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A Study of the Use of Wearable Devices for Healthy and Enjoyable English as a Foreign Language Learning in Authentic Contexts

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ABSTRACT

We designed an English as a foreign language (EFL) learning activity supported by smart watches to combine EFL learning with physical exercise such as walking around the school community. We tested the feasibility of our approach to facilitate EFL learning and make it healthy and enjoyable through single subject experimental design. In addition, we researched the affordances of smart watches for EFL learning and healthy and enjoyable living. We collected the following data: (1) student learning outcomes evaluations, (2) a questionnaire survey, and (3) interviews with the students. According to our results, the students performed the best on learning tasks when they used smart watches. The students perceived that smart watches were easy to use and useful for EFL learning. They also perceived that the learning activity supported by smart watches was useful for their health and positive emotions. The students mentioned several features of smart watches that were useful for EFL learning, physical activity, and positive emotions. For example, the dictionary in smart watches helped the students translate unfamiliar vocabulary, and the fitness tracking tool helped track and record the number of steps taken. The students were happy to learn EFL and to monitor their physical activity progress using smart watches. Furthermore, a significant correlation between learning performance and physical activity was revealed, suggesting that the students who did more physical exercise are those who demonstrate better learning performance. On the other hand, no correlation between learning performance and student perceptions and between physical activity and student perceptions was found, suggesting that most students, no matter how well they performed and exercised, had positive perceptions. Based on our results, we suggest designing learning activities combined with physical exercise supported by smart watches to facilitate EFL learning, physical activity, and positive emotions.

Keywords

Authentic contexts, EFL learning, Health, Positive emotions, Wearable device

Introduction

Scholars have suggested that for learning to be meaningful and effective it should take place in authentic contexts (Alioon & Delialioğlu, 2017; de la Guía et al., 2016; Herrington & Herrington, 2008; Kiernan & Aizawa, 2004). The reason is because authentic contexts reflect the way the knowledge will be used in real life (Huang, Yang, Chiang, & Su, 2016). Authentic contexts can be found outside of school, e.g., convenience stores or cafeterias in the local community (Huang, Shadiev, Sun, Hwang, & Liu, 2017). Scholars have also suggested that students need to do physical activities to maintain their health and positive emotions (MacIntyre & Vincze, 2017; Malina, 2001; Pishghadam, Zabetipour, & Aminzade, 2016; Uher, Kuchelova, Cimbolakova, & Pivovarnik, 2016). An instructor may design a learning activity for students to apply newly learned knowledge outdoors and to engage in physical exercise (e.g., walking) at the same time. In turn, physical activity may bring about positive emotions. In this case, the learning activity will facilitate learning, health and positive emotions, and the learning will be healthy and enjoyable.

Due to recent advancements in technological development, it became possible to produce smaller, cheaper and faster computing devices (Shadiev, Hwang, & Huang, 2017). As a result, stationary, portable or mobile computers started to evolve into seamlessly wearable technology featuring an increasing number of smart functions with high-computing power (Kim & Shin, 2015). Wearable technology, such as smart watches, appeals to a broad range of user interests, as it incorporates a wide variety of sensors for continuously measuring, recording and displaying different information, e.g., fitness, health-monitoring, location tracking, voice recognition and recording, and communication (Bower & Sturman, 2015; Müller, Divitini, Mora, Rivera-Pelayo, & Stork, 2015). This is why smart watches can be regarded as potential tools to support learning and healthy and enjoyable living, particularly if these are combined into healthy and enjoyable learning. However, despite the increased interest by the research community in smart watches, few studies have been carried out with such a focus. For example, the effectiveness of smart watches on healthy and enjoyable learning has not been closely examined. In addition, the affordances of smart watches for healthy and enjoyable learning are still unclear. The

results related to the effectiveness of smart watches on and the affordances of smart watches for learning and healthy and enjoyable living can be useful for researchers and educators in the field.

Therefore, this study seeks to obtain data that will help address this research gap. To this end, we designed an EFL learning activity combined with physical exercise and supported by smart watches. During the activity, students applied newly learned knowledge to the real world and physically exercised at the same time. Smart watches helped students complete learning tasks, monitor physical activity, and communicate with other students regarding their healthy and enjoyable learning. We aimed to explore whether our learning activity supported by smart watches can facilitate EFL learning and make it healthy and enjoyable. In addition, we investigated the affordances of smart watches to support healthy and enjoyable learning. Finally, we studied the relationship among the research variables. The following research questions were addressed:

- Do students perform better on a learning task when they use smart watches?
- How do students perceive a learning activity supported by smart watches?
- What are the affordances of smart watches for healthy and enjoyable learning?
- How are the research variables of this study correlated?

Related studies

Learning in authentic environments

Situating learners in real scenarios where they can meaningfully learn and practice has become a major priority for many educators and researchers (de la Guía et al., 2016; Shadiev, Huang, Hwang, & Liu, 2018). When learning is extended to authentic environments, it becomes more effective and meaningful (Alioon & Delialioğlu, 2017; Kiernan & Aizawa, 2004; Shadiev, Huang, Hwang, & Liu, 2017). According to the theory of authentic learning, context and learning should not be separated (Herrington & Herrington, 2008; Shadiev, Hwang, Huang, & Liu, 2015). Students learn much better when they are immersed in real scenarios because their interaction with learning contexts has a profound impact on the way they interpret an activity and their engagement with it (de la Guía et al., 2016). Lave and Wenger (1991) argued that learning is context-related, and they emphasized the importance of learning in a specific context. Collins (1988) suggested that learning is significantly influenced by situations; however, learning in the class is abstract and disconnected from real-life scenarios. That is, schools ignore the interdependence of context, situation and cognition and teach the abstract and decontextualized knowledge, so it cannot be retrieved in real-life contexts (Alioon & Delialioğlu, 2017; Shadiev, Hwang, & Liu, 2018). Under such an approach, knowledge itself is seen by learners as the final product of education rather than a tool to be used dynamically to solve problems.

