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# Gamifying and Mobilising Social Enquiry-based Learning in Authentic Outdoor Environments

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**ABSTRACT**

There has been increasing discussion among educators and researchers about harnessing the idea of gamification to enhance the current learning and teaching practices in school education. Leveraging the context-aware mobile technology and student-centred learning theories, we have developed a mobile application, Gamified Authentic Mobile Enquiry in Society (GAMES), to support students in conducting authentic outdoor enquiry-based learning in social humanities education. This paper reports the quasi-experimental study in which we evaluated the learning effectiveness of GAMES in terms of supporting students' knowledge construction, in comparison with the conventional outdoor enquiry-based learning approach. It involved a total of 559 Grade-10 students from top, middle, and bottom academic-banding schools. Results indicated that, compared to the conventional approach, GAMES had different degrees of positive effects on the high, moderate, and low academic-achieving participants. This study not only provides grounds for a wider adoption of GAMES in social humanities education, but also makes a contribution to empirical evidence in the field by designing, implementing and evaluating gamified mobile learning in authentic outdoor contexts.

**Keywords**

Social enquiry-based learning, Gamified learning, Authentic outdoor mobile learning, Context-aware technology

## Introduction

There has been a persistent belief that learning in game-like contexts can promote students' motivation and engagement (Games & Squire, 2011; Gee, 2013; O'Feil, Wainess & Baker, 2005; Papert, 1993; Piaget, 1970; Prensky, 2016). By taking advantage of this humans' psychological predisposition, "gamification of learning" aims to integrate game mechanics and technologies into non-game learning environments to motivate and engage students in the pedagogic process (Burke, 2014; Kapp, 2012; Landers, 2014; Lee & Hammer, 2011). The recent K-12 edition of the New Media Consortium Horizon Report (Johnson, Adams Becker, Estrada & Freeman, 2016) forecasts that *gamified learning* will become a part of students' lives in schools in the coming decade.

Rather than being passive knowledge recipients in traditional schooling, the twenty-first century education encourages students to play the active, learner-centric role to construct new knowledge on their own (Howland, Jonassen & Marra, 2012). Enquiry-based learning (EBL) has been one of the student-centred instructional practices advocated in today's school education (Elder & Paul, 2009; Ho, 2012; Small, Arone, Stripling & Berger, 2012; Wallace & Husid, 2011). EBL requires students to construct knowledge self-directedly via recursive exploration and reflection in the learning process (Hwang, Chiu & Chen, 2015; Shih, Chuang & Hwang, 2010). While EBL can be applied in both *science education* and *social humanities education*, this paper focuses on the latter.

Traditional classrooms in schools are never a desirable venue for conducting EBL in social humanities education (Ip & Fok, 2010; Lim, 2004). To pursue meaningful explorative and reflective tasks in EBL, students are best to be situated in real-world, real-life contexts (Hill, 1994; Jansen, 2011; Small et al., 2012). Yet, the conventional type of outdoor fieldtrips is ineffective to engage and scaffold students in the course of EBL (Shih et al., 2010; Wake & Wasson, 2011; Zurita & Baloian, 2012; Jong, 2013, 2015b). While designing effective outside-the-classroom EBL activities remains a challenge in social humanities education (Johnson et al., 2016; Hwang et al., 2015), our work aims to address this pressing need.

Harnessing the context-aware mobile technology (in particular, the Global Positing System [GPS]) with the basis on student-centred learning theories, we have developed a mobile application, *Gamified Authentic Mobile Enquiry in Society (GAMES)*, to authentically support students in conducting outdoor EBL in social humanities education. This paper reports the quasi-experimental study (with a total of 559 Grade-10 students) in which we evaluated the learning effectiveness of GAMES. Specifically, the study focused on probing into the effects of GAMES on supporting different academic-achieving students' knowledge construction, in comparison with the conventional outdoor EBL approach.

We organise the rest of this paper as follows. The next section is a review of the related work. Then, the design and implementation of GAMES will be elaborated. After that, we will delineate the method, findings, implications, and limitations of the study. At the end of the paper, a conclusion of our observations in this study will be drawn.

## Related work

### Gamification and gamified learning

Video game-based learning or edutainment is about "the marriage of video games and education" (Prensky, 2016). Fun is always the best driving force for learning; "making learners feeling fun" by engaging them via gaming is a desirable motivating approach to education (Papert, 1993; Piaget, 1970). Video games (hereinafter referred to as games) are interactive activities with continuous challenges that engage players in an active learning process to master the rules and pursue the tasks therein (Koster, 2005). In fact, since the 1980s, there has been positive research evidence showing that harnessing games in the course of learning and teaching can effectively promote students' motivation for eventually achieving the intended educative goals (e.g., Adam, 1998; Chee, 2016; Cordova & Lepper, 1996; Dede, 2011; Erhel & Jamet, 2013; Jong, 2015a; Lan, 2015; Malone, 1981; Shaffer, 2007). Instead of the direct adoption of games, an alternative way to leverage the idea of gaming in education is *gamification*. This term was selected as a runner-up for the word of the year by Oxford Dictionaries in 2011 (Burke, 2014).

The conception of "gamification" was first introduced in 2010 and initially adopted in the marketing field (Landers, 2014; Simões, Redondo & Vilas, 2013). After that, its application has been extended to other fields, including education. In Deterding, Dixon, Khaled and Nacke's (2011) definition, "gamification is the use of game design elements and game mechanics in non-game contexts" (p. 9). In Kapp's (2012) definition, "[g]amification is the use of game-play mechanics for non-game applications (also known as 'funware'), particularly consumer-oriented web and mobile sites, in order to encourage people to adopt the application" (p. 10). In fact, so far there has been no consented definition of gamification; however, most of the definitions found in the literature do share similar features. Burke (2014) has given a concisely summarized elaboration on gamification — a strategy of using *game mechanics* and *experience design* to *digitally* engage people to achieve *intended goals* in non-game contexts. "Game mechanics" is about the core elements generically found in many games, e.g., points, badges, and leader boards. "Experience design" is about the experiential journey that engages players in a game, e.g., game play, play space, and story line. "Digitally" is about players' interactions with computers, smartphones, tablets, or other digital devices. "Intended goals" are the pre-set goals that the organiser (e.g., a person, an organization, a company, etc.) wants players to reach at the end of a gamified activity.

A common and key challenge faced by schools for years has still been around students' motivation in learning (Lee & Hammer, 2011). The initiative of gamification in education attempts to use game-like environments and game-play experiences to engage students in educational activities. Strategies of educational gamification are generally termed *gamified learning* (Kapp, 2012; Landers, 2014; Simões et al., 2013). Again, the field has yet to come up with a single, consented definition for gamified learning. In this paper, on top of Burke's (2014) elaboration on gamification, we adopt Dominguez's et al. (2014) definition of gamified learning — an approach to integrating the idea of gamification into the learning process to support students in attaining intended educative goals engagingly.

To gamify the course of learning, it is not just a matter of infusing how many game mechanics into a learning environment (Landers, 2014). The focus should be placed on the meaningful integration of the mechanics into experience design for sustaining students' continuous participation in the environment (Dominguez et al., 2013; Kapp, 2012). Lee and Hammer (2011) have proposed a design framework for developing gamified learning environments. This framework, which guides our present work, contains three vital components:

- The *cognitive* component. A gamified learning environment should contain a system of rules articulated to a series of learning tasks that lead students to master the rules. Each task (and the corresponding goal) can be further divided into a number of sub-tasks (and the corresponding sub-goals) to lower students' *cognitive* *load* (Sweller, Ayres & Kalyuga, 2011) in the learning process. In addition, to better support students in attaining all of the goals, it is desirable to offer them some non-linear flexibility to complete the tasks in accordance with their own ability and personal preference, without forcing them to follow a specific sequence.

