performance, and anxiety

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. English ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Online gaming experience</td>
<td>.121</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Learning performance</td>
<td>.801***</td>
<td>.099</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Anxiety</td>
<td>-.347**</td>
<td>-.005</td>
<td>-.445**</td>
<td></td>
</tr>
</tbody>
</table>

Note. **p < .01; ***p < .001.

Findings from the interviews

The interviews were analyzed to understand the students’ experience and feedback on learning English with the ELORPG. The results are described based on the four aspects of the interview questions with the comparison between the students’ levels of prior English ability and online gaming experience. Firstly, regarding the conditions of learning in the game, the high online gaming experience students expressed that they were more interested in gaming (such as rewards and fighting) than learning. On the other hand, the low online gaming experience students expressed that they paid full attention to playing the ELORPG. They read the task descriptions carefully to comprehend the meaning for completing the tasks.

Secondly, with regard to the design of the English language learning content the students learned via the game, the high English ability students mentioned that the English questions were not too difficult, but they thought the ELORPG was more challenging compared to Chinese online games because the tasks were presented in English, increasing the level of task difficulty. They also regarded the ELORPG as a tool for stimulating their English learning and cited that their English ability seemed to have improved after playing the ELORPG. On the other hand, the low English ability students expressed that the task descriptions written in English were too complicated for them to comprehend.

Thirdly, when asked about problems experienced within the game and the solutions to the problems, the high English ability students mentioned that they would use the function of online chatting to discuss the problems, whereas the low English ability students said that they would just guess the answers when they did not understand the questions written in English. Their attitude became negative when they met questions beyond their comprehension level.

Fourthly, regarding the students’ interest in using a similar learning environment in the future, most expressed that they were willing to use the ELORPG constantly because it is interesting, and learning English is not that unpleasant anymore. They also mentioned that the inspiring features in the ELORPG enhanced their interest in using a similar learning environment in the future. Table 6 shows sample quotes from the students with different levels of English ability and online gaming experience.

Table 6. Sample quotes from the students during the interviews

<table>
<thead>
<tr>
<th>Low online gaming experience</th>
<th>Low English ability</th>
<th>High English ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I didn’t understand most of the English content, so I guessed to answer questions. (S1, S2)</td>
<td>When I didn’t understand some new words or sentence patterns, the text prompts helped me a lot. (S3)</td>
</tr>
<tr>
<td></td>
<td>The ELORPG is interesting. Although it is designed in English, I still want to play the ELORPG. Learning English isn’t that boring anymore. (S1, S2)</td>
<td>I read the task descriptions carefully to comprehend the meaning for completing the tasks. (S3, S4)</td>
</tr>
<tr>
<td></td>
<td>When providing the wrong answer, the coins were deducted. Thus, I paid more attention to the learning content. (S7)</td>
<td>When encountering English problems, I discussed them with my peers online. (S4)</td>
</tr>
</tbody>
</table>

| High online gaming experience | After completing a task, I got coins. It made me very happy. (S5, S6) | The questions weren’t too difficult for me. (S8) |
|                             | I learned some English vocabulary while carrying out the tasks relating to fighting the monster. (S5) | The ELORPG is challenging. Playing a game and learning English at the same time is very interesting. (S7, S8) |
|                             | The task descriptions were too long and too difficult to comprehend. (S5, S6) | |

Note. S1–S8 represent the students’ IDs.
Discussion

Based on the key findings presented in the previous section, Figure 3 presents a framework that illustrates the effects of prior knowledge on learning performance and anxiety in DGBL. More specifically, it illustrates how the levels of prior English ability and online gaming experience affect learning performance and anxiety, as well as the relationships between prior English ability, online gaming experience, learning performance, and anxiety. This framework can be applied to help designers develop a personalized DGBL system where game design features can match the needs of learners with different levels of English ability and online gaming experience. By doing so, both high and low prior knowledge learners can interact with the system based on their needs, which will in turn enhance their learning performance and reduce their anxiety in DGBL.

Figure 3. A framework of the effects of prior knowledge (English ability and online gaming experience) on learning performance and anxiety in DGBL. (Note. H: high English ability/online gaming experience, L: low English ability/online gaming experience, +: positive correlation, -: negative correlation)

The high English ability students outperformed those with low English ability

In examining the impacts of the levels of English ability on learning performance, the results showed that the high English ability students performed significantly better than the low English ability students. The results echo those of Sotelo-Dynega, Ortiz, Flanagan, and Chaplin (2013), who found that higher levels of English proficiency resulted in higher cognitive test performance. To identify why the low English ability students’ learning performance was significantly worse than that of the high English ability students, one possible reason might be that all the task descriptions written in English were beyond their comprehension level. The findings from the interviews indicated that the task descriptions were too difficult to comprehend for the low English ability students. Consequently, the students’ learning performance was affected to varying degrees according to their prior English ability levels. The low English ability students had difficulties understanding the English content, and thus the improvement in their learning performance was not as great as that of the high English ability students. However, if the levels of the content were lowered, it would be too easy for the high English ability students; hence the overall learning performance would be limited. The findings suggest that different levels of learning tasks could be incorporated according to the levels of students’ English ability (Hsu, Hwang, & Chang, 2013).

The low online gaming experience students outperformed those with high online gaming experience

The results showed that the low online gaming experience students performed significantly better than the high online gaming experience students. Therefore, the prior online gaming experience did affect individuals’ learning performance, but the degrees of the effects varied by prior online gaming experience. One possible reason might be that the low online gaming experience students needed to read the task descriptions carefully because they were not familiar with game operations in general and so needed guidance. The findings from the interviews indicated that the low online gaming experience students read the task descriptions carefully to comprehend the meaning for completing the tasks. On the other hand, the high online gaming experience students paid attention mainly to playing, such as carrying out the tasks relating to fighting the monster. Consequently, the levels of prior online gaming experience affected the students’ behavior, leading to the differences in their learning performance. These results differ from those of Suh et al. (2010), who indicated that prior experience with online games did not affect learning performance. This study, however, showed that prior online gaming experience affected learning performance, in that the ELORPG was more helpful for students with less gaming experience.
The low English ability students had higher degrees of anxiety than those with high English ability

The results revealed that the low English ability students experienced significantly higher degrees of anxiety than the high English ability students. One possible reason was that a large quantity of information used in the ELORPG was provided in English, which made it more challenging for the low English ability students to comprehend. In the interviews, the low English ability students replied that the English content was beyond their comprehension level, which made them anxious during gameplay. These findings are consistent with those of Kili (2005), who found that anxiety was created if the task difficulty was beyond learners’ ability. Liu (2012) also showed that students with lower language proficiency tended to have higher anxiety when learning a foreign language. Nevertheless, this study found that even with a higher level of anxiety, the low English ability students who were interviewed mentioned that the ELORPG could stimulate their English learning and that they got satisfaction from the contextual game-based language learning environment overall.

Relationships between prior English ability, online gaming experience, learning performance, and anxiety

In examining the relationships between the students’ English ability, online gaming experience, learning performance, and anxiety, the results showed that the students’ prior English ability was positively correlated to their learning performance but negatively correlated to their anxiety. The findings are consistent with those of Chang, Tseng, and Tseng (2011), who found a positive relationship between learners’ English proficiency levels and their performance. Moreover, the findings are in line with those of Dewaele and Ip (2013), who reported that students’ English proficiency was negatively correlated with their foreign language anxiety. The abovementioned findings suggest that prior English ability is an influential factor in English learning performance and anxiety. In addition, the results showed that the students’ anxiety was negatively correlated to their learning performance. The findings echo those of Abu-Rabia (2004), who found that there was a negative correlation between students’ anxiety and their performance in English spelling, writing and reading comprehension. Therefore, the findings indicate that the higher the anxiety, the poorer the English learning performance.

Conclusion

This study investigated how prior knowledge, in terms of prior English ability and online gaming experience, affects students’ English learning performance and anxiety in the proposed contextual game-based language learning environment, ELORPG. The findings of this study reveal that prior knowledge plays influential roles in the context of DGBL. There are five main findings of the study: (a) the high English ability students demonstrated significantly better learning performance than the low English ability students; (b) the low online gaming experience students demonstrated significantly better learning performance than the high online gaming experience students; (c) the low English ability students experienced significantly higher degrees of anxiety than the high English ability students; (d) prior English ability was positively correlated to learning performance but negatively correlated to anxiety; and (e) anxiety was negatively correlated to learning performance. These findings suggest that prior knowledge is a critical factor in the contextual game-based language learning environment, affecting both learning performance and anxiety, but the degrees of the effects vary.

The findings of this study have implications for course instructors and system developers. For example, course instructors should be given the opportunity to receive appropriate training in the design and development of DGBL courses to align with the needs of the academic curricula, and they should not underestimate the educational value of digital games. Moreover, the findings suggest that system developers who design a DGBL system should consider learners’ prior knowledge, especially their prior academic ability and online gaming experience. If the learning content and game interaction can be adapted to different levels of learners, they could perform better in such a personalized DGBL system. Furthermore, instructors should seek ways to eliminate learners’ negative emotions, such as anxiety, when designing their instructions with DGBL systems for language learning or other courses. For example, it is necessary to make the learning context less stressful for those learners with a low level of academic ability. Thus, they can practice more and enhance their learning performance in an enjoyable, stress-free environment.

Although the findings of this study demonstrate the importance of investigating the effects of prior knowledge on learning performance and anxiety in the context of DGBL, some limitations should be noted. One is the small number of participants. The research results would be more representative with a larger sample size. In addition, the participants explored in this study have an Asian cultural background; therefore, it is suggested that future studies explore whether both the cognitive and affective learning outcomes of participants from different cultural backgrounds.
backgrounds reveal differences in the levels of English ability and online gaming experience. Moreover, prior knowledge was the individual difference factor examined in this study. There is a need to further consider other individual differences, such as cognitive style, gender differences, and socio-economic status. Such evidence would not only be helpful in promoting the use of DGBL systems, but would also be useful for developing personalized DGBL systems.

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References


Using Narrative-based Contextual Games to Enhance Language Learning: A Case Study

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Corresponding author

ABSTRACT
This paper describes a narrative-based design framework that organizes three narrative elements (i.e., storyline, character, and quest) to support a contextual game-based environment for language learning. Using this design framework, a PlanetAdventure system was developed to examine its feasibility and its effects on student language learning. A case study with 61 college students who used the game-based system to learn English vocabulary words was conducted. The findings revealed that their learning achievement was enhanced after using the system. The majority of the students favored the game-based learning experience. Based on these data and behavior logs, the students can be sorted into three clusters with different learning patterns. The findings and implications of developing contextual game-based learning environments are also discussed.

Keywords
Narrative, Context, Game-based learning, Language learning

Introduction

English has become an important common language over the world. In a non-native English speaking country such as Taiwan, English proficiency is valued as a critical competence for participation in the international community (Lan, Sung, & Chang, 2009). Vocabulary learning plays a fundamental role in building English proficiency, including learning English as a second language (Nguyen & Khuat, 2005). The theory of second language acquisition (SLA) suggests that language should be learned in a meaningful context, which is linked to society, culture, and life experiences (Eun & Lim, 2009). When students are situated in a context, the contextual and non-linguistic cues in the context allow students to comprehend and retain their learning (Ray, 2012; Upal, Gonce, Tweney, & Sline, 2007). However, most learning activities in Taiwan are conducted via traditional rote and de-contextualized methods (Lan, Wei, & Chiu, 2014). Such de-contextual approaches may fail to promote language learning.

Recently, digital games have been identified as having the potential to enhance language learning (Di Blas & Paolini, 2014; Ibáñez et al., 2011). Digital games offer the characteristic of representation, presenting the details of objects and scenes in a context via multimedia (Chen et al., 2017). Situated learning theory (Lave & Wenger, 1991) contends that learning should be situated in a specific context, rather than out of context (Kindley, 2002). Students in the context are encouraged to integrate needed knowledge and skills in a meaningful way, which benefits student transfer learning (Clark & Mayer, 2011; Clark, 2009). Digital games could simulate or represent learning contexts and concrete examples. When students learn from context, they become good at discriminating similarities and differences among various examples. This experience can help them process what they have learned. Therefore, they will better understand how to apply their knowledge and skills from one scenario to other scenarios (Cormier & Hagman, 2014; McKeough, Lupart, & Marini, 2013).

Based on the ability of digital games to represent contexts, a number of studies have used digital games to support language learning, in which the interactive environment creates contexts that enrich the learning experience (Lin & Lan, 2015; Huang & Yang, 2012; Yip & Kwan, 2006). These studies leverage the power of representation to embody a set of concrete scenarios to foster students’ exploration, observation, and interaction (Toscano et al., 2015; Chien et al., 2013). For instance, Barab and his colleagues (2015) developed a game-based learning environment to facilitate students’ scientific inquiry. In the environment, students were encouraged to observe, propose, and evaluate their hypotheses. Such exploration and interactions in digital games are beneficial to student participation and learning performance (Tsai, Yu, & Hsiao, 2012; Kebritchi, Hirumi, & Bai, 2010; Papastergiou, 2009; Tüzün et al., 2009). Di Blas and Paolini (2014) developed a multi-user 3D game-based environment to promote student language learning, in which students are situated in authentic contexts to learn foreign language through interacting with peers or communicating with computer-controlled characters (Ibáñez et al., 2011).
Nevertheless, although the aforementioned studies contribute to our understanding of game-based language learning, the literature still appears to lack a systematic framework for guiding the integration of language learning with contextual game-based environments. Such a framework is significant because a contextual game-based environment requires systematic guidelines to ensure that the interplay between gaming and learning is effective and engaging for students. In particular, although narrative is a pervasive game element (Ke, 2016; Qian & Clark, 2016; Chen, Ciou, & Chi, 2017) and can provide scaffolding and support (Dickey, 2006; 2007), few studies investigate how narrative could be applied to enhance game-based language learning. To this end, this study proposes a narrative-based contextual game framework and investigates its influences on students’ language learning. The research questions addressed in this study are: (1) How can narrative be incorporated into the development of a contextual game-based language learning system? (2) What are the influences of such a contextual game-based language learning system on student achievement, perception, and behaviors?