Herrington and Herrington (2008) listed several critical characteristics of authentic environments. First, authentic environments provide authentic contexts that reflect the way the knowledge will be used in real life. That is, learning should take place in a physical environment containing a large number of resources that preserves the complexity of the real-life setting and reflects the way the knowledge will ultimately be used. Second, authentic environments provide authentic activities. Such activities reflect the kind of activities that people carry out in the real world; they are meaningful and relevant to students and present complex tasks to be completed over a sustained period of time, rather than a series of shorter disconnected examples. Third, authentic environments create opportunities for learners to share their learning experiences and to practice with other leaners of various levels of expertise. That is, students share their experiences and are able to access experiences of learners at various levels of expertise. As a result, students learn different perspectives on the topics from various points of view and model their skills and performance based on that of experts. Fourth, authentic environments offer authentic learning assessments within the tasks and promote reflection. The assessment is integrated with the learning activities, peer assessment is encouraged, and learners are assessed based on their outcomes. Learners have the opportunity to compare themselves with other learners at varying stages of accomplishment and improve their performance and skills.

Communicative language teaching approach and task-based learning method

The communicative language teaching (CLT) approach emphasizes interaction. According to this approach, language skills should be developed through meaning-based real communication (Ellis, 2009). That is, learners should learn not only the structure and forms of a language but also its function and purposes and produce language output to advance their communicative abilities (Nunan, 2004). Task-based language learning (TBLL) is one central method of the CLT approach (Kiernan & Aizawa, 2004). This method is student-centered, and it

emphasizes the use of the target language to complete meaningful tasks (Nunan, 2004). In TBLL, the instructor designs different tasks, and the learners use the target language to complete the tasks (Kiernan & Aizawa, 2004). Ellis (2009) argued that such tasks must satisfy the following criteria: (1) language learning activities should focus on "meaning" so that processing the semantic and pragmatic meaning of utterances is emphasized; (2) some kind of knowledge "gap" should exist that requires learners to convey information, to express an opinion or to infer meaning; (3) in order to complete language learning activities, learners should make use of their own linguistic and nonlinguistic resources; and (4) there should be a clearly defined outcome other than the use of language.

Healthy and enjoyable learning

Our lifestyle choices decisively affect the risk of developing major noncommunicable diseases. Physical inactivity is a type of lifestyle behavior with insufficient physical activity when a person spends most of his time sitting or lying, while reading, using a computer, watching television and so on. Physical inactivity is the major risk factor that increases the likelihood of noncommunicable diseases. Such a lifestyle may weaken the immune system, lead to muscle atrophy, cause anxiety and other undesirable health problems (Uher et al., 2016). On the other hand, physical activity enhances or maintains physical fitness and overall health and wellness. Despite the well-known benefits of physical activity, many adults and children are not active enough and lead relatively sedentary lifestyles. Therefore, for the health and well-being of the individuals, the importance of regular physical activity lifestyle throughout childhood, adolescence and adulthood is emphasized, and opportunities to engage in physical activity should be increased (Malina, 2001).

The positive effects of physical exercise on learning performance were reported elsewhere. For example, Salinas, Messias, Morales-Campos, and Parra-Medina (2014) examined the relationship between English language proficiency (ELP), physical activity, and physical activity-related psychosocial measures. Their findings showed that ELP was associated with physical activity. Liu, Sulpizio, Kornpetpanee, and Job (2017) tested for possible positive effects of physical activity when learning a second language (L2). Participants in an experimental group rode a bicycle, whereas participants in a control group sat on a chair during the experiment; all of them were simultaneously presented with new vocabulary and corresponding pictures/translation. The results showed that physical activity improved L2 learning; the experimental participants performed much better on posttests compared to their counterparts. Christopher, Dzakiria, and Mohamed (2012) combined English learning and sports activity. First, in class, students learned about a particular sport (e.g., badminton or basketball), discussed it, and learned related vocabulary. Then, outdoors, the students participated in the sporting activity and used English to interact with the people around them. After the activity, the students described their feelings, their surroundings, the rules and regulations of the sport, their performance, and the skills and actions involved. The results showed that there was improvement in use of the English; students were more expressive in using the English and more confident and motivated after the sports activity. Some scholars also explored the relationship between health and education. Most of them agreed that physical education programs need to be incorporated into curricula to maintain the health and learning performance of students. Two studies showed that students who participated in such programs demonstrated good health and did not experience a drop in standardized test scores (Sallis et al., 1999; Dwyer et al., 1983). Another study showed that students who engaged in physical education programs maintained overall health and wellness and scored significantly higher than their peers who had not engaged in such programs (Schoener et al., 1988). Several studies showed that learning languages has an impact on health. For example, Zauche et al. (2017) suggested that language learning influences education and health outcomes. Tam and Page (2016) claimed that those with good language abilities have better general health. Antoniou and Wright (2017) argued that language learning can be important for maintaining healthy brain function, e.g., working memory, declarative memory, as well as the interaction between declarative and procedural memory.