- The *emotional* component. A gamified learning environment should be able to provide students with feelings of "success" and "failure" in the learning process. It is expected that students will have positive emotions when they have successfully accomplished a learning task. To stimulate their positive emotions, the reward system (underpinning to the environment) should offer them some sorts of immediate awards, such as points, badges, levelling-up the progress bar, unlocking the next task, etc. On the contrary, students will have some degree of anxiety when they have failed to accomplish a learning task. However, to avoid turning their anxiety into frustration, it is desirable to keep the stakes low and the penalty mild, so that they are still willing to actively participate in the learning environment.
- The *social* component. A gamified learning environment should possess learning tasks that facilitate social interactions among students. The interactions can be in the form of collaboration (e.g., working towards a common goal) and/ or competition (e.g., contending to perform better than others). Both collaborative and competitive interactions will provoke students' new "public" identities in the environment. These identities will bring them the new social credibility and recognition, which will have a beneficial impact on learning, such as enhancing student engagement in pursuing the tasks and initiating new approaches to their learning participation.

There has been research evidence showing that gamified learning can effectively strengthen students' learning motivation (similar to the findings in game-based learning research in general), but may not consequentially promote their learning performance (Attali & Arieli-Attali, 2015; Dominguez et al., 2014; Muntean, 2011; Simões et al., 2013). In fact, gamified learning should not solely be aimed at increasing students' willingness to participate in learning, but also providing them with a more supportive environment that favours a higher level of knowledge construction (Burke, 2014; Howland et al., 2012; Kapp, 2012). Pedagogic integration of learner-centric, constructivist learning theories into the design of gamified learning for promoting deep learning is an important area that needs more research effort (Landers, 2014; Lee & Hammer, 2011).

**Enquiry-based learning (EBL)**

Knowledge in all disciplines is continuously expanding (Chee, 2016; Gee, 2013; Howland et al., 2012). Therefore, equipping today's youngsters with the ability to become "knowledge builders" and "life-long learners" is far more vital than to master the contents in textbooks. EBL (also named "inquiry-based learning" in the literature) emphasises the development of students' skills of and dispositions to knowledge construction and life-long learning (Wallace & Husid, 2011). Both the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the Organisation for Economic Co-operation and Development (OECD) have regarded EBL as one of the important instructional approaches to facilitating meaningful student-centred learning in school education (Ho, 2012).

In Wallace and Husid's (2011) definition, EBL is the process of "seeking knowledge, raising questions, searching for answers, evaluating information, and asking new questions based on new understandings" (p. 21). In Small's et al. (2012) definition, EBL is a process that "involves connecting to personal interests and a desire to know, gaining background knowledge, asking questions that probe beyond simple fact gathering, investigating answers to gather evidence from multiple perspectives and sources, constructing new understandings and drawing conclusions with support from evidence" (p. 3). In fact, there had been no standard definition of EBL among educators and researchers. Nevertheless, most of EBL strategies in the literature (e.g., Chadwick, 2008; Eisenberg, Berkowitz & Johnson, 2010; de Jong, 2016; Jansen, 2011; Stripling, 2003; Stripling, 2008) do share common pedagogic aims and involve similar enquiry actions, such as raising questions, searching for knowledge and information to answer the questions, and asking new questions based on continuous reflection (Elder & Paul, 2009).

The application of EBL can be found in both science education (e.g., de Jong, 2006; Ucar & Trundle, 2011) and social humanities education (e.g., Hwang et al., 2015; Lim, 2004; Shih et al., 2010). Different from scientific EBL that focuses on probing into the physical truths on the "natural" earth, social EBL emphasizes looking into humans and their relationships with the "societal" world from multiple perspectives, values and interests (Hill, 1994; Jansen, 2011; Small et al., 2012). In social humanities education, EBL usually pivots on a *societal issu*e which is of real-life, open-ended, complex, changing, and/ or controversial nature (Chadwick, 2008; Small et al., 2012), e.g., "to what extent are traditional customs compatible with modern society." Inspired by Dewey's

(1958) theories of *learning through experience*, Vygotsky's (1978) *zone of proximal development*, as well as Bruner's (1986) *interpretation in learning*, Stripling (2003; 2008) has proposed a model with specific explorative and reflective actions that shape the course of EBL. The actions, which guide our present work, are:

- *Connection*—to get an overview of the issue via acquiring the related background information, as well as articulating the information to one's prior knowledge;
- *Investigation*—to probe into the issue via searching for and evaluating new information to answer the questions related to the issue, as well as illuminating new questions (if any);
- *Construction*—to develop new understandings of the issue via articulating the information on hand to one's prior knowledge, as well as drawing conclusions grounded with evidence;
- *Reflection*—to reflect on one's learning via identifying the strengths and weaknesses of the enquiry process, as well as setting goals for improvement.

EBL in social humanities education works best when learners can engage in the authentic real-world contexts to have first-hand interactions with people and contexts (Chadwick, 2008; Eisenberg et al., 2010; Wallace & Husid, 2011). Thus, traditional classrooms in schools are never the most suitable place for EBL to take place (Hill, 1994; Ip & Fok, 2010; Jansen, 2011; Li & Lim, 2008). Even the conventional form of fieldtrip activities in outdoor environments organised and led by teachers is not effective enough to motivate and support students' knowledge construction in EBL (Jong, 2013; Jong, 2015b; Shih et al., 2010; Wake & Wasson, 2011; Zurita & Baloian, 2012). In fact, how to design effective outside-the-classroom EBL activities has yet to be explored in social humanities education (Hwang et al., 2015). Our work aims to address this challenge.

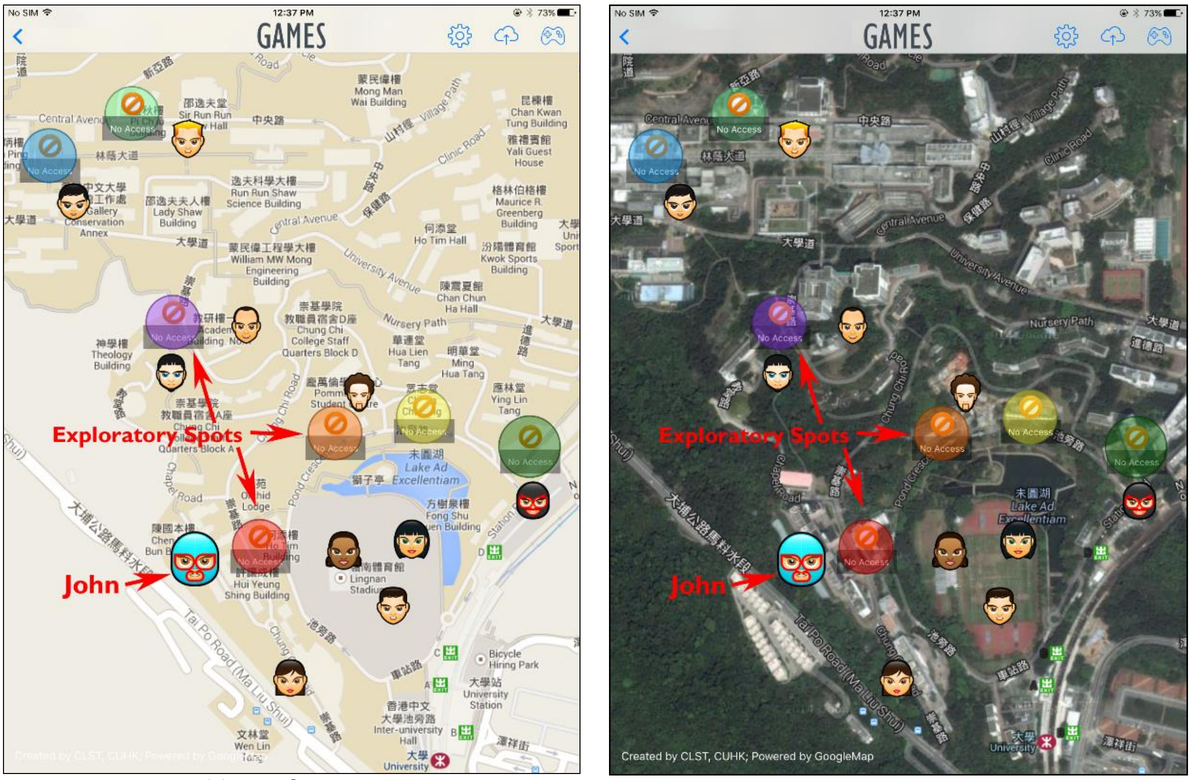
Fieldtrip learning has been considerably adopted in ecology, geography and cultural education (Bell, Lewenstein, Shouse & Feder, 2009; Eshach, 2007; Nadelson & Richard Jordan, 2012). Conventionally, before the fieldtrip, the teacher designs a set of paper-based worksheets which aim to support students in exploring the outdoor site. The worksheets usually provide "exploratory hints" in the form of short text-based guiding questions. During the fieldtrip, students will respond to the questions with written text. However, in the qualitative study with in-depth interviews with secondary students and teachers, we have found the following common and prominent problems in conventional fieldtrip learning (Jong, 2013, 2015b):