**Design framework**

Narrative focuses on the storyline that engages students in the story and compose the story in the gaming process (Shih et al., 2015). A narrative environment allows students to collaborate, strategize, plan, and interact with objects, learning resources, or other students via motivational and cognitive supports (Novak, 2015; Dickey, 2007). To foster contextual language learning, this study proposes a Narrative-based Contextual Game for Language Learning (NCGLL) framework, which emphasizes three significant narrative elements, including storyline design (Novak et al., 2016), character design (Dickey, 2006), and quest designs (Chen et al., 2012) in three different dimensions, as illustrated in Figure 1.

![Figure 1. NCGLL framework](image)

**Storyline design (engaging structure dimension)**

Since storyline is one of the major motivators for game-based learning (Ke, 2016; Qian & Clark, 2016; Novak, 2015), the purpose of storyline design is to engage students in the virtual context based on a well-designed structure, which consists of a scenario, an opening event, and a challenge. Scenario refers to a set of specific contexts represented in the virtual environment, which can enhance the authenticity of learning contents. Contexts are crucial because it has been argued that comprehension comes from the context in which the language occurs (Krashen, 1981). Contexts offer students rich information, including objects themselves as well as the relationships among various objects. Such rich information is helpful in comprehending and retaining knowledge. Information presented in a contextual way can engage students in the knowledge acquisition process (Herrington, Reeves & Oliver, 2014). Additionally, contexts also provide students with an immersive environment, which further allows them to have the sense of “really being there” and develop an emotional connection with the environment (Haring, Chakinska, & Ritterfeld, 2011). Both of these contribute to engaging learning.
Next, the opening event and challenge are also closely related to the structure of a story – a set of events organized in a reasonable and attractive way in the story. The former (i.e., opening event) emphasizes a first event that can initiate and “hook” student attention (Novak et al., 2016). This is because curiosity is a necessary precondition for exploration in the game-based environment (Berlyne, 1960). The latter (i.e., challenge) focuses on following events in the story that sustain their interest via crises. The sequencing of challenges in a story creates an emotional tension that influences student sustenance (Laurel, 1993). Such tension may be further sustained by a “confrontation” design which uses a dramatic three-act structure (Chatman, 1980) containing setup, confrontation, and resolution. Setup aims to establish the main character and the world where he/she lives in. Then, the coming of a serious problem changes the life of the main character, who needs to face a series of challenges (i.e., confrontation). The difficulty levels of the challenges often increase before the climax, and finally the main character solves the problem (i.e., resolution). Such a confrontation curve can maintain student attention and participation in the game-based environment.

Character design (meaningful goal dimension)

The purpose of goal dimension is to offer a meaningful goal via three related elements: avatar, non-player-character (NPC), and dialogue. Avatars and NPCs are two categories of actors used in digital games. The former (i.e., avatars) refers to the images of the students themselves appearing in the virtual environment, which offers students a sense of presence (i.e., of being there) via representing and controlling their self-images. Because people tend to regard self-images as themselves and the behavior of their self-images as theirs (Chae et al., 2016), self-images can enhance students’ feelings of telepresence in the virtual world (Qiu & Benbasat, 2005). For instance, when students clearly observe the relationship between what they did in the real world and what the consequences were in the virtual world, their feeling of control and self-presence can be enhanced.

The NPCs (non-player characters) are simulated figures controlled by the software whose goal is to offer meaningful and enhanced goals in the two aspects of social commitment and negotiation. For social commitment, goal commitment is a critical element that influences student motivation and task performance (Locke & Latham, 2002). Difficult goals require more effort and persistence, and higher goal commitment often leads to a better performance. Thus, to achieve more difficult goals, stronger goal commitments are needed. NPCs can offer students a sense of “being together with” in a social space (Haring, Chakinska, & Ritterfeld, 2011). Students’ goal commitment is enhanced by social commitments created by interacting and negotiating with NPCs. This design further involves the design of the NPCs’ dialogues, which is related to the negotiation aspect. Negotiation refers to the process of discussing with NPCs to reach an agreement with them. To this end, the design of dialogues can stimulate students’ clarification, elaboration, argumentation, and compromise, further contributing to their goal pursuit.

Quest design (inquiry pedagogy dimension)

The purpose of the pedagogy dimension is to foster students’ knowledge acquisition via quest design, which includes the design of three mechanisms: property, discovery, and reasoning. Specifically, quests often involve properties that need to be investigated to discover their histories or sources. Thus, the properties in the digital games can trigger interesting or mysterious questions (e.g., where are they from, or what are their histories), which can link to the content of quests, and offer an immediate goal for students to initiate inquiry-based learning. Therefore, quests driven by the properties can play the role of “anchor” and offer a starting point for inquiry-based learning.

In a sense, when students conduct inquiry-based learning, they are invited to participate in a series of discovery and reasoning processes. This is because inquiry-based learning is an active learning that is initiated by a question or problem in a specific context. During the process, students discover related cues and evidence from the context, and attempt to identify the relationships between questions and evidence. Thus, inquiry-based learning is a journey of thinking, which provides a valuable context for students to acquire, clarify, and apply the concepts they have learned (Edelson, Gordin, & Pea, 1999). When students develop their own knowledge and solutions via inquiry and discovery, their ownership of the knowledge can be enhanced. In addition, when students actively create and construct their own knowledge, what they learn is further linked to their prior knowledge. Thus, such learning experiences can deepen their understanding.
Implemented system

Based on the NCGLL framework, a learning system, named PlanetAdventure, is implemented. The storyline of the system extends the background setting of the novel “The Little Prince.” A student plays the role of the little prince who loves his rose on planet B-612, but one day he finds the rose has been murdered. Thus, the game goal for the students is to solve the mystery: who murdered the rose.

Storyline design (engaging structure dimension)

The goal of storyline design is to engage students in the game environment. Three elements are taken into account, including scene, opening event, and challenges. First, to support the background setting of the PlanetAdventure, a game world consisting of four planets is established so that students can travel and explore, including the b-612 planet where the little prince lives (Figure 2), the forest planet (Figure 3), the mushroom planet (Figure 4), and the light planet (Figure 5). These scenes offer students authentic contexts to learn English. In addition, the opening event is a mystery in which the little prince finds that his planet is different — his rose has been murdered. The challenge across the storylines is whether the little prince can solve the mystery.

Figure 2. Screenshot of the PlanetAdventure system (b-612 planet)

Figure 3. Screenshot of the PlanetAdventure system (forest planet)
Character design (meaningful goal dimension)

The purpose of character design is to offer students meaningful goals. This involves three elements: avatar, NPC, and dialogue. The avatar is the little prince that helps students project themselves into the game world. Additionally, different NPCs are designed to provide concrete and clear goals, such as “sloth geographer,” “lake goddess” (Figure 3), “fox,” “penguin king” (Figure 4), and “lantern fish” (Figure 5). These NPCs are portrayed as cartoon animals with problems, who need the students to help them solve their problems. If the students help these NPCs, the students can receive clues about the murderer. Interaction and communication via the dialogues with the NPCs forms a social environment that offers students more opportunities to learn and use language.
Quest design (inquiry pedagogy dimension)

The primary goal of quest design is to provide pedagogies to foster knowledge acquisition. It contains three key elements: problem, discovery, and reasoning. A problem often serves as an anchor of inquiry-based learning, which is a starting point for learning. Because the student needs to understand what the NPCs are saying, they will pay more attention to the dialogues. In this way, the student is further encouraged to explore the game world, and interact with various NPCs to obtain more information. Because the information is collected and knowledge is constructed by students, the feeling of ownership of the knowledge can be enhanced. Further, as the student continuously correlates the findings with the problem, this iterative process of discovering and reasoning is helpful to deepen their thinking and knowledge comprehension.

Method

To address the research questions, the researchers conducted a case study in which the participants used the PlanetAdventure system. Its effects on students were evaluated in three aspects: learning achievement, perception, and behaviors.

Participants and procedures

The participants were 61 first-year college students recruited from a “basic English” class, where they had general English abilities but wanted to improve their reading and vocabulary in various themes. The PlanetAdventure system was developed to learn 30 English words related to the theme of a fantasy adventure, including 10 basic words, and 20 advanced words. The details of these English vocabulary words are listed in Appendix. The words were presented to the participants via dialogues with NPCs. For the game goal (i.e., finding the murderer who killed the rose), the participants were required to carefully read the message of the dialogues. In this way, they learned these words in a meaningful and contextual way. As illustrated in Figure 6, the following procedures were conducted.

- Preparation session: before the participants used the system, a pre-test was conducted to evaluate their prior knowledge as the baseline.
- Usage session: the participants were introduced to the operations and functions of the PlanetAdventure system, to ensure that all of them knew how to use the learning system. The participants were then permitted to freely use the learning system for 40 minutes. During this session, their behaviors were collected.
- Evaluation session: after the usage session, the participants were given a post-test and a perception questionnaire. The former was compared with the pre-test to investigate their learning achievement. The latter was used as self-reported evidence to understand their learning experience.

![Figure 6. Procedures conducted in this study](image)

Data collection

To collect students’ data about their achievement, perception, and behavior, three kinds of tools were used in this study. The details are given below.

- **Achievement test**: A pre-test and post-test were given before and after the system was used. The two tests were identical, but they were formatted in different order to prevent the rote effect. The test contained 30 fill-in-the-blank questions with scores ranging from 0 to 30.
- **Perception questionnaire**: To measure students’ learning experiences for the specific PlanetAdventure system, a perception questionnaire was developed by the authors. It consists of four facets, including perceived helpfulness (3 items), joyful experience (3 items), narrative design (2 items), and scaffolding design (2 items). These items were further formatted as a 5-point Likert scale ranging from “strongly
disagree” (point = 1) to “strongly agree” (point = 5). The questionnaire demonstrated adequate reliability (Cronbach’s α = 0.84). The responses of “agree” (point = 4) and “strongly agree” (point = 5) were regarded as positive responses for further analysis.

- **Behavior logs:** two categories of student behavior data were recorded in the system logs during the usage session. One is the display time, which refers to the time a dialogue panel appears, and can be regarded as an indicator of how much attention the students gave to the dialogues. The other is click number, which refers to the number of mouse clicks on a vocabulary explanation. This can be viewed as an indicator of the degree to which the students paid attention to the vocabulary explanation.

Data analysis

Three quantitative analyses approach were applied to analyze data in this study.

- For achievement test, a paired samples t-test was conducted to examine the learning gains during the use of learning system.
- For the perception questionnaire, since one-sample t-tests are sometimes used to examine students’ choices in the questionnaire (Chen et al., 2018), this approach is also adopted to examine whether students’ choices were significantly different in this study.
- The data collected from the achievement test, perception questionnaire, and behavior logs were analyzed via two-stage cluster analysis (i.e., k-means approach is used after a hierarchical cluster) to identify possible different learning patterns. All of the analyses were performed on Statistical Package for Social Sciences software.

Method

Achievement test

The results of the pre-test and post-test are given in Table 1. The means of the scores improved from 10.73 to 25.14. In addition, the standard deviation fell from 5.12 to 4.73. The findings of the paired-samples t-test indicated that the improved scores had a statistically significant difference, implying that the PlanetAdventure system helped students improve their learning. A possible explanation was that the use of PlanetAdventure did help them comprehend the meaning of the vocabulary words via contextual game-based playing, which seems to echo to the argument that the contextual and non-linguistic cues in the context enable students to comprehend and retain knowledge (Ray, 2012). This supports the perspective that language should be learned in a meaningful context (Eun & Lim, 2009).

<table>
<thead>
<tr>
<th>Table 1. Results of the achievement test</th>
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<tbody>
<tr>
<td><strong>Pre-test</strong></td>
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<tr>
<td>Score</td>
</tr>
<tr>
<td>Score</td>
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</table>

Note. **p < .01.