Emotion is very important in our everyday life, as it is a core process that impacts almost everything we do (MacIntyre & Vincze, 2017). Emotion is the representation of internal states and is tied to physical and sensory feelings (Pishghadam et al., 2016). Emotions can be negative (e.g., anxiety, fear or anger) or positive (e.g., joy and interest). The negative emotional state of students has proved to be disruptive for learning (Fredrickson, 1998). This is especially true during the foreign language learning process because languages are difficult to learn (Pishghadam et al., 2016). Students have negative experiences processing learning material and lower academic success during the learning process, and this arouses intense negative emotions (MacIntyre & Vincze, 2017). According to related studies, negative emotions not only affect learning but also health by causing a number of physical health problems, most notably coronary heart disease and some cancers. On the other hand, the positive emotional state of students has proved to be essential for improving learning. For example, Pekrun,

Goetz, Titz, and Perry (2002) suggested that students' positive emotions relate in positive ways to student learning, self-regulation, and achievement. Pekrun et al. (2002) found that positive emotions correlated with students' academic motivation, effort spent at academic tasks, use of metacognitive strategies in learning, and academic achievement. Fredrickson (1998) and Pishghadam et al. (2016) argued that positive emotions broaden the scope of attention, cognition, and action as well as build physical, intellectual, and social resources. That is, those in a positive emotional state notice more items in their visual field, engage more social connections, and tend to have urges to act in a greater variety of ways relative to those with negative emotions (MacIntyre & Vincze, 2017). According to Tugade, Fredrickson, and Barrett (2004), positive emotions are good for health. Furthermore, positive emotions contribute to psychological and physical well-being (Tugade, Fredrickson, & Barrett, 2004). For example, positive emotions are useful in preventing and treating anxiety and depression and thereby optimizing health (Fredrickson, 1998). Other scholars have argued about the impact of exposure to physical activity on emotions. For example, Biddle (2000) claimed that performing physical activity has positive benefits on emotions and moods. Wankel and Berger (1990) found the psychological and social benefits of physical activity; positive emotions were reported to be a main reason for physical activity involvement. Therefore, it is important to cultivate positive emotions in students by engaging them in different physical activities.

To make students learn better, be physically active and happy, a learning activity can be designed. For example, teachers may incorporate learning and physical exercise (e.g., walking to and from school instead of taking a bus) into a learning activity. Such an opportunity can be created to weave physical exercise into students' daily routines with respect to many different subjects. For a language learning class, following task-based language learning and authentic learning principles, students can be assigned learning tasks to apply newly learned knowledge to the real world. Teachers may ask students to explain to their classmates how to get to their home from school in the target language. Students may complete this task on their way home from school, and objects, situations and scenarios in the surrounding contexts can help student complete their tasks. Walking while working on the learning task may bring about positive emotions. Such a learning process will lead to healthy and enjoyable learning.

Smart watches for healthy living and learning

A smart watch is a wrist-worn, general-purpose, networked computer with a wide variety of sensors for continuously measuring and displaying different information for users (Barfield & Caudell, 2001; Reeder & David, 2016). Smart watches are familiar to most people, increasingly available as a consumer device, and enable near-real time continuous monitoring of physical activity and physiological measures. Mukhopadhyay (2015) claimed that smart watches are very popular in many applications, such as medical, entertainment, education, and other fields. According to recent studies (Lee, Bojanova, & Suder, 2015), health and activity monitoring were the most popular uses for wearable technologies, followed by information access (i.e., tell time, search for directions) and communications (i.e., send a text). The following example may explain how smart watches can be useful to support healthy living. With respect to daily physical activities, smart watches display a feedback with the number of steps taken, and users may compare it to the standards of their personal goal. Such feedback has positive effects on goal engagement. On one hand, if a user's number of steps has contributed to accomplishing the goal, the feedback shows that user is on the right track and motivates continued action. On the other hand, if the goal was not accomplished, feedback signals that more effort or self-control is needed. Therefore, feedback motivates users to take enough or more steps, and it stimulates and supports healthy behavior (Dijkstra & Kooy, 2017).

Smart watches can also be successfully applied to education (Dijkstra & Kooy, 2017; Mukhopadhyay, 2015). The reason is because smart watches are useful and provide a wide range of opportunities to educators due to the following pedagogical affordances (Bower & Sturman, 2015). Smart watch devices have the ability *to provide in situ contextual information*. That is, smart watches can be used for receiving or searching for additional background information. The *recording of information* using smart watches was also identified as a pedagogically benefit, e.g., students can use smart watches to record and show what they are doing in the learning contexts as well as to replay recorded content for reflective reprocessing. *Communication* features include the opportunity to integrate communication streams into the learning process to make it social, which is very important because students across different locations may exchange learning information, discuss ideas with others, help one another to complete class assignments, or see an event from someone else's viewpoint (Wu et al., 2014). As a result, this can be useful in increasing the acquisition and retention of new knowledge. Smart watches are seen to *provide timely unobtrusive and contextualized feedback*, e.g., students can receive instant feedback on their recorded content from the system or from other students via online chat and then try to

improve their content. In addition, smart watches *provide well-timed and relevant push notifications* to reach students when they are busy in order to grab their attention and facilitate healthy living and/or learning, e.g., to suggest they take more steps or to remind them of a newly learned concept. The *hands free access* of smart watch devices enhances learning experiences through logistical and other pragmatic implications, e.g., smart watches provide learners with hands-free access to contextually relevant knowledge (Bower & Sturman, 2015), and learners are able to send or receive *in situ* information and keep moving at the same time.

Lungu (2016) argued that the smart watch is a useful learning tool in a way that makes a user consult it easily for a learning strategy called microlearning, which is known for quickly closing skill and knowledge gaps. The learner can take advantage of the smart watch and study anytime and anywhere, especially during dead moments of the day (e.g., waiting for the school bus at the bust stop). Chen (2016) suggested that learning in smart watch-enhanced learning environments takes place in a state of physical mobility. Such environments are different from those created by mobile technologies (i.e., smart phones) because the devices to be used in former are wrist-worn, which enables learners to interact with them without slowing down their movement or standing still. That is, wearable technology enables learners to move and interact with the device smoothly.