- *Teacher-oriented learning.* The student-to-teacher ratio of a class is large (e.g., 30:1 in Hong Kong in general). Usually, in the fieldtrip, the teacher brings the whole class to each exploratory spot one by one, without allowing students to plan and adjust their own exploratory route. Also, the teacher controls the time to be spent at each spot. This largely violates the core learner-centric proposition in fieldtrip learning (Nadelson & Richard Jordan, 2012).
- *Low learning motivation.* Often, students' motivation will gradually decrease during the fieldtrip because they are not allowed to control the time spent at each exploratory spot in accordance with their own learning pace and interest. Besides, whenever a class of 30 students crowd in a spot, it is too difficult for everyone to thoroughly explore the context and closely interact with the locals (Eshach, 2007).
- *Non-engaging learning scaffolds.* The paper-based worksheets and the text-based guiding questions are the primary learning support to students during the fieldtrip. Usually, the questions are presented in a boring fashion and can only be responded with text. This paper-and-pencil approach cannot attract today's youngsters who are "digital natives." They are eager to have technological tools for supporting their learning process (Prensky, 2016).
- *Lack of peer-interactions.* In the fieldtrip, students are often suggested to work in groups to conduct the exploration together. However, in reality, they are more concerned about whether they can complete the questions on the worksheets by the end of the fieldtrip. Instead of interacting much with others, they spend a lot of time copying the factual information observed at each spot onto their worksheets. This kind of rote effort, however, does not contribute to meaningful learning (Howland et al., 2012).

## Gamified Authentic Mobile Enquiry in Society (GAMES)

Adopting Stripling's (2003, 2008) EBL model, as well as Lee and Hammer's (2011) gamified learning framework, through the EduVenture® Composer (a cloud-based authoring system, see http://ev-cuhk.net) (Jong & Tsai, 2016), we have developed *GAMES* — a tablet-based GPS-supported mobile application (viz., an App) to gamify and mobilise social EBL in authentic outdoor environments. With GAMES, during the course of enquiry, students can plan their own route and control the time to be spent at each exploratory spot according to their own ability and interest, without largely relying on their teachers.

GAMES uses a two-tier interface approach to presenting the digital material that supports students in probing into a specific societal issue in an outdoor environment (Jong & Tsai, 2016). The first-tier interface is an *electronic map* of the fieldtrip site (see Figure 1). Students can select either the graphic view (Figure 1a) or the satellite view (Figure 1b) based on their own preference. An *avatar* on the map is used to indicate the authentic geographical position of each student at the site (see the avatar of a student, John, in Figure 1). Based on the GPS information continuously received by the tablet, John's avatar on the screen will move in accordance with his physical movement in the fieldtrip. He can also see the movements of other avatars that denote his classmates in a real-time manner. A number of exploratory spots (with each embedded with a specific enquiry task) are pre-marked on the map (see the "stop signs" in Figure 1). The task at each spot has yet to be accessible until John physically arrives at the corresponding geo-location at the site.




(a) Graphic view (b) Satellite view

*Figure 1*. First-tier interface of GAMES

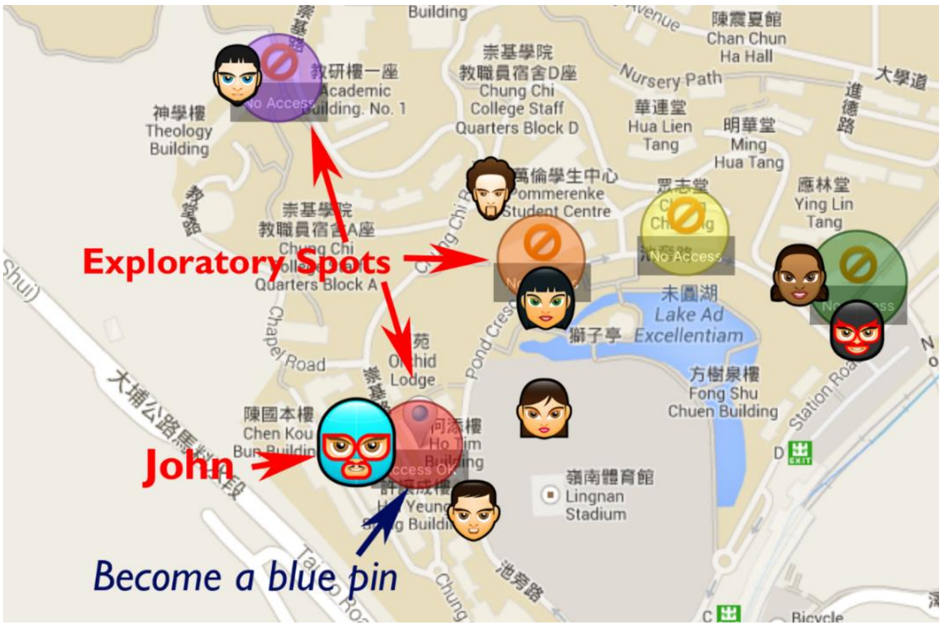
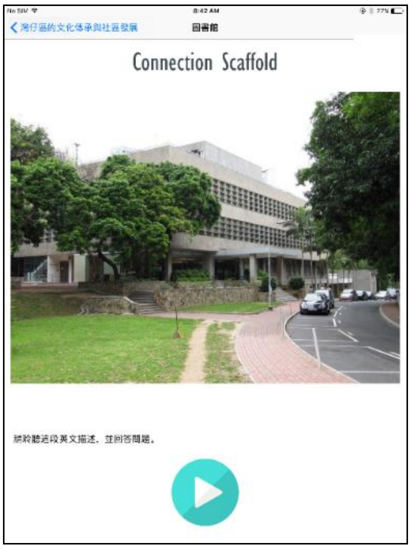
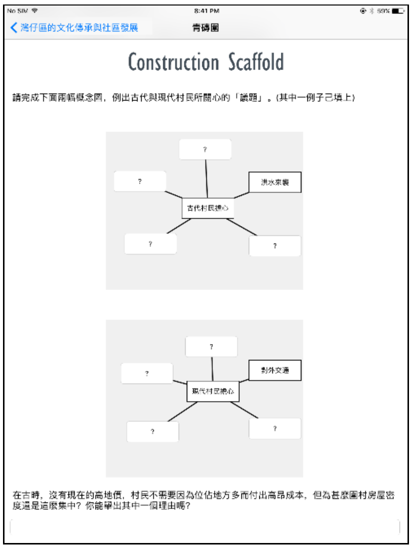