Perception questionnaire

The results of the questionnaire are shown in Table 2. The majority of responses are positive for each of the four facets (i.e., 69%, 79%, 74%, and 85%). Further, the one-sample test was used to examine the statistical difference, and the results demonstrated that the average score was significant for all four facets: perceived helpfulness (t = 53.08, p < .01), joyful experience (t = 49.26, p < .01), narrative design (t = 40.62, p < .01), and scaffolding design (t = 52.83, p < .01). This implies that most of the students felt that the PlanetAdventure system is interesting and helpful in their English learning (especially in vocabulary and reading). In addition, the narrative design and scaffolding design of the PlanetAdventure system were regarded as useful mechanisms for holding their interest and stimulating vocabulary learning.
Table 2. Results of the questionnaire

<table>
<thead>
<tr>
<th>Categories/Items</th>
<th>Agreement</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived helpfulness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This system improved my mastery of the vocabulary words</td>
<td>54/61 (89%)</td>
<td>4.13</td>
</tr>
<tr>
<td>This system improved my listening ability</td>
<td>42/61 (69%)</td>
<td>3.87</td>
</tr>
<tr>
<td>This system enhanced my reading ability</td>
<td>48/61 (79%)</td>
<td>3.97</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3.99**</td>
</tr>
<tr>
<td><strong>Joyful experience</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This system is a well-integrated system for gaming and learning</td>
<td>54/61 (89%)</td>
<td>4.28</td>
</tr>
<tr>
<td>I liked to learn English via such a game-based system</td>
<td>50/61 (82%)</td>
<td>4.15</td>
</tr>
<tr>
<td>I looked forward to using this system in the future</td>
<td>48/61 (79%)</td>
<td>4.20</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4.21**</td>
</tr>
<tr>
<td><strong>Narrative design</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The narrative design of this system stimulated my learning interest</td>
<td>45/61 (74%)</td>
<td>4.05</td>
</tr>
<tr>
<td>The narrative design of this system motivated me to engage in exploration, problem-solving, and learning</td>
<td>46/61 (75%)</td>
<td>4.05</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4.05**</td>
</tr>
<tr>
<td><strong>Scaffolding design</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The explanation function helped me comprehend the meaning of the vocabulary words</td>
<td>53/61 (87%)</td>
<td>4.15</td>
</tr>
<tr>
<td>The review function helped me summarize what I have learned</td>
<td>52/61 (85%)</td>
<td>4.08</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4.11**</td>
</tr>
</tbody>
</table>

Note. **p < .01.

Learning pattern

A two-stage cluster analysis (i.e., k-means approach is used after a hierarchical cluster) was conducted to explore students’ learning patterns. Because the results of the hierarchical cluster analysis suggested there were three groups with different characteristics, a k-means approach with the three groups was employed. The results are given in Table 3. Among the variables, ANOVA demonstrated that three variables had statistical differences: click number ($F = 28.409, p < .01$), display time ($F = 226.818, p < .01$), and narrative Q2 (i.e., one questionnaire item of narrative; $F = 3.641, p < .05$). This implies that three categories of student learning patterns can be identified: the majority of students were efficient learners (Cluster 3, $n = 27$) who had relatively low click numbers and display time, and also liked the narrative design (means = 4.11). Next, some of the students (Cluster 2, $n = 20$) were learners who had moderate click numbers and display times but did not like the narrative design (means = 3.70). The remaining group consisted of holistic-acquiring learners (Cluster 1, $n = 14$) who strongly favored narrative design (mean = 4.43), and had higher click numbers and display times.

Table 3. Results of cluster analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Means</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cluster 1 ($n = 14$)</td>
<td>Cluster 2 ($n = 20$)</td>
<td>Cluster 3 ($n = 27$)</td>
<td>$F$</td>
</tr>
<tr>
<td>Gained score</td>
<td>14.79</td>
<td>14.65</td>
<td>14.04</td>
<td>.207</td>
</tr>
<tr>
<td>Click number</td>
<td>27.64</td>
<td>17.30</td>
<td>2.37</td>
<td>28.409**</td>
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<tr>
<td>Display time</td>
<td>857.85</td>
<td>456.93</td>
<td>67.98</td>
<td>226.818**</td>
</tr>
<tr>
<td>Helpfulness (Q1)</td>
<td>4.43</td>
<td>4.05</td>
<td>4.04</td>
<td>2.413</td>
</tr>
<tr>
<td>Helpfulness (Q2)</td>
<td>4.14</td>
<td>3.75</td>
<td>3.81</td>
<td>1.036</td>
</tr>
<tr>
<td>Helpfulness (Q3)</td>
<td>4.21</td>
<td>3.70</td>
<td>4.04</td>
<td>2.744</td>
</tr>
<tr>
<td>Joyfulness (Q1)</td>
<td>4.57</td>
<td>4.05</td>
<td>4.30</td>
<td>2.723</td>
</tr>
<tr>
<td>Joyfulness (Q2)</td>
<td>4.50</td>
<td>4.00</td>
<td>4.07</td>
<td>2.146</td>
</tr>
<tr>
<td>Joyfulness (Q3)</td>
<td>4.43</td>
<td>4.05</td>
<td>4.19</td>
<td>.999</td>
</tr>
<tr>
<td>Narrative (Q1)</td>
<td>4.36</td>
<td>3.80</td>
<td>4.07</td>
<td>2.068</td>
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<tr>
<td>Narrative (Q2)</td>
<td>4.43</td>
<td>3.70</td>
<td>4.11</td>
<td>3.641*</td>
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<tr>
<td>Scaffolding (Q1)</td>
<td>4.29</td>
<td>4.20</td>
<td>4.04</td>
<td>.821</td>
</tr>
<tr>
<td>Scaffolding (Q2)</td>
<td>4.21</td>
<td>4.15</td>
<td>3.96</td>
<td>.807</td>
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</table>

Note. *$p < .05$; **$p < .01$. 

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Implications and discussion

Learning patterns with individual differences

The findings of learning patterns seemed to be closely connected with the explanations of individual differences and cognitive styles. The narrative-based contextual environment not only presented information about individual object, but also detailed relationships among these objects. Therefore, students were required to organize various types of information simultaneously in a context (Kalyuga & Plass, 2009). However, previous studies indicated that not all students can effectively deal with multiple information sources (Ishii & Yamauchi, 1994). Different cognitive styles (e.g., Holists and Serialists) should be considered because they represent consistent individual different preferences in organizing and processing information (Messick, 1976).

This perspective can be used to explain the differences among the three clusters of learning patterns. For the students of cluster 3, their outcome may be due to the fact that the contextual environment matched their cognitive styles. Previous studies indicate that the context not only provides text and graphic information, but also the surrounding situation, which was helpful for Holists because they tended to process information in a “whole-to-part” global way (Jonassen & Grabowski, 2012). Thus, they are efficient learners. Students of cluster 1 may be good at processing visual and verbal information together simultaneously. As suggested by the dual-coding theory, visual and verbal channels are processed differently (Paivio, 1971), and combining the two channels can result in better performance (Clark & Mayer, 2016). Because these students liked (means = 4.43) the narrative design, they spent relatively more time on interacting with the NPCs. Thus, they were holistic-acquiring learners. Since the students of cluster 2 disliked the narrative design (means = 3.70), they had lower click numbers and display times than the students of cluster 1 (i.e., holistic-acquiring learners). The context may not have been appropriate for their cognitive styles. Consequently, they did not learn more efficiently than the students of cluster 3 (i.e., efficient learners). These individual differences might be taken into account in the future when developing a contextual game-based learning environment.

Levels of contextual representation

Based on the advanced multimedia technology, a salient characteristic of digital games is the power of representation, which can immerse students in an authentic or imaginary context. Studies show that different levels of contextual representation such as text, graphics, sound, and context influence student learning (Chen et al., 2017). Multimedia learning (Mayer, 2001; Mayer & Moreno, 2003) asserts that optimal learning occurs when visual and verbal information is presented simultaneously because students have separate channels for processing visual and verbal information. Thus, when the two forms of information are linked together, students can receive integrated information that further enhances their comprehension (Rusanganwa, 2015) and long-term memory (Kulhavy, Stock, & Kealy, 1993). From this perspective, students of cluster 3 can benefit most from a game-based learning environment that provides both visual and verbal information.

It has also been argued that the contextual and non-linguistic details in the context can contribute to students’ learning comprehension and retention (Ray, 2012; Upal et al., 2007). More specifically, different levels of contextual representation vary in how much information is conveyed to students and how such information is presented. For instance, the text reveals symbolic and abstract information, whereas the graphic offers visual and concrete information. The context not only delivers rich information on a specific object, but also the relationships among objects in the context. Thus, when what students learn is linked to their society, culture, and life experiences, learning occurs in a meaningful context that is helpful for their second language acquisition (Eun & Lim, 2009). According to this point of view, students of cluster 1 benefit most from a game-based learning environment that offers rich contextual and non-linguistic details.

Conclusion

This study addresses two research questions. For the first question (How can narrative be incorporated into the development of a contextual game-based language learning system?), this study proposed a heuristic NCGLL framework to guide the development of a contextual game-based language learning system. Using this framework, a PlanetAdventure system was constructed to evaluate its feasibility. For the second question (What are the influences of such a contextual game-based language learning system on student achievement, perception, and behaviors?), the findings of this study showed that (1) the students improved their learning achievement, and the improved scores were statistically significant. This implies that the PlanetAdventure
system contributed to their learning achievement. (2) The students had a positive perception of the system on the four dimensions of perceived helpfulness, joyful experience, narrative design, and scaffolding design. This implies that the PlanetAdventure system appeared helpful to their English learning. (3) Further analysis can not only be used to improve the design of game-based environments for language learning, but also empirically support the application of context-based learning systems. Regarding practical aspect, a design framework was proposed to guide the implementation of contextual game-based language learning systems. This study contributes to the research field of technology enhanced language learning in terms of theoretical and practical aspects. Regarding theoretical aspect, this case study deepens our understanding of the positive influences of contextual game-based language learning on students’ achievement and perception. Such findings can not only be used to improve the design of game-based environments for language learning, but also empirically support the application of context-based learning systems. Regarding practical aspect, a design framework was proposed to guide the implementation of contextual game-based language learning systems. This initial attempt and heuristic experience might further inspire more researchers to investigate how game features could have an ingenious interplay with context-based language learning.

This study contributes to exploring the development of contextual game-based language learning, but it has some limitations. First, it is a short-term study that does not examine the long-term effects of the system. Further, it is a case study that provides preliminary findings but requires more research to examine the potential value and limitation of digital games as learning tools, especially compared to other approaches.

Acknowledgements

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References


## Appendix

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The Online Ecology of Literacy and Language Practices of a Gamer

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ABSTRACT

Previous studies have examined how to integrate video games in formal education settings across disciplines and from various perspectives. However, few have explored digital literacy practices prompted by gaming as a fan practice. Drawing on New Literacy Studies frame of analysis, this qualitative case study attempts to unearth the literacy and language learning practices of Selo, an active gamer who translates games from English into Spanish for fun and whose translations prompt online language discussions with other gamers in the fandom (an online space where fans share their activities). With interviews, online observation and screen cast videos, we analyse Selo’s fandom, literacy practices and workflow when translating, and the language learning events in the online communities of gamers he is involved in. Results show that (1) Selo’s fandom is a complex semiotic social space with users exhibiting varying degrees of involvement, functions and roles (players, readers, commenters, translators, beta-testers), (2) Selo has a sophisticated set of literacy skills (IT, linguistic, sociocultural), and (3) by resorting to other fans’ feedback online to offset his language deficiencies, Selo and other fans learn situated, meaningful language items under authentic conditions of textual production.

Keywords

Affinity spaces, Digital literacy practices, Fan translation of video games, Language learning, Virtual ethnography

Introduction

From a socio-constructivist perspective, contextualized social interaction in language learning is key to produce satisfactory learning outcomes (Lantolf & Thorne, 2006). Providing learners with rich, authentic experiences similar to the experiences outside the classroom stands out as an indispensable teaching practice:

“Learning a language like English or Spanish, or a social language like the language of physics or civics, is hard to do in the isolation of the four walls in a classroom. Furthermore, such isolation privileges those who have already had relevant experiences outside the classroom and have already thereby begun an authentic process of language development” (Peterson, 2013, p. xii).

Video games (for abbreviation, games) encapsulate a wonderful excuse for incorporating learning and situating meaning in rich environments. Games as a context of study and learning therefore have been researched consistently over the last years, but the virtual social spaces built around them need further attention from pedagogically useful perspectives. According to Barton and Lee (2013), a better understanding of online environments is necessary to unfold the changing nature of language, language learning, and the dialogue between literacy practices in and outside the classroom. The Internet expedites the creation of spaces to use and reflect on language and communication. Language is central in the constant learning happening in online worlds, and because of the circulation of the Internet, vernacular language practices are more circulated and public. We undertake this line of thought as the guiding principle in this paper.

Literature review

Video games and learning

Research in video games in education (also, serious gaming) is relatively new but rapidly growing. An important bulk of studies assume that integrating games in the learning process favours students’ motivation and self-accomplishment in a welcoming yet cognitively challenging environment: “games are pleasantly frustrating,” states Gee (2007, p. 131). This stays far from traditional paper-based classrooms, which are centred in the oral and written transmission of knowledge. Games are also said to promote more significant learning: “I don’t want to give kids video games in schools, I want to give them worlds that make words meaningful, whether these worlds are virtual, real, or a mixture of the two” (Gee, 2007, p. 4).