Recent evidence suggests that there have been few studies that have been sufficiently conducted to explore smart watch applications for learning, or the relevant studies are still in the preliminary stages (Bower & Sturman, 2015; Kim & Shin, 2015). However, some learning scenarios were proposed for smart watch-supported learning environments. Dijkstra and Kooy (2017) suggested that learners may receive questions or assignments and feedback on their learning via smart watches. For example, secondary school students may be presented with some familiar routes in their environment as well as unfamiliar ones and be asked to calculate how many steps they need to take for each. The accelerometer sensor of smart watches detects users' steps and counts them (Reeder & David, 2016); this sensor may provide feedback containing social comparisons and competition regarding physical activity, e.g., "you are doing great compared to your friends!" Buchem, Merceron, Kreutel, Haesner, and Steinert (2015) proposed extending a typical learning environment with the level of engagement made available through smart watches. Smart watches can capture live data from individual learning activities and identify appropriate moments for carrying out learning interventions in a wide variety of scenarios. Chen (2016) used smart watches for simple, unobtrusive physiological measurements. Smart watches measured and tracked heart rate changes during self-paced learning processes and provided students with dynamic feedback about their emotional status in order to alleviate their anxiety and promote learning engagement.

Language learning with smart watches

Smart watches may offer various pedagogical benefits for language learning. First, smart watches incorporate wireless connectivity and provide seamless access to contextually relevant information as well as enable interaction with information (Bower & Sturman, 2015). This makes smart watches a valuable tool to aid language learning both in the classroom and outside of it (Kim & Shin, 2015). Second, the multimedia tools of smart watches allow students to create their own content in environments outside of school and access content created by other students (Sen, Subbaraju, Misra, Lee, & Balan, 2016). For example, students can practice their writing or speaking skills by introducing or describing some objects, situations and scenarios from surrounding contexts by creating texts, images, and audio files using multimedia tools of smart watches. Students then can share their content with peers using smart watches for further reflection, discussion, and collaboration (Dubey, Goldberg, Abtahi, Mahler, & Mankodiya, 2015). Another feature of smart watches is feedback or notifications that are generated as a visual cue, auditory signal or haptic alert. Students can receive optimally timed notifications of newly learned concepts, and their repetitions can lead to language skills improvement (Lungu, 2016).

Some studies on EFL learning using smart watched were carried out recently. An English practice application has been developed with a card-based interface for smart watches in Pham, Chen, Nguyen, and Hwang (2016). Since only a few users used this application on smart watches, the researchers focused on its effectiveness for personalized adaptive learning with smartphones. Lungu (2016) developed the Time to Learn application for the smart watch to learn foreign vocabulary. The application was readily available anytime a student looked at it. It presented a word recognition challenge for the student, and after every challenge, the student provided feedback on whether he/she knew a given word or not. These two studies focused on vocabulary learning and were still preliminary. de la Guía et al. (2016) introduced IoT and wearable technologies for young students learning a foreign language. Students were asked to prepare a meal; they shared the responsibility for finding the various ingredients, shopping, and finding the appliances and kitchenware to lay the table. The students were provided with many IoT objects (e.g., food products and kitchenware items) with near-field communication (NFC) tags,

and they had to identify a given item from among a large number of objects and scan it via the NFC reader on the wearable device. The results of their study showed the great benefits of using wearable and IoT technologies for creating realistic scenarios in which learners can meaningfully and effectively learn a foreign language.

Method

For this study, we employed an experiment. According to Fraenkel, Wallen, and Hyun (2014), intervention can be tested with an experiment to determine whether it influences outcomes. We employed single subject experimental design. According to Fraenkel et al. (2014), such a design is most commonly used to study the changes in behavior and performance an individual exhibits after exposure to an intervention. We followed an A-B principal method of single-subject experimental design; this is a two phase method composed of an intervention condition (Phase A) and a control condition (Phase B) (Creswell, 2014). If any changes are observed, then one may conclude that the intervention has had an effect. The usefulness of such a research design and its reliability and validity are reported in Creswell (2014) and Fraenkel et al. (2014). In this present study, students participated in a learning activity supported by smart watches (Phase A: an intervention condition) first and then they participated at a learning activity without smart watches support (Phase B: a control condition). We compared students' learning outcomes obtained after each phase to prove that a learning activity supported by smart watches is feasible and effective.

Subjects and research procedure

Eighteen junior high school students from one class participated in this study. The demographic information of the participants is presented in Table 1. Most of the participants were 14-15 years old. Half of the participants were boys, and the other half were girls. This is because equal numbers of boys and girls are usually assigned in classes of most Asian countries, e.g., China (The State Council Information Office of the People's Republic of China, 2015). The participants had at least four years of experience using computers, and most of them had used smart watches for less than one year.

Table 1. Participants' profile

Category	Frequency	Percentage (%)
Gender		
Male	9	50
Female	9	50
Age (years)		
14	9	50
15	9	50
Experience to use computer (years)		
1-3	0	0
4-6	11	61
7 and more	7	39
Experience to use smart watch (years)		
less than 1	15	83
1 to 3	3	17
more than 3	0	0

Figure 1 presents our research procedure. We carried out a pretest before the learning activity to measure student prior knowledge. After that, each student received a smart watch, was instructed in how to use it, and was told about the learning activity details. To get acquainted with the smart watch and its functions, the students used it for one week. In the following two weeks, the students participated in a learning activity. The learning activity was supported by smart watches during the first week, and no smart watch support was provided during the learning activity in the second week. In the last class, interviews and a questionnaire were administered to investigate student learning experiences and perceptions.

We admit that this was a short-term study. Fraenkel et al. (2014) argued that, in some studies, the data on variables are usually collected within a fairly short time. In such cases, the instruments used are administered in a single session or in two sessions one immediately after the other. Creswell (2014) suggested such a design for researchers to better control conditions in order to focus on the effect of an intervening variable. This is often easier to do when conducting a short-term investigation. Large scale studies are then carried out to verify the

results from short-term studies. The notion of a short-term intervention has been widely used in educational research, including for mobile-assisted language learning. Here, two examples are provided: (1) the effectiveness of English practice application on EFL learning was explored for a seven-day period in Pham et al. (2016), and (2) the intervention to measure the effects of a situated mobile learning approach on the learning motivation and performance of EFL students was 5 hours long in Huang et al. (2016).