*Figure 2*. Checking-in an exploratory spot and unlocking the task therein

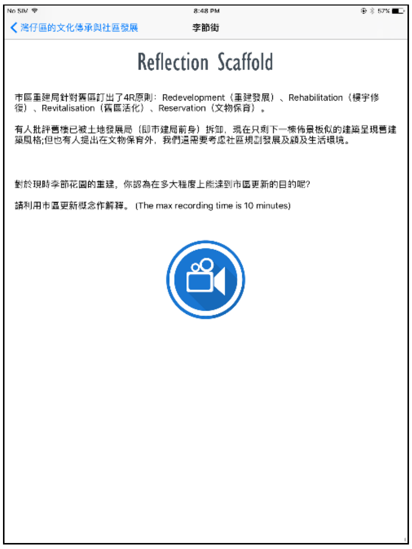



*(a) Connection scaffold: Voice navigation*


*(b) Investigation scaffold: Context capturing*




*(c) Construction scaffold: Mind mapping*




*(d) Reflection scaffold: Video blogging*

*Figure 3.* Second-tier interface of GAMES

A location which is selected as an exploratory spot in GAMES should possess (i) high contextual relatedness to the society issue, and (ii) high affordance for embedding the four enquiry sub-tasks (i.e., Connection, Investigation, Construction and Reflection) framed by Stripling's (2003, 2008) EBL model. Let us continue to use John as an example to illustrate how GAMES supports a student in outdoor EBL. After John has checked in the spot, the task will be unlocked and the "stop sign" on the screen will become a "blue pin" (see Figure 2). Then, by tapping on the pin, he can enter the second-tier interface (see Figure 3) to access the task which is composed of four sub-tasks (viz. *digital scaffolds*):

- The Connection sub-task/ scaffold, which is in the form of voice navigation, equips John with the background information about the issue and relate his prior knowledge to the information. Figure 3a shows a voice-navigation Connection scaffold.
- The Investigation sub-task/ scaffold, which is in the form of data-collection exercise (e.g., context capturing via photo-taking and video-recording gadgets, environmental surveys, as well as audio-recording interviews with the locals), guides John to gather new information to answer the questions related to the issue. Figure 3b shows a context-capturing Investigation scaffold.
- The Construction sub-task/ scaffold requires John to work with two to three neighbourhood classmates currently at the spot to discuss and generalise the information that they have individually gathered in the Investigation sub-task via mind mapping, as well as proposing an interim conclusion about the issue with the evidence on hand via audio recording. Figure 3c shows a mind-mapping Construction scaffold.

- The Reflection sub-task/ scaffold assists John, via video blogging, in reflecting on his weaknesses when exploring this spot (e.g., too shy to interview the locals) and the limitations of the interim conclusion, as well as setting new goals for exploring the next spot. Figure 3d shows a video-blogging Reflection scaffold.

After John has completed all the four sub-tasks at an exploratory spot, he will be immediately awarded a "star" on his *progress bar* (see Figure 4). On the other hand, if he leaves a spot without completing all the sub-tasks therein, the App will vibrate to alert and request him to revisit the spot for finishing the missed sub-task(s). A *leader board* in the App will dynamically indicate how many stars each classmate has obtained and how much time he/ she has spent on obtaining the stars in a real-time manner. Figure 5 captures the upper part of the leaderboard showing that John is currently on the top because so far he has got the largest number of stars with the shortest time. Table 1 summarizes the game mechanics and experience design that are integrated into GAMES to support the course of outdoor EBL in accordance with Lee and Hammer's (2011) gamified learning framework in the cognitive, emotional and social aspects.

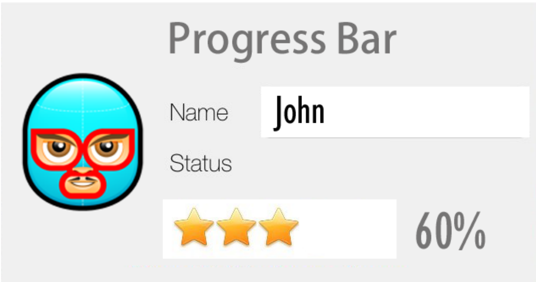



*Figure 4.* Progress bar in GAMES

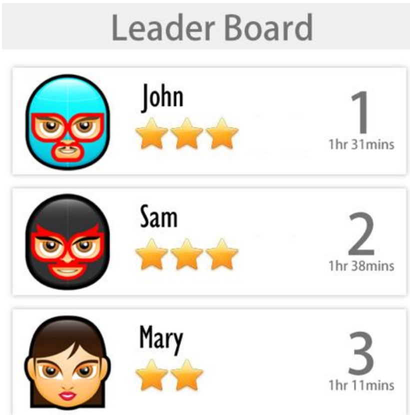



*Figure 5.* Leader board in GAMES

*Table 1.* Game mechanics and experience design in GAMES

| Aspect of gamified learning (Lee & Hammer, 2011) | Game mechanics and experience design integrated into GAMES |
|---|---|
| Cognitive | • According to his own preference, John can flexibly plan his enquiry route and control his time to be spent at each exploratory spot according to his ability and interest, without being "forced" to follow a specific sequence.<br>• The exploratory task (goal) at each spot is divided into sub-tasks (sub-goals) to lower John's cognitive load in the learning process.<br>• The design of the sub-tasks is ruled by Stripling's (2003, 2008) EBL model; in other words, the rules of Connection, Investigation, Construction, and Reflection guide John to probe into every spot to attain the corresponding goal. |
| Emotional | • When John successfully locates an exploratory spot (via his physical movement at the fieldtrip site), he can unlock the exploratory task therein.<br>• A "star" (visible achievement) will be immediately awarded to John and shown on his progress bar once he has successfully completed all the sub-tasks at a spot.<br>• If John has failed to complete all the sub-tasks before leaving a spot, apart from not being awarded a star, he will be alerted and requested to go back to |

| | |
|---|---|
| | the spot to finish the uncompleted sub-task(s). This low-stakes penalty aims to maintain John's willingness to go on participating in the fieldtrip. |
| Social | • To eventually get a star after visiting an exploratory spot, when conducting the Construction sub-task, John has to work collaboratively with his classmates to discuss and generalise the collected information to give an interim conclusion about the issue with evidence.<br>• During the fieldtrip, John is competing for an upper position on the leaderboard against other classmates, based on how many stars that he has obtained and how much time he has spent so far to get the stars.<br>• Both collaborative and competitive interactions provoked in the learning process stimulate John to develop a new "public" identity in the learning context and make him more engaged in the fieldtrip. |

## Research design

We employed a quantitative approach to answering the research question of this study: "Can the adoption of GAMES promote different academic-achieving students' knowledge construction in social humanities education, in comparison with the conventional outdoor EBL approach?" The collection of qualitative data was to serve the purpose of supplementing the quantitative findings.

### Liberal Studies (LS)

Liberal Studies (LS) is a "young" core subject of social humanities education in the new senior secondary education system (i.e., Grade-10 to Grade-12) under the recent education reform in Hong Kong (Education Bureau, 2014). The Hong Kong Diploma of Secondary Education Examination (HKDSE), which is a high-stakes public examination, has started to include LS as an examination subject since 2012 (Curriculum Development Council, 2014). The core curricular aim of LS is to develop students' knowledge and multiple perspectives on various societal issues in cultural, social, economic, political and technological contexts.