Video games are often seen as an instrument and an environment to transfer and teach curricular knowledge, mainly Social Sciences (Wouters et al., 2013; Young et al., 2012), Natural Sciences (Steinkuehler & Duncan, 2009).
and language (Gee, 2007). Beyond curricular content, some studies attempt to demonstrate that games can act as a motivational tool or driving force to develop transversal and transferable skills, such as improving perception and attention keeping (Green & Bavelier, 2003), collaborative problem solving strategies (Chen & Hwang, 2017), digital and traditional literacy (Gee, 2007; Steinkeuhler, 2007), IT and informational skills (Hayes, 2008), systematic thinking (Squire, 2005), ethical reasoning (Simkins & Steinkuehler, 2008) or scientific reasoning (Steinkuehler & Duncan, 2008). There is also the hypothesis that tracing back what learners do while playing games and modelling learners’ performance can improve the design and application of assessment instructions and instruments (Shute & Becker, 2010). With no conclusive results yet, this may be a promising field of research using learning analytics (VITAL Project). From a sociocultural perspective, games are seen as an architecture and the experience of gaming as a complex system with myriad ecological relationships (Davidson, 2011; Gee, 2007). Lastly, in line with gamification, some studies examine how the design of “just-in-time” instructions from games can be applied in pedagogical contexts (Gee, 2007).

These studies do not fully account for the role of situational and contextual factors around or beyond the gaming experience. A frequent criticism is that studies on games in formal contexts adopt excessively positivistic perspectives. They depart from more or less interventionist experiments, with presumptions of an ideal technological use at all levels (policy, curriculum, school, teacher, student) and variables (material, competence). They often disregard that teachers might not be sufficiently skilful at games and gaming, which hinders adequate pedagogical intervention by means of scaffolding techniques. Teachers must know the games as pedagogical tools in order to lead students into deducing connections between games, gaming experience, curricular contents and pedagogical objectives (Kim et al., 2009). Additionally, studies about gaming in formal contexts do not contemplate the conditions in which young people normally play in their leisure time, in reference to informal contexts of learning:

“[T]here appears to be a disconnect between the possible instructional affordances of games and how they are integrated into classrooms. Games are often multiplayer and cooperative and competitive; they engage players in several hours of extended play, allow rich “hint and cheat” websites to develop around player affinity groups, and are played from weeks to years. However, most schools trade off extended immersion for curriculum coverage, individual play, and short exposures, goals that are not well aligned with engaging video game play.” (Younes et al., 2012, p. 80)

These studies do not fully consider that students may have previously acquired skills and knowledge from their gaming experiences, with fellow gamers in local contexts or within international communities online. Besides this lack of empirical studies connecting informal learning and gaming, a recent surge of interest in communities of young people conducting literacy practices like scanlation (fan-made scanning and translation of manga) (Valero-Porras & Cassany, 2016) motivates our interest in what gamers do online, as it appears to be a rich context for the study of language learning online (Sauro, 2017). Other studies cover related topics like fanfiction and how fans build identities online (Black, 2007), or how to incorporate fan practices into the language classroom by looking to fan-made archives for models of tasks (Sauro, 2014) or feedback opportunities (Behrenwald, 2012).

**Research questions**

Our main objective is to explore and analyse what gamers actually do and learn motivated by their gaming activity in informal, online settings. We focus our study on the case of Selo, a Spanish gamer. Through Selo’s experiences and literacy practices, we access other online communities of gamers, too. We propose three research questions:

- How do gamers organize themselves in online spaces?
- What digital literacy practices do gamers conduct and how?
- What language learning do gamers experience and how?

**Theoretical framework**

**Affinity spaces**

With the objective of understanding how gamers organize themselves online and what they do and learn in the online spaces and how, we consider the concept of affinity spaces. Related to the notion of communities of practice (Lave & Wenger, 1991), affinity spaces are concerned with a group of people characterized by the
“allegiance to, access to, and participation in specific practices that provide each of the group’s members the requisite experiences” (Gee, 2000, p. 105). According to Gee (2007), this allegiance is primarily attached to shared practices and endeavours and secondly to the other people in the group inasmuch as they share culture, objectives or particular traits. Affinity members need other people in the group—and some discourse and dialogue—so that those practices can exist. But the practices and the experiences from them guarantee the allegiance to the group, and not members themselves. Affinity spaces are an open field for the popular culture of mass media (films, television series, video games, literature). Common among young people’s daily lives, digital technologies and social media create new, enhanced opportunities for affinity spaces, fan practices, discourses and dialogues to spread out over the Internet (Gutiérrez-Martín & Torrego-González, 2017). Affinity spaces are a special kind of semiotic social spaces (Gee, 2005). Semiotic social spaces and affinity spaces share that they are concerned with the way in which people construct and interpret meaning. For instance, in a real-time strategy game like Age of Empires, people may accept warfare tactics as normal practices, but they most probably will not in their daily, non-virtual routine. In popular culture, fans are the members of the affinity space, and the fandom (a portmanteau term of fans and kingdom) is the affinity space around a certain practice holding them together. Literacy practices in affinity spaces of the fandom are diverse, including fanfiction, fanzine, fanart, fandubbing, fansubbing, scanlation, or fan translation of games.

New literacy studies

In order to comprehend the literacy practices and language learning of gamers online, we draw on the theoretical lenses of New Literacy Studies (NLS) (Barton, 2007). NLS do not construe reading and writing as universal and context-free cognitive skills. Instead, NLS promote an ecological and holistic perspective on reading and writing, which are conceived as social practices with social purposes and objectives. Human groups actualize reading and writing, bound by sociocultural and historical contexts. NLS have covered both dominant (official, institutional, in-school) and vernacular literacy practices (leisure, private, out-of-the-school). Most recently, studies have attended to digital literacy practices, which are social interactions mediated by written texts—in a broad, multimodal sense of written—generated and/or distributed on the web (Barton & Lee, 2013; Gillen, 2014). NLS have proven successful in analysing the ecology of digital literacy practices of a scanlation community (Valero-Porras & Cassany, 2016), by applying the constituent parts of a literacy practice (Barton, 2007): (1) participants, roles and relations, (2) spaces and environments, (3) purpose and social context, (4) artefacts and tools, (5) activities, (6) values, beliefs and attitudes, and (7) routines, norms and patterns of behaviours. This paper attempts to translate this into the analysis of a community of gamers. Gamers consume global media cultural products (video games), and transform such products into popular culture resources, with a high degree of appropriation. Such appropriation include hacks—adapted or sequel games based upon original games (Muñoz Sánchez, 2009)— or the fan-made translation of old games in Japanese or English into local languages (O’Hagan, 2009). In the process of transforming games into a product of popular cult, gamers meet, talk and (re)act online developing practices and constructing discourses and meanings relevant to specific contexts, such as the affinity space(s) they are a member of (Gee, 2005). This may occur locally and transnationally, given the affordances of the Internet.

Methods

This is a qualitative, exploratory case study, with instruments from virtual ethnography (Hine, 2015). We gain access to one informant who represents our case study: Selo (Figure 1), a young gamer, whose active life online and literacy repertoire seem like a suitable platform to access the fandom of gaming, the online ecology of fan literacy practices Selo and other gamers conduct, the social relationships they maintain and the language learning they extract.

Figure 1. Selo’s avatar and description on online forums
Access to Selo

The eligibility criteria were ages up to 30 and a dynamic fan activity online. We accessed gaming sites and privately communicated with potential informants. Two informants before Selo declined to participate.

We present Selo’s case because previous studies describe fan translation mostly in terms of the digital skills needed to hack and translate the game (Muñoz Sánchez, 2009; O’Hagan, 2009). However, these do not account for the literacy and language learning events involved in the process of fans translating games. During the initial interview, we learn that Selo conducts and promotes multiple literacy practices around gaming (translating games), stimulating online discussion on language. Given Selo’s profile, we think we can provide a detailed photograph of the literacy and language learning practices in online communities of gamers.

Context

Selo is a 30-year-old male from Catalonia. He is bilingual in Spanish and Catalan and studied English through compulsory education (B2 level). He spends large amounts of his spare time playing games. He does not have a specific genre of preferred games. He uses a desktop computer and some emulation software to play console-based games. Thanks to Selo, we access the communities in which he actively participates:

- Romhacking.net, an international, multilingual online community with forums but also repositories of fan-made hacks and translations of games.
- Four Spanish-speaking online forums about games and gaming; reviews, guides, cheat-codes (lists of commands to modify the behaviour of a game), news and related information.

Data collection

Fieldwork extended from December 2016 until June 2017. Our data collection instruments are interviews, online observation, videos with screen recordings and email conversations.

Interviews

Initially we conducted an exploratory, semi-structured, in-depth interview lasting about 60 minutes. The interview with Selo took place face-to-face in Selo’s town (17/Dec/2016). We transcribed selected excerpts of the interview. The interview covered five topics:

- Digital profile: access to technologies, daily routine online.
- Digital identity: email, social networking.
- Gaming: consoles, games, time spent, transition from a gamer offline to a fan online.
- Conflicts: misunderstandings online, management of personal sensitive data.
- Fan culture: interests, practices, content curation and production, process of fan translation.

Online observation

We conducted non-participant online observation with two objectives: (1) to describe the online spaces where gamers and fans meet, and (2) to explore the most relevant literacy practices. These data were stored by means of screenshots, annotating all relevant data of the sites (visitors, comments, informant’s profiles). We conducted the online observation at different times during April and May 2017.

Screencast videos

As part of the online observation in relation to fan-made translations of games. Selo provided the whole process of translating a game of his choice, until the moment he made the translation public for the community on Romhacking.net and announced it in the forums that the translation was available for download. Selo used screencast software to record his screen activity, and sent the video files on April, 30th 2017.
Emails

As a secondary data collection instrument, we stored the email conversations with Selo. Selo was ready to clarify any doubt regarding his online activity, the videos or any other issue. We initiated email conversations on November 30th 2016, the day in which we first contacted Selo through Romhacking.net. We last contacted via email on September 18th 2017.

Corpus of data

The corpus of data is composed of 1 interview (60’), 55 screenshots of Selo’s online fan activity, 8 screencast videos in which Selo shows the process of translating a game and publishing it online, and 47 emails with informal contacts between the Selo and the researcher to make arrangements to meet for the interview, send the videos or links and clarify Selo’s perceptions regarding some issues (the concept of “gamer” or “geek”).

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<thead>
<tr>
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<th>Interview</th>
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<td>No.</td>
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<td>55</td>
<td>8</td>
<td>47</td>
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<tr>
<td>Min.</td>
<td>60</td>
<td>720</td>
<td>79</td>
<td>3450</td>
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Ethics

In conformity with the International Association of Internet Researchers (Markham & Buchanan, 2012), we attempt to guarantee the anonymity, confidentiality and safety of all subjects directly or indirectly involved. Our universities validated the ethical standards of our research.

Analysis

We undertook a descriptive and inductive codification of data (Saldaña, 2015). Initially, we classified our data according to their nature: Selo’s perceptions and opinions, presentation of translations on online forums, discussion on translation and/or language, other communication among members of the fandom. Following Valero-Porras and Cassany (2016), we coded the data under the constituent parts of a literacy practice, as detailed in the Theoretical Framework. We triangulated multiple sources of data, covering practices (videos, observation) and perceptions (interview, emails).

Results

Ecology of Selo’s fandom

As a gamer, Selo has always been involved in online communities to access information, comment on new games or meet other gamers with whom he can play. One of the most active sites about gaming world-wide is Romhacking.net. Romhacking.net is mainly devoted to hacks and translations of games. Hacks are some sort of spin-off or alteration of a given game, while translations change the scripted text players read. Retro games from the 80s, 90s and early 2000s were not commercialized outside Japan or the USA, so they are only available in Japanese and/or English. Since such games will not be translated into local languages, some gamers presently adopt the role of fan translators. They produce translations for the Romhacking.net community in 29 languages, including Spanish. In June 2016, Selo decided to start translating since, he reports, Spanish was underrepresented on Romhacking.net.

There was a boom of fan-made translations into Spanish in the early 2000s, but they are not stored anywhere. Maybe, they were on the sites of the translators, sites which are dead now, and there is no way you can get the translations. That's why I publish on Romhacking, which is international and multilingual, but there were a few translations in Spanish. I do this to centralize the downloads. (Selo, interview, 17/Dec/2016)

There are some active groups of fan translators, but Selo translates on his own because “not everybody is equally committed to the work or its quality” (interview, 17/Dec/2016). Selo could easily upload his translations on Romhacking.net and deem his fan task complete. However, he publicizes his translations online among other
fans. He moderates threads in four Spanish-speaking gaming forums. This extends Selo’s literacy practices on a sociocultural level beyond gaming and translating (Figure 2).

Figure 2. Selo’s literacy ecology

Selo as gamer, reader, commenter and fan translator. Selo plays games, reads information about games and comments about games. But most importantly, he assumes the role of fan translator. According to Gee’s (2005) understanding of affinity spaces, Selo’s translations are the “generator” in this networked fandom, as they fill it with content. Selo’s translations as the content of the fandom is later appropriated differently by members of the community. According to Selo, all fans in the fandom play games, but some exhibit an online fan activity geared toward consuming games and reading texts, and others toward producing and writing texts (Selo’s translations and fans’ online comments):

The first translations I made has hundreds of downloads. My sites also have hundreds of visitors each month, but just a few leave a comment, congratulating me on my job, suggesting new games to translate or how to translate. This is why I have the forums that I named “The retro translation of the week.” It’s fun to see people who like my translations. (Selo, interview, 17/Dec/2016)

In triangulation with our observation of the fandom, we categorize fans in Selo’s fandom as players, readers and commenters.