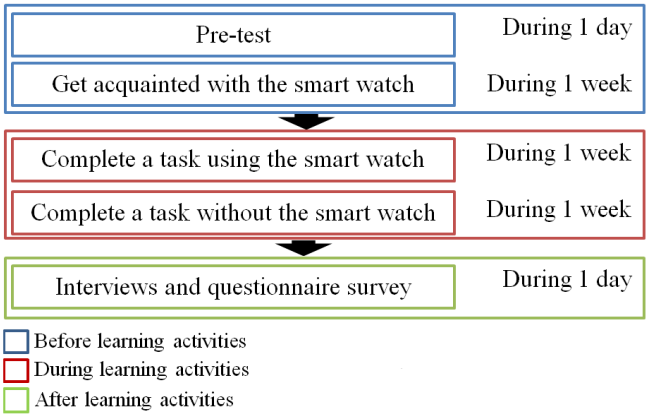

Figure 1. Research procedure

Learning activity

An English course was conducted in this study. A one-hour class was carried out three times a week in a conventional classroom by the instructor. Our learning activity was divided into indoor (in classroom) and outdoor (outside of school) activities. The learning goal of the indoor learning was to improve student vocabulary and reading and listening skills using textbook material, whereas the outdoor learning was aimed at improving student vocabulary and writing and speaking skills by applying newly learned knowledge to the real world. Indoor learning included learning new vocabulary and grammar, reading textbook dialogues, listening to audio dialogues, and then applying newly learned knowledge to complete textbook exercises. Outdoor learning included applying newly learned knowledge to the real world, and for that, the students kept a diary in which they recorded the everyday events that happened to them. The students were asked to think about what happened each day and then to write it down and talk about it. For example, they described objects or people (e.g., a kind and professional waiter in a breakfast store), situations (e.g., encountering a friend in local supermarket), and scenarios/events (e.g., celebrating grandma's birthday party) they saw or experienced in their local community. More details about the pedagogical benefits of a diary in the learning process can be found elsewhere (Hwang, Hsu, Shadiev, Chang, & Huang, 2015). This learning task was designed based on the "I was sleeping when you called" topic from the course textbook that students learned in class. From the topic, students learned new vocabulary, past continuous and past simple tenses, and sentence patterns of the theme. Then, to complete the task, the students used the newly acquired knowledge to describe what happened to them each day. In the first week, the students wrote entries in a diary with the support of smart watches (Task 1), and in the second week, the students kept a diary without smart watch support (Task 2). The screen size of smart watches is too small and, therefore, may be too inconvenience when inputting diary entries, so we asked the students to keep paper-based diaries and write entries in those diaries. Smart watches were used by the students to aid them in keeping a diary. For example, they used the (1) dictionary to translate new vocabulary for a diary and to determine how this vocabulary can be used in different contexts; (2) the communication tools to communicate with their peers, for example, to call their classmates to request/provide help or discuss some other learning issues; (3) the voice recording tool to record verbal content (e.g., description of objects, people, situations and scenarios) and share with peers for further discussion; and (4) the speech recognition tool to speak in English and get feedback about pronunciation. In addition, the students used (5) the fitness tracking tool of the smart watches to monitor their physical activity.

Research tools

We collected and analyzed the following data: (1) pretest and healthy learning tasks, (2) perceptions toward the learning activity supported by the smart watches, and (3) interviews with students. The use of multiple data sources allowed for the triangulation of the main findings and rendered the conclusions richer, more nuanced, and more reliable.

Pretest and healthy learning tasks

In the pretest, the students were asked to recall what has happened in their life lately and write it down. For example, the students could write about an important event, such as having an important conversation with their friends/parents/teachers or seeing something unusual on their way back home from school, and their feelings about it. We designed two healthy learning tasks for students (please refer to the Learning activity section). For the test and tasks, the students were asked to use appropriate sentences (at least 3-5 sentences) and the sentence patterns they learned in class. In terms of the healthy aspect of the learning tasks, we asked the students to be physically active (i.e., walk around their local community) when they worked on the tasks. The smart watch displayed how many steps they took every day, and the students included this information in their task sheets.

Perceptions toward the learning activity supported by smart watches

We employed a questionnaire survey to explore student perceptions toward the learning activity supported by smart watches. The questionnaire was developed based on the technology acceptance model (TAM) proposed by Davis (1989). The TAM has been successfully employed in a wide array of educational research areas (Hwang et al., 2014; Hwang et al., 2016). Researchers demonstrated that a TAM-based questionnaire is valid and reliably measures learners' perceptions toward the intervention (Davis, 1989). The following dimensions were included in the questionnaire: *ease of smart watch use* or *EU* (four items), the degree to which a student believes that using a smart watch would be free of physical and mental effort; *the usefulness of the learning activity supported by the smart watch* or *UL* (four items), the degree to which a student believes that the learning activity supported by the smart watch would enhance his or her learning performance; *behavioral intention to use a smart watch for learning in the future* or *BI* (two items), a learner's subjective probability that he or she will use a smart watch for learning in the future; *the usefulness of the learning activity supported by smart watches for health* or *UH* (three items), the degree to which a student believes that the learning activity supported by the smart watch would enhance his or her health; and *the usefulness of the learning activity supported by smart watches for positive emotions* or *UPE* (two items), the degree to which a student believes that the learning activity supported by the smart watch would enhance his or her positive emotions.