The curriculum of LS is composed of a number of thematic areas. Each area consists of different enquiry modules, and every module consists of a number of societal issues. For example, the issue involved in this study, "to what extent are traditional customs compatible with modern society?" is under the "Culture and Modern Life" module which belongs to the "Society and the Environment" area. Stripling's (2003, 2008) EBL model is one of the popular instructional practices adopted by the LS teachers in Hong Kong.

### Participating schools, teachers and students

Secondary schools in Hong Kong are categorised into three academic bands based on the overall academic performance of their students in attaining the learning objectives of the formal school curriculum; Band A, Band B, and Band C are respectively the top, middle, and bottom bands. We selected three schools at each academic banding among our research partners to take part in this study (i.e., 9 schools in total; 3 Band-A schools, 3 Band-B schools, and 3 Band-C schools). The following were the selection criteria:

- Each school should provide two Grade-10 classes to participate in the study.
- There is no significant difference ($p > .05$) between the LS examination mean scores of these two classes in the previous semester.
- The classes have yet to learn the "Culture and Modern Life" module.
- The classes have experience in participating in conventional outdoor fieldtrips (with paper-based worksheets) framed by Stripling's (2003; 2008) EBL model in the previous semester.
- The LS teachers among the selected schools have comparable academic background and years of experience in facilitating conventional outdoor fieldtrips (with paper-based worksheets) framed by Stripling's (2003, 2008) EBL model.

The nine teachers respectively from the nine selected schools each possessed a master degree and around five years of the related outdoor EBL facilitation experience. Among the nine schools, a total of 559 students participated in the study; 192 were high-achieving students (from the Band-A schools), 190 were moderate-achieving students (from the Band-B schools), and 177 were low-achieving students (from the Band-C schools).

Their average age was 16.35. In each school, one class was assigned to the experimental group, and another class was assigned to the control group. Table 2 shows the distribution of different academic-achieving students in the experimental and control groups.

*Table 2.* Distribution of different academic-achieving students in the experimental and control groups

| | High-achieving students *n* = 192 | Moderate-achieving students *n* = 190 | Low-achieving students *n* = 177 |
|---|---|---|---|
| Control groups | 95 | 95 | 88 |
| Experimental groups | 97 | 95 | 89 |

**Experimental procedure and data collection**

The quasi-experiment of this study involved enquiring into the societal issue, "to what extent are traditional customs compatible with modern society." The experimental manipulation was outdoor EBL with GAMES, while the control manipulation was outdoor EBL with paper-based worksheets (i.e., the conventional approach). For writing convenience, we use G-EBL and P-EBL to denote the experimental manipulation and the control manipulation respectively.

Six months before the experiment, we started designing for the fieldtrip and the supporting materials for both G-EBL and P-EBL. The preparation included determining the fieldtrip site, exploratory spots and duration, as well as developing the contents to be used in GAMES for G-EBL and the worksheets for P-EBL. The design of the contents for both manipulations was based on Stripling's (2003; 2008) EBL model. Each contained the same number of exploratory spots, and the task at each spot was composed of the same sub-tasks of Connection, Investigation, Construction, and Reflection (learning scaffolds). The main difference was that the content of GAMES was in a gamified manner and G-EBL students responded to the learning scaffolds digitally (as described previously in the "GAMES" section), while the content of the worksheets was in a conventional text-based manner and P-EBL students responded to the learning scaffolds with written text.

Four months before the experiment, we set up a review committee to evaluate the materials developed for G-EBL and P-EBL to ensure that they aligned with the curricular aim of the "Culture and Modern Life" module and were of comparable quality. The committee was composed of two education professors respectively from two other institutions, six LS teachers respectively from six non-participating schools (2 at Band A, 2 at Band B, and at 2 at Band C), and one government curriculum officer. Two months before the experiment, we explained to each of the nine teachers the research details, as well as familiarising him/ her with the pedagogic idea of G-EBL and the technical operation of GAMES.

The same experiment was separately carried out in each participating school. The size of each group (experimental/ control) ranged from 29 to 33. The same teacher in each school facilitated both the experimental manipulation (G-EBL) and control manipulation (P-EBL). The manipulation and the corresponding data collection work conducted in each group were completed within three consecutive days, involving the following procedures:

- *Day 1: Briefing*. One day before the fieldtrip, the teacher conducted a 35-minute briefing session to tell each group about the arrangement of the fieldtrip, such as the location, transportation, duration, assembling/ dismissing points, safety issues, and how to use the fieldtrip material (GAMES/ worksheets).
- *Day 2: Fieldtrip*. The fieldtrip involved five hours in total. Without the teacher's intervention, the experimental group conduced G-EBL with the digital supporting material (with GAMES). Led by the teacher in a conventional manner (as aforementioned in the "Related work" section), the control group conducted P-EBL with the paper-based supporting material (with the worksheets).
- *Day 3 morning: Knowledge test*. One day after the fieldtrip, we administered an unseen knowledge test (one hour) to each group. The test was in Chinese and in the typical format of the LS public examination in Hong Kong. It consisted of three open-ended questions which were customised from the recent five-year public examination questions related to the societal issue used in this study. The perfect score of the test was 45 (15 marks for each question). The validity of the test and marking scheme were scrutinised by the review committee (as aforementioned in the previous sub-section). All completed test papers were individually marked by three trained markers who were postgraduate education students majoring in LS in the first author's university. The marking was done anonymously, i.e., the school and group information on the test papers were removed before they were passed to the markers. The first author was responsible for reconciling and discerning the discrepancies among the markers' work.

- *Day 3 afternoon: Interview*. Right after the test, we randomly selected two students (one male and one female) from the experimental group for a group interview (45 minutes). We aimed to gain more understanding about how they perceived G-EBL. The interview was audio-recorded, and conducted in Chinese (the mother tongue of the students) and in semi-structured format. The guiding question was "How is your learning experience with GAMES, in comparison with your past fieldtrip learning experience?." We transcribed the interview clips and adopted Maxwell's (2013) four-phase qualitative analysis approach (coding, categorizing, memoing, and contextualizing) to analyzing the interview transcript and complement the knowledge test results.

## Results

We received a total of 542 completed knowledge test papers from the nine schools (return rate = 96.96); 185 were completed by the high-achieving students, 182 by the moderate-achieving students, and 175 by the low-achieving students. The findings regarding different kinds of academic-achieving students are presented in the following sub-sections.

### High-achieving students

Table 3 shows the descriptive statistics of the test scores obtained respectively from the experimental and control groups in the Band-A schools. An independent samples *t*-test on the scores indicated that the experimental-group students' average score (35.55) was significantly different from the control-group students' (32.81), $t(183) = 1.88$ $p < .05$). The Cohen's *d* was 0.28. In other words, the learning effect of G-EBL on supporting the high-achieving students' knowledge construction was stronger than P-EBL's, but the effect size was small (Cohen, 1998). We further conducted an independent samples *t*-test to assess if the gender factor (male students vs female students) had an influence on the test results obtained from the experimental group. The analyses indicated that there was no significant difference ($p > .05$).