- **Fans as players** are not part of the forums but download and play Selo’s translated games from Romhacking.net. Selo’s most successful translation has been downloaded 1660 downloads (last checked 14/Sept/2017).
- **Fans as readers** play the games and consume the translations, and also leave a comment of gratitude. With their expression of gratitude, they curate Selo’s content and reinforce his identity as a fan translator for the Spanish-speaking gaming community. Out of 55 screenshots of Selo’s forums, 6 are comments from users who exclusively expressing their gratitude toward Selo and his work. Similar to the like button on Facebook, this influences Selo’s identity as a fan translator but falls out of the scope of our study.
- **Fans as commenters** play games and consume Selo’s translations, but also comment online about the games and/or the translations. They write reviews about the games and their experience playing them; they request and provide software recommendations to execute, hack and/or translate the games, and they offer their help as potential graphic editors and beta-testers. As beta-testers, other fans search for possible unintended, graphic alterations in the game and proofread the translated text. After they test the game, they provide critical comments on the translation strategy or particular language chunks. Fans’ feedback on Selo’s translations and Selo’s response construct a dialogue of language learning. Beta-testers resemble “beta-readers” in fanfiction (Black, 2007), where shadow readers comment on a fan-made literary piece prior to publication.

Within Selo’s fandom, we scrutinise two issues: (1) Selo’s literacies and fan translation process as the main generator, and (2) as a by-product of Selo’s translations, the forum comments and how they serve for informal language learning.
Selo’s literacies

Selo follows a systematic workflow to translate every game. We are able to inspect this workflow thanks to the screen cast videos, showcasing Selo’s translating process of a game until it gets published online. We observe 7 stages (Figure 3):

1. Decoding the texts,
2. Translating the texts,
3. Testing the games,
4. Creating a patch with the translation,
5. Publishing the patch,
6. Advertising the translations, and
7. Curating and managing the network of fans who use the translations. This expands previously established workflows of hacking and fan translation, where only the more technical literacy skills (decoding, testing, patching) were analysed (Muñoz Sánchez, 2009), without regard to the more sociocultural ones (publishing, advertising, curating).

Figure 3. Selo’s fan translation workflow.

Selo’s workflow underscores the complexity of fan translation as a multi-layered digital literacy practice. Fan translation requires highly sophisticated IT literacy to decode or extract the texts from the game (Stage 1) and manipulate them. Selo is not only competent in writing Spanish and comprehending English (with some difficulties), but also in working with hexadecimal systems of coding used in retro games. Other IT skills Selo exhibits are graphic editing if the translated text alters some graphics in the game, and file conversion, which means creating a patch—a file modifying the game file—so the translation is visible in the game while playing it. Without these IT skills, fan translation is not possible.

Of course, fan translation implies the actual transfer from one language to another (Stage 2). Fan translation of games, as with other types of audiovisual translation, is constrained by the mode of the text: character limit is Selo’s biggest challenge. Selo follows 5 steps to translate each sentence:

- He reads each sentence and searches for unknown words or phrases on different resources (Google Translate, WordReference, Wikipedia).
- He provides a tentative first translation in Spanish.
- He tests the game to verify if the sentence fits the screen (using more characters than allowed per sentence deforms the graphics of the game).
- If the sentence does not fit the screen, he rephrases the first translation and provides a shortened version using different linguistic strategies (concision, synonyms, omission).
- He re-tests the game for verification.

In order to translate the phrase “the firepower you’ll face to rescue them is awesome” (Figure 4), Selo takes up to 10 minutes. Selo first reads and makes sure he comprehends the original text. He searches for any unknown word or phrase. In this case, he uses Google Translate to search for “firepower.” Once he is sure he understands the text, he provides a first tentative translation. He tests the game but the sentence does not fit the screen. He shortens the first translation by choosing a more concise translation of to face (in Spanish, enfrentarse a (to face) vs. encontrar (to find)). He compromises the meaning partially, as enfrentarse a (to face) and encontrar (to find) in Spanish are partial synonyms.
Selo situates translation socioculturally (Figure 3). When translating, although he is quite faithful to the original text because this means less graphic editing, he (1) uses an international version of Spanish, because of his global audience, and (2) changes culturally-bound terms (measurements) without an impact in the story:

*People from all over the world download my translations, mostly, from Latin America and Spain. I have followers in Argentina, Chile... people who don’t know English or simply want to play in Spanish. [...] I try to be quite neutral and use non-specific phrases or words. There’re two options: either you can be neutral and never use idioms or specific words [localisms, Castilian Spanish slang] or make two make two versions of the same game, because I know some of the words from Latin America, but not all their talking. Pounds, feet and inches... I also change those.* (Selo, interview, 17/Dec/2016)

He also researches the stories and characters of the games, so he can produce pragmatically adequate solutions. Figure 5 is an online interaction from our screenshots. There, a fan highlights *honrada* as a possible translation mistake or some translation needing clarification. Selo justifies the translation of *Righteous* as *Honrada* in Spanish, because he documented himself on Wikipedia about the proper names in the game (also part of a series of manga) and he remarks the coined translations of proper names in the Spanish game and manga series. Selo and fellow fans learn that language transfer is more than code-switching and covers socio-pragmatic and cultural issues.

*Figure 5. Fan’s comment and Selo’s reply concerning a proper name in a game*
Once translated, Selo tests and creates a patch to execute the game with the translation (Stages 3 and 4). In so doing, he fully revises the language and edits graphics if necessary. The translation is then ready for publication on Romhacking.net (Stage 5). However, Selo also understands his translations as sociocultural products construed in dialogue with others. He notes that gamers today are essentially interactive and social:

*Currently, a gamer FOR ME is somebody who, besides liking A LOT games, plays as much as possible, but also keeps informed, interacts with others through social networks, forums, online games...* (Selo, email, 28/Jun/2017)

He is thus determined to advertise and curate the translations online (Stages 6 and 7) “in order to reach a wider audience,” ultimately converting fan translations into products open to public scrutiny and co-construction of meaning. In Selo’s words, “managing” translations is harder than translating games (Figure 6).

**Figure 6. Fan’s comment and Selo’s reply concerning Selo’s work**

**Fans’ comments**

Thanks to Selo’s “management” of translations, other fans review and comment in the forum threads he creates. Selo tags these forum threads as “the retro translation of the week” and uses them to publicize his translations among Spanish-speaking gamers. In the first post, Selo generically asks for “help to improve,” not specifying what kind of help. Over time, we observe a dialogic curation of content, covering 4 main themes: (1) functions of translated games, (2) translation and language, (3) socialization, and (4) conflicts:

<table>
<thead>
<tr>
<th>Functions of translated games</th>
<th>To understand the narrative of games</th>
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<td>To increase the number of games in Spanish</td>
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<td>To increase the quality of previous translations</td>
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<td>Concepts of reading/writing</td>
<td>4</td>
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<td></td>
<td>Suggestions on language items</td>
<td>12</td>
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<tr>
<td></td>
<td>Selo’s response to criticism</td>
<td>3</td>
</tr>
</tbody>
</table>

| Socialization                | Selo’s justification of language choices | 6 |
|------------------------------| Praise to Selo’s work | 6 |
|                              | Game reviews | 3 |
|                              | Requests for new translations | 2 |
|                              | Personal comments and experiences | 1 |

| Conflicts                    | Competition in the fandom | 1 |
|------------------------------| Copyright and authorship | 1 |

**Table 2. Themes and topics in comments online**

We observe fans who leave a comment of like or praise of Selo’s work (“fans as readers”). Other fans leave a comment with some “help to improve the translations” (“fans as commenters”). For the purposes of this section, we consider those commenters who leave a comment regarding “Translation and language” (31 screenshots out of 55). Fans reply to Selo’s translations with theoretical (the concepts of translation, reading and writing) and practical considerations (suggestions for language improvement, prompting Selo’s response to criticism and justifications for language choices). Figure 7 exemplifies how these interactions occur in relation to Selo’s translation of *Master of Darkness*. 

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With much verbal courtesy, the anonymous fan improves Selo’s rendering in terms of (1) economy of language (With the rising sun > Al amanecer instead of Al sol naciente), (2) lexicon choice (ridge > colina instead of cresta), (3) comprehension-based translation mistakes (looked at the outside of Castle Dracula > pudo divisar el Castillo de Dracula), and (4) syntactical calques (the position of at last [al fin, por fin] in the Spanish sentence). The proofread version of the fan yields a pragmatically adequate solution (Nord, 2009), closer to the register and tone in Master of Darkness, a game of mystery and murder with literary intertextuality (Dracula, Jack the Ripper).

Additionally, fans advise that Selo should move from a literal translation strategy to a communicative strategy (Figure 8) (Hurtado, 1999). Fans note that a more or less free style is relevant to translate more adequately. This evokes past research on how translation is disregarded in schools across Europe, ignoring the benefits translation has for language learning (Pym, Malmkjaer, & Gutierrez-Colon Plana, 2013).

The examples above sustain the idea that language learning happens thanks to the digital literacy practices derived from the passion for games in the fandom. Fan translation is the consequence of some gamers’ active involvement in the community. This involvement entails hours of work, harnessing numerous literacy skills and practices systematically (Selo’s literacies). Such work collects other fans’ feedback online (Fans’ comments), so that thousands of gamers in multiple locations can play a refined product in their local language (Ecology of Selo’s fandom).
Discussion and conclusion

The findings correspond to the constituent elements in a literacy practice (Barton, 2007) and respond to our research questions and discussion of the findings in relation to the literature.

Participants, roles and relations; spaces and environments; purpose and social context

Similarly as with other fandoms (Valero-Porras & Cassany, 2016), gamers account for elaborated networked affinity spaces to produce valuable content for the community (Research question 1). They reunite in online affinity spaces and (re)act according to set roles and functions, which may be explicitly or implicitly adopted depending upon members’ engagement in the community. Selo adopts the roles of fan translator and moderator in online forums in order to publicize, manage and curate his translations. Other fans stand as readers and consumers downloading Selo’s translations and reinforcing his identity as a fan translator with a gratitude comment. Others actively engage in Selo’s forums by means of language-related comments. In so doing, they implicitly play the role of beta-testers and proof-readers. This underpins the idea that prosumption (Beer & Burrows, 2010; Jenkins, Mizuko, & Boyd, 2015) in the age of the participatory culture is the normal transaction of cultural capital, more so in popular culture settings such as gamers’ communities. This challenges unidirectional conceptions of authorship (and learning) and emphasizes the role of users, readers and learners as agents in their process of (self-)discovery.

Artefacts and tools; activities; values, beliefs and attitudes; routines, norms and patterns of behaviour

Gamers conduct and deploy highly sophisticated digital literacy practices (Research question 2) like fan translation. As seen in our analysis, fan translating comprises IT and linguistic-communicative skills, in an expanded notion of literacy (reading, writing, coding) (Vee, 2013). In fact, fan translators are already literate coders as well as digital readers and writers. They embody the idea that “reading and writing practices of literacy are only one part of what people are going to have to learn in order to be ‘literate’” (Vee, 2013). With highly sophisticated digital literacy practices, gamers confirm that such vernacular practices are not associated with the “uneducated” although they may “not be recognized as valid or valuable by dominant institutions of society” (Barton & Papen, 2010, p. 10). As noted by Selo and proved by his experiences, gamers are not solitary but socially interactive individuals who learn collaboratively. However, canonical portrayals may state otherwise (Milner, 2013).

Conversely, we argue that these literacy practices are so valuable that Selo, as a gamer and fan translator, acquires a great deal of language knowledge a great deal of language knowledge (Research question 3). This language knowledge stems from the two main phases of his activity: translating and curating (Figure 3). Firstly, while he is translating on his own he searches for language information and doubts online (sources of language information, e.g., use of Google Translate for terminological doubts; Figure 4) and cares that the textualization of the translated text fits the screen of the game (linguistic strategies, e.g., synonyms, concision; Figure 4). Secondly, Selo receives corrective feedback from fans and remakes the linguistic rendering in the translations. We presume that fans giving feedback also learn implicitly by signalling and reflecting on Selo’s mistakes and translation problems, but we cannot be sure (see Limitations and future research). There is dialogue, negotiation of meaning and language socialization around games. This matches similar considerations in studies on games with some embedded component of social interaction (Liang, 2012; Thorne, 2008; Zheng, Wagner, Young, & Brewer, 2009). The differentiating aspect here is that such social interaction is not given to gamers. An interesting finding is that gamers create their own semiotic social space (Gee, 2005) for language learning opportunities out of “personal interest.” Previous studies on games as a motivational hook in technology teaching claim that “personal interest,” associated with personal likes and inner motivation, is the ideal kind of interest to engage learners in learning (Ting, 2010).

By translating games for fun, Selo—and presumably to a lesser extent, other fans—develop foreign and native languages at the levels of linguistic form, semantic meaning and pragmatic use, which are crucial for any language play to convey meaningful language learning (Cook, 2000). We have selected a variety of interactions that depict how literacy and language practices intersect and develop online driven by the fan translation of games. But most fans’ comments refer to typography, spelling, and grammatical correctness; some comments refer to lexical-syntactical issues, and less frequently, some comments refer to socio-pragmatic and sociocultural issues. An influencing factor here might be the cultural norms attached to the affinity spaces of gaming online in
relation to net-etiquette and proper behaviour before voluntary, self-regulated fan practices and activities (as shown in Figure 9).