Interviews

We conducted one-on-one semistructured interviews with the students. The interviews were aimed toward an exploration of the students' experiences using the smart watches during Task 1 and toward the provision of insights into their perceptions about the usefulness of the learning activity supported by smart watches for learning, health, and positive emotions. Each interview lasted 20 minutes.

Figure 2. Smart watch

Smart watch

We employed ASUS ZenWatch 2 smart watches (Figure 2-a) to support healthy and enjoyable student learning (ASUS, 2017). The ASUS ZenWatch 2 features a 1.63 inch 320x320 touch display, a Qualcomm Snapdragon 400 processor, and 512 MB RAM and 4GB ROM. It comes with Bluetooth and WiFi connectivity features to connect to the internet or other devices. The ASUS ZenWatch 2 is compatible with many applications, e.g., Wellness App. The ASUS ZenWatch 2 has a built-in speaker and built-in microphone that enable making and receiving calls (Figure 2-b), setting audible alarms, and recording and hearing app notifications and sounds (Figure 2-c). In addition, users can exchange short messages, emojis, and multimedia files with others (Figure 2-d) and view different notifications and other important information on a display. A built-in pedometer counts

steps and reports activity progress in real time as well as daily and weekly activity summaries in the form of timelines and charts (Figure 2-e). In addition, we developed the ezTranslate APP for smart watches (Figure 2-f), which enables speech input through speech-to-text recognition technology, the translation of vocabulary from English into Chinese and vice versa, and saying vocabulary or sentences aloud through text-to-speech recognition technology.

Data analysis

The written content of the task outcomes was coded using a sentence as a coding unit. We scored them on a 10-point scale (with 10 as the highest score). The following assessment criteria were applied (The Ministry of Education, 2007): (1) Knowledge and Understanding: subject-specific content acquired, and the comprehension of its meaning and significance; (2) Thinking: the use of critical and creative thinking skills and/or processes; (3) Communication: the conveying of meaning through various forms; and (4) Application: the use of knowledge and skills to make connections within and between various contexts. Task outcomes were assessed in a balanced manner with respect to the four categories. Student speaking performance was also measured with respect to pronunciation and fluency. To this end, the students had to speak their created content aloud. Differences in learning performance were measured by comparing student learning performance on each task. The assessment was carried out by three raters, and notable differences in the scoring were resolved through rater discussions until a consensus was achieved. The inter-rater reliability of the scoring was evaluated using Cohen's kappa. The result exceeded 0.80 (before the discussion) and 0.90 (after the discussion).

Eighteen valid answer sheets to the questionnaire were obtained from 18 students. The students responded to the questionnaire items using a five-point Likert scale anchored by the end-points "strongly disagree" (1) and "strongly agree" (5). The internal consistency of the survey was tested by employing Cronbach's α. The values for *EU* (α = 0.827), *UL* (α = 0.941), *BI* (α = 0.833), *UH* (α = 0.975), and *UPE* (α = 0.873) demonstrated the high reliability of the questionnaire.

All interviews were audio-recorded with the students' permission and were then fully transcribed for analysis. The text segments that met the criteria to provide the best research information were highlighted and coded. The codes were then sorted into categories; codes with similar meanings were aggregated together. Established categories formed a framework to report findings pertinent to the research questions. The inter-rater reliability of the interview data was also evaluated by using Cohen's kappa, and the result exceeded 0.90.

A paired samples t-test was employed to measure the differences in the student learning performance on the pretest and the tasks completed with and without the smart watches. Paired samples t-tests typically consist of one group of units that has been tested two or more times. We also computed the correlation among our research variables to measure the degree to which they are related. To this end, we employed the Pearson correlation coefficient. The a priori alpha-level was set at 0.05 for all statistical analyses in this study since an alpha level of less than 0.05 is acceptable in most educational research as statistically significant.

Results

Prior knowledge and learning performance with and without smart watches

The results of the student prior knowledge and learning performance evaluation on the tasks with and without smart watches are presented in Table 2. According to the results, there was a significant difference between scores on the pretest (M = 2.89; SD = 2.72) and learning performance on Task 1 (M = 6.17; SD = 2.06), t = -5.804, p = .000. In addition, the results showed a significant difference between scores on the pretest (M=2.89; SD=2.72) and learning performance on Task 2 (M = 5.61; SD = 2.77), t = -4.151, p = .001. Finally, we found that learning performance on Task 1 (with smart watches) was significantly higher than learning performance on Task 2 (without smart watches), t = 2.149, p = .046.

Table 2. Results of the pre-test and learning performance evaluation

Prior knowledge		Task 1 (with smart watches)		Task 2 (without smart watches)	
Mean	*SD*	Mean	*SD*	Mean	*SD*
2.89	2.72	6.17	2.06	5.61	2.77

Student perceptions toward the learning activity supported by smart watches

The results of the questionnaire survey are presented in Table 3. According to the results, student perceptions were high regarding the ease of smart watch use (M = 4.26, SD = 0.56), the usefulness of the learning activity supported by smart watches for learning (M = 3.99, SD = 0.74), the behavioral intentions to use smart watches for learning in the future (M = 4.47, SD = 0.51), the usefulness of the learning activity supported by smart watches for health (M = 4.57, SD = 0.50), and the usefulness of the learning activity supported by smart watches for positive emotions (M = 4.67, SD = 0.48).

Table 3. Student perceptions toward the learning activity supported by smart watches

Variables	Mean	*SD*
Ease of smart watches use	4.26	0.56
Usefulness of the learning activity supported by smart watches for learning	3.99	0.74
Behavioral intentions to use smart watches for learning in the future	4.47	0.51
Usefulness of the learning activity supported by smart watches for health	4.57	0.50
Usefulness of the learning activity supported by smart watches for positive emotions	4.67	0.48

Affordances of smart watches for healthy and enjoyable learning

Based on the interview results, the following affordances of smart watches for healthy and enjoyable learning were derived: hands free access, translation, speech- and text-to-speech recognition, notifications, voice recording, information sharing, communication, fitness tracking, and enjoyable learning.