*Table 3.* High-achieving students' knowledge test results

| | Experimental groups (*n* = 92) | Control groups (*n* = 93) |
|---|---|---|
| Average | 35.55 | 32.81 |
| Standard deviation | 10.03 | 9.86 |

When we interviewed the experimental-group students, they shared their desirable learning experience with GAMES, in comparison with the conventional outdoor EBL approach that they had experienced before. The following are some translated interview excerpts:

- *Aaron (pseudonym):* In the conventional fieldtrip, we used to write a lot on the worksheets …… without a proper table, I cannot write properly … it is also time-consuming … but yesterday, with the App, I could use photos, audios and videos to document most of my observations during the exploratory process.
- *Amy (pseudonym):* The approaches to checking-in the exploratory spots and unlocking the enquiry tasks were quite novel to me. It was like playing a treasure hunt game … it is much funnier than what we used to do in the conventional fieldtrip … I felt happy whenever I successfully located a spot at the fieldtrip site.
- *Andrew (pseudonym):* In the conventional fieldtrip, the guidance on the worksheets is largely text-based … I found the voice navigation function of the App very useful …… I could listen to the guidance while making the observation accordingly.
- *Andy (pseudonym):* Undoubtedly, I did not want to be at the bottom position (on the leader board), haha … otherwise, I would be so ashamed … Yes, it was more interesting than the conventional fieldtrip …… and the competitive atmosphere did make me more engaged in the learning process.
- *Angel (pseudonym):* Unlike the conventional fieldtrip, you will never miss any sub-tasks when using this intelligent App. It will alert and request you to finish the sub-tasks even though you have left the spot … in fact, this function did help me twice during the fieldtrip yesterday … thanks for the App.
- *Ann (pseudonym):* Yesterday, I could decide my own exploratory route during the fieldtrip. It made the whole learning process more self-directed … Also, the collaboration in the Construction sub-task at each spot provided me with more insights into the societal issue from multiple angles. This never happens in the conventional fieldtrip. I hope my teacher can give us more chances to use this App to conduct outdoor learning in LS in the future.

**Moderate-achieving students**

Table 4 shows the descriptive statistics of the test scores obtained respectively from the experimental and control groups in the Band-B schools. An independent samples *t*-test on the scores indicated that the experimental-group students' average score (29.86) was significantly different from the control-group students' (22.65), $t(180) = 4.61$, $p < .001$). The Cohen's *d* was 0.69. In other words, the learning effect of G-EBL on supporting the moderate-achieving students' knowledge construction was stronger than P-EBL's. The effect size was medium to large (Cohen, 1998). We further conducted an independent samples *t*-test to assess if the gender factor (male students vs female students) had an influence on the test results obtained from the experimental group. The analyses indicated that there was no significant difference ($p > .05$).

*Table 4.* Moderate-achieving students' knowledge test results

| | Experimental groups ($n$ = 92) | Control groups ($n$ = 90) |
|---|---|---|
| Average | 29.84 | 22.65 |
| Standard deviation | 10.12 | 10.64 |

When we interviewed the experimental-group students, they elaborated that they were more engaged in the course of learning with GAMES, in comparison with the conventional outdoor EBL approach that they had experienced before. The following are some translated interview excerpts:

- *Ben (pseudonym):* It was so convenient to learn with this App … I could quickly gather the information that I observed during the fieldtrip through photo taking and audio recording. In the conventional fieldtrip, I can only use text to document my observations … it is not an effective approach as sometimes it is very hard to record all details in words …… fortunately, the App alerted me to revisit the spot … I had overlooked a sub-task at that spot … I got back the star at that spot finally, haha.
- *Bethany (pseudonym):* Yesterday, it was really like playing a game … in the activity, I wanted to get all stars and obtain the No. 1 position on the leader board …… it was not just about competition, but also collaboration. I did work together with the classmates when doing the Construction sub-task at each spot. The competitive and collaborative atmosphere made me very engaged in the whole learning process.
- *Betty (pseudonym):* The process of finding out the exploratory spots in the activity was so interesting, like Facebook™ check-in …… I never have this sense of success when participating in the conventional fieldtrip. It was also funny to see other classmates (the avatars) who took different exploratory routes moving on the App.
- *Billy (pseudonym):* I deem that doing reflection via video blogging is a very efficient way, especially when we are learning outside the classroom. In fact, using text to document the reflection in the conventional fieldtrip is very time consuming and inconvenient …… I prefer doing more explorative work rather than writing during a fieldtrip.
- *Bobby (pseudonym):* The App provided us with both collaborative and competitive tasks. Yesterday, on the one hand, we had to work together at each spot to co-construct the mind map. On the other hand, we were contending for the upper positions on the leader board. Both collaborative and competitive atmospheres made the whole learning process very engaging … especially the competition element which will never be found in the conventional fieldtrip.
- *Brenda (pseudonym):* The App allowed me to decide my exploratory route and time spent at each spot, without relying much on the teacher ……. Different from the conventional fieldtrip, yesterday the whole class did not crowd into a spot simultaneously. Therefore, we had more room to enquire about the context of every spot and interact with the local people around.

**Low-achieving students**

Table 5 shows the descriptive statistics of the test scores obtained respectively from the experimental and control groups in the Band-C schools. An independent samples *t*-test on the scores indicated that the experimental-group students' average score (20.07) was significantly different from the control-group students' (12.95), $t(173) = 6.33$, $p < .001$). The Cohen's *d* was 0.81. In other words, the learning effect of G-EBL on supporting the low-achieving students' knowledge construction was stronger than P-EBL's. The effect size was large (Cohen, 1998). We further conducted an independent samples *t*-test to assess if the gender factor (male students vs female students) had an influence on the test results obtained from the experimental group. The analyses indicated that there was no significant difference ($p > .05$).

*Table 5*. Low-achieving students' knowledge test results

| | Experimental groups ($n$ = 89) | Control groups ($n$ = 86) |
|---|---|---|
| Average | 20.07 | 12.95 |
| Standard deviation | 9.11 | 8.52 |

When we interviewed the experimental-group students, they expressed that GAMES made the whole learning process more supportive and exciting, in comparison with the conventional outdoor EBL approach that they had experienced before. The following are some translated interview excerpts:

- *Calvin (pseudonym):* Unlike the conventional fieldtrip, this time I could audio-record the contents of the interviews with the locals. It helped me a lot because I am an absent-minded person. I will easily forget what interviewees said. Yesterday I could audio-record the content first and re-play the sound bites again when needed, such as when conducting the Construction sub-task and Reflection sub-task at each spot.
- *Chloe (pseudonym):* I like gaming … The yesterday activity was very much like a game. Everyone was like a player … I was so happy that I could decide my own exploratory route … I had never been so engaged in participating in a learning activity … but yesterday I completed all the learning tasks. After finishing all the sub-tasks at a spot, I was looking forward to accessing the next one …… Since I did not know what I would do at the next spot, it made the whole learning process very exciting.
- *Christine (pseudonym):* I hate to participate in the conventional fieldtrip because the tasks are usually very boring. However, yesterday I was quite engaged ……. I didn't miss any tasks as the App would always alert me if I missed anything …. I felt energetic when I was awarded a star after completing the task at a spot.
- *Colin (pseudonym):* I hate writing, so I love this App so much …… I can speak a lot in front of a camera. However, if you ask me to express all the things with text, I don't think I am able to do it. So, I don't like the conventional fieldtrip. This App is an excellent tool for students, like me, who are not good at writing, haha.
- *Connie (pseudonym):* The real-time updating feature of the leader board made the learning process very exciting. Although I was not very enthused about winning the No. 1 position, I did not want to be positioned at the bottom, haha …… I also made use of the information on the board to evaluate my on-going progress by comparing with other classmates'.
- *Conrad (pseudonym):* I am a super gamer, and I always win in video gaming, haha. That's why I was so into this activity … I wanted to get the No. 1 position on the leader board. See, yesterday I did it, haha … I collaborated with my classmates to conduct the Construction sub-task at each spot seriously. Without using this App, I think I wouldn't have this enthusiasm.