![Figure 9. Excerpt with norms and rules from Romhacking.net](image)

This may have a double reading. On the one hand, we see that Selo and fans conform to the requirements of the discursive genre (online forum) and social context (fandom) and activity (fan translation) of their affinity space (gaming). This shows a high level of sociocultural awareness in technology-mediated discussions on the part of gamers as language users and learners. This connects well with Figures 7 and 8, where fans address Selo with verbal courtesy and hedging strategies. This aligns with the idea that language learning surpasses code-switching and is embedded in discourse and literacy (Abraham & Williams, 2009). On the other hand, by conforming to the social and cultural norms of the online sites, fans may find it difficult to criticize more openly Selo’s translating strategy or language issues beyond typography, spelling and grammar. This may compromise more meaningful language learning interactions and reduce the amount of language learning events. Further studies may want to validate or refute this assumption in similar contexts.

**Limitations and future research**

Our study encounters limitations pointing at future research. We cannot extrapolate our findings to every gamer, fan or fan community. Exploratory and not intended for generalization, our study showcases Selo and fellow fans, with active online profiles. Not every fan or gamer has this level of implication. We cannot exactly determine who learns what, but that there exits learning about language and other topics. This is particularly true in relation to the gamers and readers who remain spectators, observing and consuming what Selo and other fans produce and write. Connected with legitimate peripheral participation (Lave & Wenger, 1991), this silent learning occurring “by being around individuals engaged in a certain task or activity” (Romero, 2004, p. 2018) needs further study. Correlating our results with other communities, languages or quantitative computer-based methods like learning analytics, may help construct a solid, multi-faceted discourse on whether all fans learn, to what extent they learn what they learn, and how fan practices can be integrated into schools for pedagogical purposes, including language education.

Methodologically, our data collection was adapted to Selo’s requirements. Despite the fact that data on the Internet is mostly public and easily accessible, Selo knows about the research and consents to participate under certain conditions. He did not want to “feel” that he was observed or followed (as with periodical interviews). This is why a closer exploration through narrative inquiry was not possible. This highlights the need of detailed guidelines for Internet-based research. An interesting topic Selo raises is the “expectation of privacy.” Not everything on the Internet is ethically researchable without consent: “Individual and cultural definitions and expectations of privacy are ambiguous, contested, and changing. People may operate in public spaces but maintain strong perceptions or expectations of privacy” (Markham & Buchanan, 2012, p. 6).

Ethically, since fan activities modify copyright content, fans cross fuzzy frontiers of legality. However, Selo and his fellow fans observe that they do not modify or translate copyright material that is still being commercialized. The likelihood of retro games to be re-commercialized in languages other than English or Japanese is minimum. Besides, recent studies evidence that there is a “positive effect of illegal downloads and streams on the sales of games because players get hooked and pay to play the game with extra bonuses or at extra levels” (Ende et al., 2015, p. 149) or revitalize older games and consoles. The concepts of copyright and authorship in the fan universe are also to be explored.

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Effective Learning Design of Game-Based 3D Virtual Language Learning Environments for Special Education Students

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ABSTRACT

This current study aimed at creating a 3D virtual environment on Second Life particularly for special education students to enhance their first language, Mandarin, learning in vocabulary and sentence structures. Four students aged between 8 and 9 participated in this research. In addition to their inherent disabilities (mild autism spectrum disorder, attention-deficit hyperactivity disorder, or mild mental retardation), all the four participants suffer from delayed language development. The purpose of the 3-month study was therefore to establish a platform enhancing their learning of Mandarin Chinese. A design-based qualitative design was adopted in this study. The collected data included in-class observation, video clips of learning process, and post-study interviews with the four disabled children. Additionally, parents’ comments on their children’s oral expression skills at home were also collected. Through a two-cycle investigation, this research proposed six categories of Human-computer interface (HCI) design principles for using virtual worlds to enhance special education students' Mandarin learning. In addition, both the interview results and the parents’ comments confirmed the effects of using this platform for special education students’ learning.

Keywords

3D virtual environment, Second Life, Speech delay, Special education students, Design-based research

Introduction

Linguistic communication skills (LCS) are very important to human daily life. It is especially essential for children’s development because it is highly relevant to their social, emotional, and learning foundation. For ordinary children, to acquire their first language (L1) through daily activities is usually not a problem (Owens, 2008), while for children with disability, their L1 acquisition is not as natural. In fact, many children with disabilities are often comorbid with language delay or language disorders (Reed, 2014). If they are unable to obtain substantial learning support through early intervention, the sequential problems in academic achievement and social skills will cause severe emotional and behavioral problems which will hinder children from successful employment after graduation and ultimately become the social issues that may need to be dealt with at high social costs (Bercow, 2008).

Thus, the LCS problems encountered by children with disabilities should be diagnosed and dealt with as early as possible. Obviously, it is both a pedagogical and a social issue if not addressed properly. For a long time, multiple teaching approaches and instruments have been used to enhance the LCS of children with disabilities. In most circumstances, traditional teaching aids, such as paper-based pictures, building blocks, word cards, and colorful charts, are used. Today, the preparation of the abovementioned teaching aids requires a high cost of manpower and material resources. What’s more challenging is that students require individualized instruction and that teachers should maintain students’ focus and interest. In recent years, multimedia and interactive eBooks are attracting special education teachers’ attention due to the multimodal input available in those advanced technical tools (Birmingham & Davies, 2001). In addition to the abovementioned computer-assisted language learning materials, 3D virtual worlds are also attracting educators’ attention in the area of special education. For example, Gilberta, Murphya, Kruegerb, Ludwigb, and Efrona (2013) investigated how 3D virtual contexts would benefit disabled learners’ mental and social relationship. A total of 61 participants with different kinds of disabilities were involved in their study. After the 3-month long involvement, the researchers confirmed that the participants were benefited from the activities in the 3D virtual contexts in terms of several affective constructs, such as reduced depression, anxiety, and loneliness, and enhanced positive affection of living satisfaction. Additionally, the capability of enhancing students’ skills to obtain actively immersive and social experience gradually makes 3D virtual worlds an important research topic in special education in recent years. Standen and Brown (2005) viewed virtual worlds as a multifunctional special education tool. They can be used to intervene special education students’ learning to improve and evaluate their independent living skills and cognitive abilities. Additionally, Stendal, Balandin, and Molka-Danielsen (2011) argued that 3D virtual worlds, such as Second Life, have the potential to tackle the challenge faced by people with a lifelong disability in maintaining friendships and staying included in communities, and therefore consequently reduce their lonely feelings caused by their inherent physical disability. In fact, several studies on using 3D virtual worlds for special education have
revealed the high potential for facilitating people with disabilities to develop essential skills for their daily life (Mitchell, Parsons, & Leonard, 2006; Standen & Brown, 2005), to improve their self-esteem, confidence (Weiss, Bialik, & Kizony, 2003) and mental health (Gorrindo & Groves, 2009), and to enhance their cognitive abilities including attention, spatial perception, and reaction abilities (Parsons, Silva, Pair, & Rizzo, 2008).

While studies on using 3D virtual worlds in special education have largely confirmed their potential for enhancing special education children’s learning, most of them focused on training children to acquire essential skills for their daily life, such as shopping in a shopping mall (Erez, Weiss, Kinozy, & Rand, 2013), undertaking physical training (Weiss, Bialik & Kizony, 2003), understanding transportation rules (Bart, Katz, Weiss, & Josman, 2008), and engaging in social interaction (Gilberta et al., 2013). Little research has been reported with regard to enhancing those children’s LCS. Furthermore, some researchers did not agree that virtual learning environments (VLE) are ready for the use in special education (Habib et al., 2012; White, Fitzpatrick, & McAllister, 2008). For example, Habib and her colleagues (Habib et al., 2012) argued that some obstacles existing in VLE would hinder disabled students from being benefited from the environment. What concerns the researchers the most is the issue of human-computer interface (HCI).

HCI is user-centered and accentuates the need for designing the e-learning environment before focusing on the computing itself (Muzzio & Serra, 2001). Likewise, HCI focuses on satisfying the needs of users, the general users and especially those with disabilities. In addition to the general guidelines for designing and structuring accessing e-learning applications, such as the Web Content Accessibility Guidelines (Kelly, Phipps, & Sloan, 2005), some additional guidelines should be considered when designing an e-learning environment for users with special needs (Debevc, Verlič, Kosec, & Stjepanovič, 2007). Regarding the research relevant to HCI for disabled users, most focuses on the design of a web-based learning environment. However, very few studies have focused on the principles of HCI design of 3D virtual worlds for enhancing special education students’ LCS development. Despite this, 3D virtual worlds, such as Second Life, have proved to be an effective environment for enhancing learners’ acquisition of a second language (L2) (Lan, 2014; Lan, 2015). It is therefore worthy of an investigation into the potential of learning in a 3D virtual world in promoting the LCS development of children with disabilities. Thus, how to design a barrier-free learning environment is a critical issue when considering a 3D virtual environment as a learning facilitator for children with disabilities.

In summary, 3D virtual technology has great potential in creating an immersive and socially interactive environment for children with disabilities to learn daily living skills and in rehabilitating their physical and mental disorders. However, the benefits of using 3D virtual worlds to the LCS learning of children with disabilities are still under investigation. Therefore, this study aims at developing a barrier-free learning environment in a 3D virtual world to enhance special education children’s LCS development. To achieve the abovementioned research goals, two research questions will be answered: (1) what are the principles of designing a 3D virtual environment for disabled children’s L1 learning? (2) What are the effects of learning L1 in 3D virtual environments on disabled children’s LCS development as perceived by the participating children and their parents?

Method

Participants

The participants were four disabled children who were diagnosed with mild autism spectrum disorder (ASD), mild mental retardation (MR), or attention-deficit hyperactivity disorder (ADHD), and all were comorbid with language delay or language disorders at an elementary school in northern Taiwan. Three of them were first graders and one was second. Table 1 lists a brief description of the four children, including their 1) categories of disability, 2) intelligence quotient (IQ), which was evaluated by the revision of the Wechsler preschool and primary scale of intelligence (WPPSI-R), and 3) their L1, Mandarin Chinese, ability which was evaluated by the receptive and expressive vocabulary test (REVT) before the study. Additionally, the results of REVT are represented by percentile rank (PR).

<table>
<thead>
<tr>
<th>Participants</th>
<th>Categories of Disability</th>
<th>IQ</th>
<th>L1 abilities (PR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ASD</td>
<td>95</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>ADHD</td>
<td>93</td>
<td>16</td>
</tr>
<tr>
<td>C</td>
<td>ADHD</td>
<td>87</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>mild MR</td>
<td>57</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1. The four disabled children’s individual information
Table 1 suggests that the participants’ L1 abilities (PRs from 3-16) were far behind those of the non-disabled students of the same age. The diagnosis reports of each child reveal that describing daily life was the L1 ability that these children most urgently needed. In addition to the low L1 abilities, the very short attention span of the four disabled children also negatively influenced their social relationship and learning behaviors. In short, the comorbid of the delayed language development and their inherent disabilities usually made them fail in social interaction and academic achievements at school.

Research design

The current study adopted a design-based research (DBR) design. Two cycles of experiment lasting for 7 months were conducted to refine the 3D virtual contexts to meet the learning needs of the four participating children. Multiple qualitative data, including in-class observation which focused on the participants’ classroom behaviors, video data which recorded the learning process of each individual child, and interviews with both the four children and their parents, were collected and analyzed during the study.

The data of the in-class observation and the record of the learning process were analyzed and discussed among the participating teacher and the research team of seven people [two technology-enhanced language learning (TELL) researchers and five 3D engineers] soon after the completion of each lesson. The findings were then used to refine the design of the latter lessons. Additionally, the interview data were transcribed by the participating teacher and were checked by another special education teacher to confirm the exactitude of the transcription.

Instruments

Platform

The 3D virtual learning contexts on Second Life were developed by the authors. A total of eight contexts related to children’s daily living experience were created: a kitchen and a dining room in a house, a convenience store, a playground, a health center at a school, a zoo, a shopping mall, a traditional market, a night market, and public transportation. The virtual contexts are composed of embedded objects that can be found and events that can occur in each scene. In addition to the static contexts and learning contents, a game-based scheme was created to deliver the learning materials via joyful activities. The basic game factors included content-based feedback, challenge-passing, adventure exploration, and joyful rewards. Therefore, the participants were able to do self-directed learning by playing and to obtain real time feedback given by the learning platform.

Figure 1 shows two of the virtual contexts used in the study. The left one is a snapshot of one corner in a convenience store. The participants can learn to name the goods and say the essential sentences while looking for and purchasing items. In addition, the right one is a health center at a school. The participants can learn the objects’ names in the health center, and the sentences to describe their physical conditions. Moreover, each virtual object is interactive, i.e., the participants can click them and hear and learn the pronunciation and the description of the clicked items.

Figure 1. A convenience store (left) and a health center (right)
Learning design

A total of eight lessons designed by the authors were used in the study. Each lesson was implemented in a virtual context by embedding the learning materials in the virtual environment. Additionally, the learning materials of all the lessons which matched the contexts were embedded. For example, the goods that can usually be found in a convenience store were placed in a virtual store for the participants to explore and learn the names of the goods. Besides, each lesson is composed of four learning rounds: basic vocabulary learning (labeling), advanced vocabulary learning (categorizing, defining, and reasoning), sentence pattern practicing, and reviewing.