Correlation among research variables

We explored the relationship among the following research variables: (1) scores for Task 1, (2) steps taken, and (3) student perceptions. According to our results, the scores for Task 1 significantly correlate with the steps taken (r = 0.652, p = .003). However, no significant relationship was found between the scores for Task 1 and student perceptions as well as between steps taken and student perceptions.

Discussion

The effectiveness of the learning activity supported by smart watches

Our results suggest that the students gained new knowledge during the learning activities, so their performance on the tasks with and without smart watches was higher compared to their prior knowledge. The difference between student learning performance on Task 1 (with smart watches) and Task 2 (without smart watches) suggests that smart watches were useful for significantly promoting student EFL learning. This finding is in line with those obtained in earlier related studies. For example, several scholars claimed that using wearable devices, such as smart watches, during language learning can facilitate language practice in authentic contexts and, therefore, foster learning outcomes (de la Guía et al., 2016; Lungu, 2016; Pham et al., 2016). The reason is because smart watches offer several pedagogical benefits, e.g., wireless connectivity so that students have seamless access to learning information, and they can interact with their teacher and peers (Bower & Sturman, 2015; Kim & Shin, 2015). In addition, students are able to create their own content using the multimedia tools of smart watches (Dubey et al., 2015; Sen et al., 2016). Furthermore, students can receive feedback/notifications on the learning material they need to study (Lungu, 2016). These features of smart watches enable the students to practice the language frequently.

Student perceptions

Our results suggest that, in general, the students had positive perceptions toward the learning activity supported by smart watches. This finding was supported by the interview results; during the interviews, the students again confirmed their positive perceptions toward the learning activity supported by smart watches. All the students agreed that the learning activity was useful for EFL learning, they took more steps during the learning activity, and it was useful for their health and positive emotions. Smart watches helped them participate in the learning activity more efficiently.

Related studies have suggested that the acceptance of technology should be evaluated on a pedagogical basis to interpret its usage (Hwang et al., 2014; Hwang et al., 2016). Davis (1989) suggested that technology acceptance can be measured through perceived ease of use, perceived usefulness and behavioral intention dimensions. Our results suggest that the students accepted smart watches for language learning in terms of its ease of use and usefulness as well as their behavioral intentions. Furthermore, the students accepted that our learning activity is useful for learning, health and positive emotions.

Affordances of smart watches

Our results revealed the following affordances of smart watches for healthy and enjoyable learning.

Hands free access: The students mentioned that they were able to operate the applications of the smart watch (e.g., open/close applications and scroll down/up applications) with hand gestures. For example, by flicking the wrist in and out, the students could scroll up and down displayed information, or by pushing their arms down, they could select and open applications. This was very convenient during the learning process and physical exercise, especially when students could not use both hands to control the smart watch.

Translation: The students said that the smart watch dictionary helped them translate unfamiliar vocabulary from Chinese into English and vice versa. This feature was especially useful when they were working on their task and did not know some vocabulary. In addition, the dictionary helped the students to see what vocabulary they translated recently as well as pin frequently used/important vocabulary in the dictionary.

Speech- and text-to-speech recognition: The speech recognition tool was useful for practicing EFL speaking skills. If the students made mistakes during speaking, the speech recognition tool could generate text with errors so that the students knew that they had made mistakes. When the speech recognition tool generated text correctly the students knew that their speech was correct. In addition, the text-to-speech recognition tool spoke out target vocabulary words and sentences so that the students could hear how to say them correctly. The students said that this tool was useful for improving their EFL pronunciation.

Notifying: The notifications feature of the smart watch was employed for learning vocabulary. New vocabulary was shown to the students regularly, and this helped them better remember it for a longer time. In terms of physical exercise, the notifications enabled the students to see data related to their steps taken, calories burned, distance traveled, and so on, which were tracked and recorded by the fitness tracking tool. If a student did not reach his/her daily goal, smart watch alerts could pop up and encourage him/her to reach it.

Voice recording: The students said that with the smart watch they were able to record their speech. Later, a student could listen to his/her recorded speech again to check whether he/she made any mistakes.

Information sharing: The students were able to share their created content, such as a recorded audio file, with other students. This feature was helpful for peer learning. Students with better proficiency could find mistakes in the audio files of lower proficiency students, point mistakes out, and suggest how to improve. In addition, lower proficiency students could listen to the audio files of higher proficiency students and learn from them, e.g., to get inspirational ideas on how to complete the task. With regard to physical exercise, the students shared the goals they achieved with their peers. Seeing the results from others motivated the students to engage in more physical activities. The students tried to take more steps if they saw that their own progress was lower compared to that of others.

Communication: The students mentioned that the communication tools of the smart watches, e.g., text or voice messaging, enabled them to communicate with each other. The communication tools were useful for learning by providing assistance to those in need to complete the task or solve related issues.

Fitness tracking: The fitness tracking tool tracked and recorded data related to the students' steps taken, calories burned, distance traveled, workouts completed (e.g., walk, run, cycling, push-ups, sit-ups), sleeping habits and heart rate.

Enjoyable learning: The students agreed that smart watches were useful for making them happy. The smart watch functions enabled the students to practice EFL skills and communicate in EFL with less anxiety about making mistakes. Since the students did not communicate with others face-to-face but via the smart watch, they had no pressure of being judged if they made mistakes. Furthermore, according to the students, using smart

watches made the learning process more interesting, fun, and engaging. Regarding physical exercise, the students felt satisfied and happy when they saw notifications about them reaching or surpassing their daily goals. During communication with others, the students cheered each other up and so this made them happier.