## Discussion

In this study, the learning scaffolds in the experimental and control manipulations were both framed by Stripling's (2003; 2008) EBL model. The main difference was that the learning process of the experimental manipulation (G-EBL) was further modelled by Lee and Hammer's (2011) gamified learning framework. The experimental-group students interacted with the learning scaffolds digitally with GAMES (c.f., the paper-based worksheets used in P-EBL). According to the knowledge test results, in comparison with the conventional approach, the G-EBL had desirable learning effects on the high-, moderate- and low-achieving participants, respectively with small, medium-to-large and large effect sizes. In the interviews with the experimental-group participants, no matter which academic banding they were from, they regarded that GAMES provided them with more engaging EBL experience, in comparison with the conventional fieldtrips that they had experienced before. The findings can be further elaborated from the cognitive, emotional and social perspectives in accordance with Lee and Hammer's framework.

From the cognitive perspective, without being forced to follow a specific sequence of visiting the exploratory spots at the fieldtrip site, the students in G-EBL could set up their own self-planned enquiry journey according to their own ability and interest (e.g., see the interview excerpts of Ann, Brenda and Chloe). It mitigated the problems of "teacher-oriented learning" and "low learning motivation" in P-EBL (Jong, 2013; Jong, 2015b). Moreover, like players mastering "game rules" in gaming, the students in G-EBL were engaged in pursuing the exploratory tasks which were ruled by Stripling's (2003; 2008) EBL model. The task at each spot presented in GAMES was further divided into the sub-tasks of Connection, Investigation, Construction, and Reflection. The digital gadgets (e.g., voice navigation, context capturing, video blogging) in GAMES also assisted them in conducting the sub-tasks more efficiently and effectively (e.g., see the interview excerpts of Aaron, Andrew, Ben, Billy, Calvin and Colin). All these "germane supports" (Sweller et al., 2011) reduced the students' cognitive load in the knowledge construction process, tackling the problem of "non-engaging learning scaffolds" in P-EBL (Jong, 2013; Jong, 2015b).

From the emotional perspective, the students in G-EBL perceived both positive and negative emotions similar to what players experience in gaming. They had a feeling of success when they located an exploratory spot with GAMES at the fieldtrip site and unlocked the exploratory task therein, as well as getting a star immediately after completing all the sub-tasks at the spot (e.g., see the interview excerpts of Amy, Bethany, Betty, Chloe and Christine). On the other hand, they had a feeling of failure when GAMES alerted and requested them to revisit the spot to complete the unfinished sub-task(s). Although failure will usually induce frustration that obstructs learners' continuous participation (Koster, 2005), the low-stakes penalty (revisiting alerts and requests) used in GAMES was able to keep the failed students in the "flow" state (Csikszentmihalyi, 2008) to go on their learning with enthusiasm (e.g., see the interview excerpts of Angel, Ben and Christine). As evidenced, GAMES provided the students with a more engaging knowledge construction environment, alleviating the problems of "low learning motivation" and "non-engaging learning scaffolds" in P-EBL (Jong, 2013; Jong, 2015b).

From the social perspective, the students in G-EBL were highly motivated to interact with one another both collaboratively and competitively. To obtain a star at each exploratory spot, they had to work toward the common goal of accomplishing the Construction sub-task (e.g., see the interview excerpts of Ann, Bethany, Bobby and Conrad). On the other hand, the students were also enthused to contend for the upper positions on the leader board in GAMES (e.g., see the interview excerpts of Andy, Bethany, Bobby, Connie and Conrad). It moderated the problem of "lack of peer interactions" in P-EBL (Jong, 2013; Jong, 2015b). Like gaming, both the collaborative and competitive interactions stimulated the students to build up new "social identities" (Lave & Wenger, 1991) during the fieldtrip. The credibility and recognition brought by the identities increased their willingness to devote their effort to construct new knowledge in the learning process (Scardamalia & Bereiter, 2006).

A possible limitation of this study might be the *Hawthorne effect* (McBride, 2015) on the experimental-group participants. Can the positive learning effects of G-BEL on these participants last? There is a need for further studying the substantiality/ change of the effects when they learn with GAMES again to enquire into different societal issues in other curricular modules. In addition, regarding the small effect size obtained in the top academic-achieving schools (though the experimental groups significantly outperformed the control groups), it might be owing to the *ceiling effect* (Cramer & Howitt, 2004). High-achieving learners generally have stronger cognitive ability and do well under conventional pedagogic practices in schools (e.g., P-EBL) (Biggs & Moore, 1993). Nevertheless, at this stage, we will not simply draw a quick conclusion that G-EBL is relatively less effective for academically-top learners. Instead, supported by the positive feedback gathered from the high-achieving students in the present research, we will further investigate whether GAMES can better empower academically-top learners when they explore more complex societal issues identified in the meta-studies on the LS curriculum (Fung, Tang & Chan, 2011; Ip & Fok, 2010), i.e., to moderate the ceiling effect by adjusting the cognitive load (Sweller et al., 2011) in the enquiry process.

## Conclusion

In this paper, we have presented our educational gamification initiative that aims to gamify and mobilise an instructional practice, outdoor EBL, in the context of social humanities education. We have also reported and discussed the quasi-experimental study for evaluating the learning effectiveness of the initiative in secondary schools. Prior research has shown that gamified learning can generally promote students' learning motivation, but not consequentially enhance students' learning performance. However, this study offers new evidence for showing that well-designed pedagogic gamification can not only promote learners' motivation but also significantly enhance their knowledge construction performance. It provides the field with grounds for further investigating a wider adoption of gamified learning in school education, making a contribution to designing, implementing and evaluating gamified mobile learning in authentic outdoor environments. Moreover, as aforesaid, LS is a "young" core social humanities subject in Hong Kong. Many teachers are still exploring the effective approaches to learning and teaching of this subject. The statutory curriculum document emphasises the importance of giving students the authentic outdoor learning opportunities to interact with the society. Our work offers local teachers, teacher educators, and education policymakers a practical reference for supporting outside-the-classroom learning and teaching activities in LS.

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## References

Adams, P. C. (1998). Teaching and learning with SimCity 2000. *Journal of Geography, 97*(2), 47–55.

Attali, Y., & Arieli-Attali, M. (2015). Gamification in assessment: Do points affect test performance? *Computers & Education, 83*, 57–63.

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (Eds.). (2009). *Learning science in informal environments: People, places, and pursuits*. Washington, DC: National Research Council.

Biggs, J. B., & Moore, P. (1993). *The Process of learning* (3rd ed.). New York, NY: Prentice Hall.

Bruner, J. S. (1986). *Actual minds, possible worlds.* Cambridge, UK: Harvard University Press.

Burke, B. (2014). *Gamify: How gamification motivates people to do extraordinary things*. Brookline, MA: Gartner.

Chadwick, D. (Ed.) (2008). *Approaches to social inquiry*. New Zealand: The Ministry of Education.

Chee, Y. S. (2016). *Game-to-teach or games-to-learn. Unlocking the power of digital game-based learning through performance*. Singapore: Springer.

Cohen, J. (1998). *Statistics power analysis for the behavioral sciences* (2nd ed.). New Jersey, NJ: Lawrence Erlbaum Associates.

Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology, 88*(4), 715–730.

Cramer, D., & Howitt, D. (2004). *The SAGE dictionary of statistics*. London, UK: Sage.

Csikszentmihalyi, M. (2008). *Flow: The Psychology of optimal experience*. New York, NY: HarperCollins.

Curriculum Development Council. (2014). *Liberal studies: Curriculum and assessment guide (Secondary 4–6)*. Hong Kong: Education Bureau.

Dede, C. (2011). Developing a research agenda for educational games and stimulations. In S. Tobias, & J. D. Fletcher (Eds.), *Computer games and instruction* (pp. 233–250). Charlotte, NC: Information Age Publishing.

de Jong, T. (2006). Technological advances in inquiry learning. *Science*, *312*(5773), 532–533.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. In *Proceedings of the 15th International Academic MindTrek Conference* (pp. 9–15). New York, NY: Association for Computing Machinery.