Interview questionnaire

The interview questionnaire was developed to understand both the four children’s attitudes towards being involved in the proposed learning activities in 3D virtual worlds and their perceptions of the effects of learning in such an environment on their LCS development. They were asked a total of 15 4-point Likert questions which were classified into 4 dimensions: satisfaction (4 items) focusing on the children’s motivation, interests, and joy when learning by playing in the virtual contexts; usefulness (6 items) focusing on the children’s perceptions of the benefits from learning in the proposed contexts in terms of their LCS development; ease of use (2 items) asking the children whether the proposed environments are easy to use; and authenticity (3 items) asking them whether learning in the virtual worlds feels real. Moreover, in order to more concretely know how the children benefited from participating in learning in the 3D virtual environments, after they answered each question, the children were also asked to elaborate on their answers with reasons.

Appendix A is the English translation of the questionnaire. Its original version is in Chinese and can be found at https://drive.google.com/file/d/1ubgKS_qp03dVuweOJPmeprDUg-lyyiZh/view.

Procedure

Figure 2 shows the procedure of the study. As shown in Figure 2, Cycle 1 started with a needs analysis in which the research team consisting of a special education teacher, two TELL researchers, and five 3D engineers met regularly to understand disabled students’ learning needs. After the learning needs were confirmed, three lessons and the corresponding 3D contexts were developed. Before the first cycle of trial, the children received training on basic SL operations which included how to move their avatars in SL, how to interact with the virtual objects by clicking, and how to listen to the questions posed by the system and to answer them by taking the correct actions.

Afterwards, the four students learned the three lessons by logging in the 3D virtual worlds and engaging in the game-based and self-directed activities. In each lesson, the special education teacher first provided the learners with essential explanations of the learning rules and the exploration targets, and then the four participants learned by playing individually. They worked on their own most of the time while the teacher and one researcher stood by offering guidance only whenever the students called out for help, especially for technical support. Additionally, all the learning processes were recorded by four cameras (one for each child) and a screen recorder installed in each computer. The in-class observation and videos were then analyzed to identify both the advantages and the areas for improvement of the proposed 3D virtual learning contexts and activities. All the analysis results served as the refining foundation for the second cycle.

After reflecting on the learning activities and 3D contexts, five more lessons and the corresponding 3D virtual contexts were developed based on the data analysis results of Cycle 1. Then, the four children started to learn the five new lessons by doing similar activities to those in the previous cycle, i.e., learning by playing individually. All the learning processes were observed and recorded as in Cycle 1. Following this, all the children were interviewed. Additionally, during Cycle 2, the parents’ comments on their children’s LCS at home were collected with a semi-structured questionnaire when they visited their children’s special education teacher and were analyzed. The questionnaire can be found at https://drive.google.com/file/d/1nM43j_DdPd-H26fe8Z8-l1DfWZPDJxFE/view. Finally, the HCI designing suggestions for developing 3D virtual worlds to enhance disabled children’s LCS were proposed based on the reflection and observation data analysis results.
Results and discussion

The results of this study described below include two parts for answering the two research questions about (1) the design principles of 3D Learning Environments and HCI for children with disabilities, and (2) the effects of learning in 3D virtual environments on disabled children’s LCS development as perceived by both learners and parents.

The design principles of 3D learning environments and HCI for children with disabilities

The principles for designing the HCI of a 3D virtual environment for enhancing disabled children’s LCS learning proposed here were obtained by synthesizing the two-cycle results of in-class observation and video analysis. One copy of the observation notes for Unit 1, the kitchen and the dining room, can be found at https://drive.google.com/file/d/1LR5jLljgvsoy_3iZG50Z0UAcig8FNDa-/view?usp=drivesdk. The principles can be classified into six categories as described below.

The levels of challenge and learning contents

When deciding on the levels of challenges and the amount of learning contents in the 3D virtual environment for children with special needs, their short attention span for learning should be taken into consideration. It was found that there should be fewer learning materials and fewer test items embedded in each virtual context for students with disabilities in comparison with regular children, no more than six items. At the beginning, 10-12 question-based learning items were included in each round of a lesson. However, it was found that after answering 6 questions, the participants lost their attention and were easily distracted by the surroundings, such as the kids walking outside the classroom.
Additionally, the participating children suffer from different disabilities; thus, not only the problem of attention-deficit, but also the difference in their capabilities to learn should be taken into account. For this reason, the learning materials should cover language skills in different levels for different disabled children. For example, there are 4 rounds of challenges in each lesson in this study with round 1 being the simplest, and round 4 the most difficult. Additionally, round 1 targets at the simplest language skill, i.e., naming objects, while the other rounds with more difficult learning materials matched children’s other learning abilities. It was found that Child D (mild MR) was able to learn the very basic skills such as naming a toy or the objects in the health center while the more advanced skills (e.g., reasoning and grouping) would be too difficult for her. However, the others with an average IQ enjoyed conquering all the learning challenges and gained satisfaction although they suffer from different disabilities (either ASD or ADHD). It was also found that the increasing difficulty of challenges in different rounds helped keep their learning interest and concentration on the learning tasks. For example, the most cheerful finding is that Child B (ADHD), who used to take medicine before coming to classes to help him concentrate on learning no longer needed to take medicine since halfway of the study. In fact, all the 4 children behaved similarly in attention extension. It was found that the time they were able to concentrate on learning was longer and longer as the study progressed.

Based on the abovementioned findings, three guidelines are provided below for effective learning design in a 3D virtual environment for children with disabilities.

- The number of challenge levels in each lesson should be limited, and four is suggested based on the findings of the current study.
- The number of the question-based learning items in each challenge level should be limited too, and a number of 5 or 6 is suggested due to children’s short attention span.
- The degree of difficulty should gradually be increased to meet the different learning capabilities of individual children as well as to maintain their attention and interest. Even for a much-delayed learner like Child D, the difficulty level of a learning task should be gradually increased, at a rate and degree suitable for his/her learning capabilities.

The 3D operation functions

The SL system provided different avatar operation functions, such as walk, run, fly, sit, and wear. They do not present a high level of cognitive load to ordinary users as beginner players. However, it was found that if all the common functions provided by SL are enabled at the start, it would hinder disabled children from successfully accomplishing the assigned missions. For example, at the beginning of the study, they loved to fly but they easily got lost in the environments and consequently stopped doing the learning tasks. Regarding the functions for social interaction, it was found that both functions, text and voice, should be carefully controlled. To type words via the text chat function is not possible for those children because of their very limited Mandarin skills. Instead, voice chat can be used for social interaction. But it was later found that voice chat is the main source of distraction for those disabled students. At the beginning, when they found that they could hear their own and others’ voices, they began to make noises, laugh and totally lose attention to learning activities.

It is worth noting that, however, if aural interaction is necessary for carrying out the assigned tasks, the voice chat function can be enabled a while later to avoid the disadvantages identified at the earlier stage because the attention period of those children had extended due to their experience in learning in the virtual worlds.

In addition to voice chat, the background sound/music or sound effects of operation functions are also the sources of distraction for disabled children. It was found that some children were very sensitive to certain sounds. For example, Child D (mild MR) was always frightened when she heard the sound of teleport. Additionally, Children A (ASD) and B (ADHD) were very sensitive to the peak sounds of the whale in the zoo (lesson 4), even though they were used to it during later lessons. On the other hand, Child C (ADHD) was always attracted by the “dadada” sound from the background.

Based on the findings described above, four guidelines are suggested below for the design and use of 3D operation functions.

- The available avatar operations in 3D virtual worlds should be minimal. At the early stage, some fast avatar moving functions should be disabled (e.g., run, fly and teleport), while only the very basic functions, such as walk, should be allowed to be used. As students’ experience in learning in 3D virtual worlds increases, more operation functions can be unlocked for disabled children.
- Some avatar-object interaction functions, such as “sit” and “wear,” should be locked for disabled learners at the early stage and be made available only when needed at a later stage.
• The voice chat function should be disabled at the start of the learning activity and enabled as needed in a later stage when children are used to learning in 3D virtual worlds.

• Background music/sound in the 3D worlds should be minimized and adjusted carefully to a comfortable level for children with disabilities.

The interactive 3D virtual objects

Because disabled children need more learning supports than do ordinary children as described in the Introduction section, a self-directed learning environment with timely feedback and learning guides is very important and useful for practical special education settings. Therefore, self-directed learning was emphasized in the study; most of the 3D objects in the virtual worlds are interactive. All the embedded learning contents can easily be accessed by a simple click. At the beginning, the classroom observation data demonstrated that the disabled children were unable to smoothly control the mouse to click the virtual objects (lessons 1 and 2). Therefore, at the beginning a sticker was stuck on the mouse to show the children which part of the mouse should be clicked, and this method was a helpful scaffold for those children to use the mouse to select the virtual objects. However, from lesson 3 onwards, none of the children needed to look for and follow the sticker while completing the learning tasks. In order to help the children successfully and correctly click the virtual objects, in addition to a sticker on a mouse, the positions of the virtual objects and their trigger areas should also be taken into careful consideration when placing the objects in the virtual worlds. If the objects were vertically placed, rather than horizontally, it would be easier for disabled children to click because we found that the occurrences of wrong-clicks were high when the objects were horizontally placed. In addition, the objects should also be placed with a certain amount of distance away from one another to lower the chance of mis-triggering. According to what was found from the video recording of the learning process, a too small trigger area embedded in an object will lead to missing or delayed feedback on children's clicks during the learning process. For example, in Lesson 3 “A health center at a school,” a click on a single OK bandage cannot be easily done for the disabled children. Consequently, they will be confused about their learning. After enlarging the trigger area to cover a whole box of OK bandage, the problem was successfully solved. Therefore, the trigger area of an object should be large enough and should cover the entire object to guarantee that it can be triggered from any angles.

Furthermore, the unnecessary information about the inherent features of virtual objects, such as “You have no privilege to purchase this,” should be disabled and should not pop out when the objects are clicked. The data from our video recordings of the sessions show that unnecessary information could easily distract their attention. Such information is usually in English, a language that they were unfamiliar with so they would usually spend much time on and got stuck with it, thinking that it was also a part of the learning material.

According to the findings described above, three guidelines are given below.

• The trigger area should cover the entire object. It can be triggered from different angles.

• Placing different objects vertically is better than doing it horizontally. If different objects should be placed horizontally, they should not be placed too close to one another.

• All the unnecessary functions or information embedded in any objects should be disabled and should not pop out when the objects are clicked.

Scene design

According to the children’s diagnosis reports as described in the section of Participants, the scene design in the study should follow children’s daily life experience so that it would be easier for them to transfer what they have learned in 3D virtual worlds to real life. For example, the traffic lights on the two sides of a road should be synchronized (Lesson 8). During the first trial, the traffic lights were not flashing synchronously on the two sides so the children were very confused and did not know when to cross the road. After modifying the control scheme of the traffic lights, they enjoyed crossing the road but noticed that nothing would happen even if they disobeyed the traffic rules. To ensure the children’s awareness of traffic safety, the teacher then reminded them of the importance of obeying the traffic rules even though they were in virtual worlds. It was found that all the children started to observe the traffic rules after the teacher’s reminder. Similar to the traffic issue, some places, such as the staff office in a post office (Lesson 8), were not allowed to enter without permission in the real world. However, in the virtual worlds, they could enter freely. Again, they were reminded of the rules applied in the real world. It was great to see that they were able to remember what the teacher had said and stopped violating the exploration rules.
In addition to the contexts, the arrangement of objects in the contexts was also important. It was found that the children loved to play with certain objects, such as a seesaw or a swing (Lesson 3) which offered hands-on interaction. At first, they were placed outside the exploration context of Lesson 2 (in a convenience store); it was found that children did not move on completing the tasks because they found those objects a great fun to play with their peers. Their attention was totally distracted away from the learning process. To deal with the problem, those fun objects were placed away from the current learning area. They were also told that they were allowed to play with them only if they successfully carried out the assigned mission. Two guidelines of HCI and scene design are given below according to the abovementioned findings.

- The design of the scenes should follow children’s daily life experience so that it would be easier for them to transfer what they have learned in 3D virtual worlds to real life and vice versa.
- Objects that easily divert children’s attention from completing learning tasks should be placed outside the learning area (on the exploration path). It is better to arrange another area to keep them and to be used as rewards.

**Navigation**

In traditional settings, disabled children are heavily dependent on teachers’ reminders and orders to continue their learning process as described in the Introduction section. In the proposed self-directed learning environment in the current study, therefore, the embedded navigation scheme then becomes very important. It was found that without clear learning steps on the screen, those children were unable to smoothly advance from one challenge level to the next. For example, in the first three lessons (in Cycle 1), the children spent a lot of time on clicking here and there or asking teachers how many questions were left to answer. The teacher was busy keeping them engaged in completing the learning missions. To deal with this problem, reminding signs were added on the screen to inform the children which round they were in and how many target objects were left for learning (see Figure 3). By doing so, the frequency of distraction significantly decreased.