Dewey, J. (1958). *Art as experience*. New York, NY: Capricorn Books.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education, 63*(1), 380–392.

Education Bureau. (2014). *New senior education curriculum.* Hong Kong: Education Bureau. Retrieved from http://www.edb.gov.hk/en/curriculum-development/kla/pshe/nss-curriculum/index.html

Eisenberg, M., Berkowitz, R., & Johnson, D. (2010). Information, communications, and technology (ICT) skills curriculum based on the Big6 skills. *Library Media connection*, *28*(6), 24–27.

Elder, L., & Paul, R. (2009). *The Miniature guide to the art of asking essential questions* (5th ed.). Dillon Beach, CA: Foundation for Critical Thinking.

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education*, *67*, 156–167.

Eshach, H. (2007). Bridging in-school and out-of-school learning: Formal, non-formal and informal education. *Journal of Science Education and Technology*, *16*(2), 171–190.

Fung, Y., Tang, T., & Chan, C. W. (2011). *Learning and teaching Liberal Studies: Theory and practice*. Hong Kong: Open University of Hong Kong Press.

Games, A., & Squire, K. (2011). Searching for the fun: A Historical perspective on the evolution of educational video games. In S. Tobias, & J. D. Fletcher (Eds.), *Computer games and instruction* (pp. 17–46). Charlotte, NC: Information Age Publishing.

Gee, J. P. (2013). *Creating smarter students through digital learni*ng. New York, NY: Palgrave.

Hill, B. (1994). *Teaching social studies in a multicultural society*. Melbourne, Australia: Longman Cheshire.

Ho, E. (2012). *Asia-pacific education system review series no. 5: Student learning assessmen*t. Bangkok, Thailand: UNESCO.

Howland, J., Jonassen, D., & Marra, R. (2012). *Meaningful learning with technology* (4th ed.). Boston, MA: Pearson Education.

Hwang, G. J., Chiu, L. Y., & Chen, C. H. (2015). A Contextual game-based learning approach to improving students' inquiry-based learning performance in social studies courses. *Computers & Education, 81,* 13–25.

Ip, C., & Fok, P. K. (2010). *Challenges of involving student voice in curriculum implementation: The Case of Hong Kong.* Hong Kong: Hong Kong Institute of Educational Research.

Jansen, B. A. (2011). Inquiry unpacked: An Introduction to inquiry-based learning. *Library Media Connection, 29*(5), 10–12.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2016). *NMC Horizon Report: 2016 K-12 Edition*. Austin, Texas: New Media Consortium.

Jong, M. S. Y. (2013). Design and implementation of EagleEye—An Integrated outdoor exploratory educational system. *Research and Practices in Technology Enhanced Learning, 8*(1), 43–64.

Jong, M. S. Y. (2015a). Does online game-based learning work in formal education at school? *The Curriculum Journal, 26*(2), 249–267.

Jong, M. S. Y. (2015b). Context-aware geography field trip with EagleEye: Teachers' first experience. In M. Chang, & Y. Li (Eds.), *Smart Learning Environments* (pp. 77–93). Heidelberg, Germany: Springer.

Jong, M. S. Y., & Tsai, C. C. (2016). Understanding the concerns of teachers about leveraging mobile technology to facilitate outdoor social inquiry learning: The EduVenture experience. *Interactive Learning Environments, 24*(2), 328–344.

Kapp, K. M. (2012). *The Gamification of learning and instruction*. San Francisco, CA: Pfeiffer.

Koster, R. (2005). *A Theory of fun for game design*. Scottsdale, AZ: Paraglyph Press.

Lan, Y. J. (2015). Contextual EFL learning in a 3D virtual environment. *Language Learning & Technology, 19*(2), 16–31.

Landers, R. N. (2014). Developing a theory of gamified learning: Linking serious games and gamification of learning. *Simulation & Gaming, 45*(6), 752–768.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? Definitions and uses. *Exchange Organizational Behavior Teaching Journal, 15*(2), 1–5.

Li, D. D., & Lim, C. P. (2008). Scaffolding online historical inquiry tasks: a case study of two secondary school classrooms. *Computers & Education, 50*(4), 1394–1410.

Lim, B. R. (2004). Challenges and issues in designing inquiry on the Web. *British Journal of Educational Technology, 35*(5), 627–643.

Malone,T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 5*(4), 333–369.

Maxwell, J. A. (2013). *Qualitative research design: An Interactive approach* (3rd ed.). Thousand Oaks, CA: Sage.

McBride, D. M. (2013). *The Process of research in psychology*. London, UK: Sage Publications.

Muntean, C. I. (2011). Raising engagement in e-learning through gamification. In *Proceedings of the 6th International Conference on Virtual Learning (ICVL 2011)* (pp. 323–329). Romania: Bucharest University Press.

Nadelson, L. S., & Richard Jordan, J. (2012). Student attitudes toward and recall of outside day: An Environmental science field trip. *The Journal of Educational Research, 105*(3), 220–231.

O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: Evidence from the computer games literature. *The Curriculum Journal, 16*(4), 455–474.

Papert, S. (1993). *The Children's machine: Rethinking school in the age of the computers*. New York, NY: Basic Books.

Piaget, J. (1970). *Science of education and psychology of the child.* New York, NY: Oxford University Press.

Prensky, M. (2016). *Education to better their world: Unleashing the power of 21st century kids*. New York, NY: Teacher College Press.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: theory, pedagogy, and technology. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 97–118). New York, NY: Cambridge University Press.

Shaffer, D. W. (2007). *How computer games help children to learn*. New York, NY: Palgrave Macmillan.

Shih, J. L., Chuang, C. W., & Hwang, G. J. (2010). An Inquiry-based mobile learning approach to enhancing social science learning effectiveness. *Journal of Educational Technology & Society, 13*(4), 50–62.

Simões, J., Redondo, D. R., & Vilas, A. F. (2013). A Social gamification framework for a K-6 learning platform. *Computers in Human Behavior, 29*, 345–353.

Small, R. V., Arone, M. P., Stripling, B., & Berger, P. (2012). *Teaching for inquiry: Engaging the learner within*. New York, NY: Neal-Schuman Publishers.

Stripling, B. K. (2003). Inquiry-based learning. In B. K. Stripling & S. Hughes-Hassell (Eds.), *Curriculum connections through the library* (pp. 3–39). Westport, CT: Libraries Unlimited.

Stripling, B. K. (2008). Inquiry: Inquiring minds want to know. *School Library Media Activities Monthly*, *25*(1), 50–52.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Heidelberg, Germany: Springer.

Ucar, S., & Trundle, K. C. (2011). Conducting guided inquiry in science classes using authentic, archived, web-based data. *Computers & Education*, *57*(2), 1571–1582.

Vygotsky, L. (1978). *Mind and society*. Cambridge, MA: MIT Press.

Wake, K. D., & Wasson, B. (2011). Supporting creativity in teaching and learning of history through small-group production of mobile, location-based game. In *Proceedings of the 10th World Conference on Mobile and Contextual Learning* (pp. 1-12). Beijing, China: Beijing Normal University.

Wallace, V. L., & Husid, W. N. (2011). *Collaborating for inquiry-based learning* (2nd ed.). Santa Barbara, CA: Libraries Unlimited.

Zurita, G., & Baloian, N. (2012). Context, patterns and geo-collaboration to support situated learning. In J. Bravo, D. López-de-Ipiña, & F. Moya (Eds.), *Ubiquitous computing and ambient intelligence* (pp. 503–511). Heidelberg, Germany: Springer-Verlag.