![Figure 3. The reminders used for guiding the children in their learning process](image)

In addition, at the beginning, because of the lack of knowledge in Chinese characters, some children were unable to read the reminders. Therefore, both textual and aural information was provided and the children were allowed to choose the one they preferred. Besides, it was found that sometimes the children could not remember or comprehend the information if it is played only one time. Multiple chances are needed for some children. Thus, the function of re-play or re-listen was added. Based on the abovementioned findings, two guidelines are given below in terms of an effective navigation design.

- The reminders showing the remaining learning missions and the current status are needed in helping disabled children progress more smoothly in the 3D virtual worlds.
- It is necessary to provide disabled children with the options to choose aural or textual information. The re-play function is also necessary for those children to re-listen or re-read the information or tasks.
**Game functions**

The game functions provided in the proposed system are proved to be essential for motivating and engaging the children. Sometimes, when Child B (ADHD), completed all the missions earlier than the others, he would visit and stay in the other environments created by the other players rather than the researchers. But soon he stayed there and felt bored. He explained that the environments he visited additionally were not fun because there was nothing left he could do except wandering. In fact, what Child B described is the common features of environments or scenes in Second Life in which no specific interactive activities are available for them. He said he loved the games in the proposed environments they used in the study. Additionally, in order to guarantee a smooth learning process, only the questions of the first level had to be answered one by one because they were basic in each lesson. The other three levels, Levels two to four, can be done without the completion of the former levels. While observing those children playing, it was found that Child D (mild MR) preferred completing sequential learning levels by answering one question after another. However, another child, Child B, preferred completing different learning levels without a particular order after his experience in learning in the virtual world increased.

In addition to the level structure (sequential or parallel), feedback is another point that is needed to be refined for disabled children’s learning. It was found that both aural and textual feedback can easily distract children’s attention from learning if too much information is given. After many trials, it was found that the symbol “O” meaning “correct” and the symbol “X” meaning “wrong” are better than the long aural or textual descriptions. The simplified message not only helps the students correct their mistakes but also provides them with timely feedback to help them concentrate on the learning process.

Reward is another factor to be considered in game-based learning. It was found that learning by playing in the virtual contexts is one kind of reward that those children love. For example, Child B (ADHD) was unwilling to help his peers before his involvement in the study. But after participating in this study, he became a friendlier child to others than he was before. He loved to help the teacher and the other three children. It is also worth noting that playing with the interactive objects, such as the swing or seesaw, or to be allowed to explore the contexts which will be learned in later lessons, can be great rewards for these children. Once the children conducted learning by playing in the virtual environments, physical rewards such as cookies or stickers were no longer necessary. Learning by playing itself can be a good reward. Moreover, those children loved to play with the interactive objects with their peers. After comparing the oral output of the four children in the recorded learning process, it was also found that they produced more Mandarin output while playing with their peers than they did while playing alone because they loved to share the experience with others.

According to the findings regarding game functions described above, four guidelines are given below.

- Although the levels should be completed sequentially or in parallel depending on the learning contents and children’s abilities, as the children’s experience and abilities improve, the design can be flexible to increase the excitement and also to meet children’s various abilities.
- The feedback given to children during the learning process should be simplified to ensure that it is correctly and promptly understood by children.
- The rewards can be offered in different ways. For example, allowing children to play some interactive toys or equipment in 3D virtual worlds and providing them with some 3D virtual objects, such as a lightsaber or a fancy sports car.
- The interactive objects that can be played by multiple users at the same time are more popular than those that can be used by one person at a time.

Although more and more researchers have proved the benefits of learning in 3D virtual worlds to disabled learners’ learning needs, they also agree that those virtual environments should be appropriately adapted. The design proposed in the current study is based on the evidence-driven and individualized design approach, which not only echoes the design principles of 2D web-based learning for disabled learners (Debevc et al., 2007; Habib et al., 2012; Muzio & Serra, 2001; Sharma & Sharma, 2013) but also expands the general design principles of 3D virtual worlds for disabled users (Kruger, 2014). Kruger (2014) argued that Second Life, OpenSim, or any other 3D virtual worlds should be appropriately adapted to allow blind people to look for or classify the virtual objects as easily as sighted people do. The design principles proposed above are based on the semester-long observation of the four disabled children with 3 kinds of disabilities and delayed language development. Therefore, the guidelines based on the design principles of learning environments would be more user-specific for HCI designers when the target users are under the same conditions. However, as only four children with three different kinds of disabilities participated in this study, further investigation focusing on other kinds of
disabilities and on a larger scale of participation is needed in the future for obtaining more detailed design principles for turning 3D virtual worlds into a more effective learning environment for disabled learners.

The children’s perspectives and parents’ comments

After finishing the two-cycle learning, all the children were individually interviewed by their special education teacher. They answered the questions as listed in Appendix A. Besides, considering their reading abilities, all the questions were orally asked by the same teacher and children’s answers were recorded and transcribed later. Table 2 lists the summary of the children’s answers. It can be found that all the four children agreed on the benefits of learning and playing in the 3D virtual contexts to their LCS and learning motivation. They all thought it was easy to use the system. And the authenticity of the 3D virtual contexts is quite high according to their perspectives.

Table 2. Children’s answers to the interview questions

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<tr>
<td>Satisfaction</td>
<td>I like it VERY MUCH.</td>
<td>I like it. It is interesting, especially when I was at the airport, in the zoo, and in the playground. I love the fast food restaurant, too.</td>
<td>I love it. It is lots of fun.</td>
<td>I like it. I do not fear learning in that. I loved the High-Speed Train station and the zoo and crossing the road.</td>
</tr>
<tr>
<td></td>
<td>All the units are very interesting, especially the fast food restaurant. The crabs in there are funny. I wish I can play with my sister after school.</td>
<td></td>
<td>I loved all the interesting places, like the zoo, and the airport and somewhere near the bus stop. I wish I can play it again. The more units, the better.</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>I learned many vocabulary words. I can say many words, like cucumber, tomato, cheese, … Learning in there helps me concentrate on learning because I love everything. I can say sentences better than before.</td>
<td>Playing in there helps me learn. I learned that I have to watch the cars when crossing the road, especially to watch the traffic lights. It helped me concentrate on learning. I now can say a lot more sentences and item names.</td>
<td>It helped me learn, especially memorize things. I did not forget what I learned in there. I can say a lot more words, but not many sentences.</td>
<td>I can concentrate more on learning. Playing in there helps me remember things, like those objects in the playground and at the airport. But I could not say more sentences yet.</td>
</tr>
<tr>
<td>Ease of use</td>
<td>It is very easy to use it. I become super soon after I started using it.</td>
<td>It is very easy to use since the first lesson. My PC only crashed once. After I re-logged in, there were no problems at all.</td>
<td>It is easy to use. I didn’t need to wait and computers didn’t crash.</td>
<td>My computer did not crash.</td>
</tr>
<tr>
<td>Authenticity</td>
<td>It is very authentic. I love my avatar very much. He is very obedient to me.</td>
<td>It is real, especially when I was in the playground.</td>
<td>Exploration in the worlds is like exploration in real world, especially in the playground. I learned I have to be careful when I cross the road.</td>
<td>The 3D virtual contexts are similar to real ones. It is like in a toy store. The airport is the most authentic one.</td>
</tr>
</tbody>
</table>

In addition to the children’s perspectives and perceptions, their parents’ comments on the benefits of the proposed learning approach to their children’s oral expressing skills at home were also collected when they visited the school during Cycle 2. All except one parents (Child B’s) provided the special education teacher with
information on what and how their children talked at home. Child B’s mother expressed that she did not know her boy’s oral expressing skills after school because his child stayed with the babysitter during weekdays. In contrast, similar to their children, all the other three parents confirmed the effects of learning in the 3D worlds on their children’s LCS development. Child A’s (ASD) mother said her boy loved to share what he did and saw in the virtual worlds and even actively shared his learning experience in the virtual fast food restaurant with a waiter in a real fast food restaurant and asked him whether there were crabs in this restaurant. She said that he also asked her to buy him the same jeans his 3D avatar was wearing.

Similarly, Child C’s (ADHD) mother also said that her boy could produce more words and sentences, especially those about night markets. Child D’s (mild MR) mother was very surprised when she saw her girl smoothly used a computer to learn. She said that her girl expressed very high interest in the activities and even asked her to buy a computer at home. At the same time, all the three mothers also thanked the special education teacher for reminding their children about the differences between the virtual and the real world, especially safety issue, such as crossing roads.

Based on what is described above, it can be concluded that both children and their parents approved of learning by playing the proposed activities in a game-based virtual world in terms of its facilitating effects on the children’s LCS development, and improvements in learning motivation and the children’s concentration. The findings of the current study prove the benefits of the immersive, interactive, and authentic features of 3D virtual worlds to disabled children’s LCS performances as well as echo the positive effects of game-based learning on children’s learning (Wang, Chen, & Chan, 2016). They also show that although 3D virtual worlds possess inherent disadvantages which may challenge disabled children’s use of this platform for pedagogical purposes, its potential as an educational application would be valuable if the HCI and learning activities are carefully designed. Therefore, the positive results obtained from this study are not only in line with the studies relating to 3D virtual worlds for special education students (e.g., Jeffs, 2010; Shah, 2014; Adamo-Villani et al., 2006), but also add to Lan’s (2015) findings that the abovementioned specific features of 3D virtual worlds are able to enhance children’s foreign language learning. Our results also echo the findings of the study by Huang and Liaw (2011), who stated that by immersing medical students into an authentic context benefits their learning motivation, attitudes, and performances. Briefly, according to the findings of this study, a carefully designed 3D virtual world is able to provide the learners, either ordinary or disabled, with a contextual learning environment in which learning becomes easier and more effective and thus learners’ performances can be improved.

Conclusion

Disability comorbid delayed language development severely influences disabled children’s school learning. They need special support, especially in their LCS development. The current study thus aimed at creating a friendly and engaging learning environment in 3D virtual worlds for catering the special needs of disabled children’s LCS development. Because of the lack of literature relevant to HCI and learning environment design principles for achieving the abovementioned goal, a design-based qualitative approach was adopted in this study to identify the principles of designing a 3D virtual environment for disabled children’s LCS learning. After the two-cycle design-based intervention, a list of design principles was identified. Furthermore, the effects of carefully designed 3D virtual environments on disabled children’s LCS performances were also confirmed by the children and their parents. The results are positive and promising; nevertheless, only four children with three different kinds of disabilities participated in this study. In view of this limitation, the arguments made in this study should be further evaluated by investigating learning in similar contexts by children with other types of disabilities in the future. Furthermore, a larger scale of participants is also needed in future research to further corroborate the findings from this study.

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Appendix A

Interview questionnaire

Satisfaction:
1. During this semester, the teacher conducted teaching through a 3D virtual world. Do you like learning in this way? Why
☐ Very interested ☐ Somewhat interested ☐ Not very interested
☐ Not at all interested
2. During this semester, the teacher conducted teaching through a 3D virtual world. Do you find it interesting? Why?
☐ Very interested ☐ Somewhat interested ☐ Not very interested
☐ Not at all interested
8. Do you agree that your interest in learning is enhanced while learning in a 3D virtual world? Why?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
15. If time allows, would you agree learning in the 3D virtual contexts in the next semester? Why?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

Usefulness:
3. During this semester, the teacher conducted teaching through a 3D virtual world. Do you agree that it helps you learn? Why?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
4. During this semester, the teacher conducted teaching through a 3D virtual world. Do you agree that this way helps you concentrate more in classes? Why?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
5. During this semester, the teacher conducted teaching through 3D virtual contexts. Do you agree that your impression could be strengthened so you would not easily forget what you have learnt when learning in this way?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
6. During this semester, the teacher conducted teaching through a 3D virtual world. Do you think you have learnt many more names of objects and necessary vocabulary words? Why?
☐ Much more ☐ Slightly more ☐ Slightly less ☐ Much less
7. During this semester, the teacher conducted teaching through a 3D virtual world. Do you agree that you have learnt many more sentence structures? Why?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
12. Do you agree that the evaluation games in the 3D virtual contexts could help you clarify what you have learnt on that day? Why?
☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree
Ease of use:

13. Do you agree that it is easy to operate the system? Why? If not, what are the problems?
   □ ☑ Strongly agree  □ ☐ Agree  □ ☐ Disagree  □ ☐ Strongly disagree

14. Do you agree that the whole procedure of learning in the 3D virtual contexts was smooth without having to wait for long, without any screen freezes or any problems with the computers? If yes, what are they?
   □ ☑ Strongly agree  □ ☐ Agree  □ ☐ Disagree  □ ☐ Strongly disagree

Authenticity:

9. Do you agree that you have more confidence in talking to others and chatting with others as an avatar in the 3D virtual contexts? Why?
   □ ☑ Strongly agree  □ ☐ Agree  □ ☐ Disagree  □ ☐ Strongly disagree

10. Do you agree that your speaking skills have been improved while having conversations with other avatars in the 3D virtual contexts? Why?
    □ ☑ Strongly agree  □ ☐ Agree  □ ☐ Disagree  □ ☐ Strongly disagree

11. Do you agree that when exploring the 3D virtual contexts as an avatar, you feel as if you were inside the game setting? Why?
    □ ☑ Strongly agree  □ ☐ Agree  □ ☐ Disagree  □ ☐ Strongly disagree