Correlation among research variables

A significant correlation between the number of steps taken and the scores for Task 1 implies that the students with better performance are those who took more steps. That is, the more steps students took, better they performed on the task. This is because these students went out to complete the task and to do physical exercise and spent more time on both learning and physical activity. They learned and practiced their EFL skills longer, and this is why they performed better. Students, who did not go out so often or for a long time did not practice their EFL skills, and so, their performance was lower. Therefore, we suggest that students need to be encouraged to go out frequently and for longer periods of time to learn and exercise. The reason for the insignificant correlation between the scores for Task 1 and student perceptions and between the number of steps taken and student perceptions is that most students, regardless of whether their scores for Task 1 were high or low and regardless of how many steps they took, believed that it was easy to use the smart watch, that the learning activity supported by the smart watch was useful for learning, that the student had high behavioral intention to use the smart watch in the future, and that the learning activity supported by the smart watch was useful for health and positive emotions.

Conclusion

We collected multiple data sources and triangulated the findings to make the research more rigorous. Based on our findings, the answer to the first research question is that the students completed the learning task better when they used smart watches. The answer to the second research question is that the students positively perceived the learning activity supported by the smart watch as facilitating healthy and enjoyable learning. The answer to the third research question is that there are several affordances of smart watches for healthy learning: hands free access, translation, speech- and text-to-speech recognition, notifications, voice recording, information sharing, communication, fitness tracking, and enjoyable learning. The answer to the last research question is that student learning performance correlates with the number of steps taken; however, student perceptions correlate neither with learning performance nor with the number of steps taken.

We make two suggestions for the teaching and research community in the field. First, we suggest designing learning activities supported by smart watches in which students are able to learn new concepts and apply newly learned knowledge to the real world while physically exercising. In this way, enjoyable and healthy EFL learning will be facilitated. Second, instructors need to make sure that students are aware of what affordances smart watches have for enjoyable and healthy EFL learning. This will help the students to utilize smart watches for more efficient, enjoyable and healthy EFL learning.

Several limitations of this study need to be acknowledged and addressed in the future. The first limitation relates to the small sample size involved in this present study. The second limitation is that the students were exposed to the learning activity supported by smart watches for a short time period. As a result, these issues may limit the generalization of the obtained results to the wider population. Another limitation is that, although we used an experimental design, we compared the effects of two different conditions (with and without smart watches) on the learning outcomes of students in the same group. That is, a control group (i.e., with different students) was absent in this study. Thus, it is possible that some other variables could influence our results. For example, the learning motivation of the students could increase during Task 1 after they receive smart watches and result in better learning performance. On the other hand, after the smart watches were taken away, the students could have lower learning motivation during Task 2 and, as a result, perform worse. Therefore, all these limitations need to be considered and addressed in future studies. We will also try to compare the smart watches used in this present study with other smart watches/wearable devices in the near future to identify the differences in terms of their features to support authentic learning with respect to pedagogical, physiological and psychological aspects.

References

Alioon, Y., & Delialioğlu, Ö. (2017). The Effect of authentic m-learning activities on student engagement and motivation. *British Journal of Educational Technology*. doi:10.1111/bjet.12559

Antoniou, M., & Wright, S. M. (2017). Uncovering the mechanisms responsible for why language learning may promote healthy cognitive aging. *Frontiers in Psychology, 8*, 1-12.

ASUS. (2017). *ASUS ZenWatch 2.* Retrieved from https://www.asus.com/us/ZenWatch/ASUS_ZenWatch_2_WI501Q/

Barfield, W., & Caudell, T. (2001). Basic concepts in wearable computers and augmented reality. In W. Barfield, & T. Caudell (Eds.), *Fundamentals of wearable computers and augmented reality* (pp. 3-26). Mahwah, NJ: Lawrence Erlbaum Associates.

Biddle, S. J. (2000). Emotion, mood and physical activity. In S. J. H. Biddle, K. R. Fox; S. H. Boutcher (Eds.), *Physical activity and psychological well-being* (pp. 63− 87). London, UK: Routledge.

Bower, M., & Sturman, D. (2015). What are the educational affordances of wearable technologies? *Computers & Education, 88*, 343-353.

Chen, J. (2016). *Enhancing student engagement and interaction in e-learning environments through learning analytics and wearable sensing* (Doctoral dissertation, Hong Kong Baptist University). Available from Open Access Theses and Dissertations, 287. Retrieved from https://repository.hkbu.edu.hk/etd_oa/287

Christopher, A.A., Dzakiria, H., & Mohamed, A.H. (2012). Teaching English through sports: A Case study. *Asian EFL Journal, 59*, 20-29.

Creswell, J. W. (2014). *Educational research: Planning, conducting, and evaluating quantitative*. Boston, MA: Pearson Education.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

de la Guía, E., Camacho, V. L., Orozco-Barbosa, L., Brea Luján, V. M., Penichet, V. M. R., & Lozano Pérez, M. (2016). Introducing IoT and wearable technologies into task-based language learning for young children. *IEEE Transactions on Learning Technologies, 9*(4), 366-378.

Dijkstra, A., & Kooy, E. (2017). The Learning model of smartphone feedback applications in the field of e-health applied to the step counter. In R. Orji, M. Reisinger, M. Busch, A. Dijkstra, M. Kaptein, & E. Mattheiss (Eds.), *Proceedings of the Personalization in Persuasive Technology Workshop, Persuasive Technology 2017* (pp. 45-49). Amsterdam, The Netherlands: CEUR Workshop Proceedings.

Dubey, H., Goldberg, J. C., Abtahi, M., Mahler, L., & Mankodiya, K. (2015). EchoWear: Smartwatch technology for voice and speech treatments of patients with Parkinson's disease. In *Proceedings of the conference on Wireless Health* (pp. 1-8). New York, NY: ACM.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2014). *How to design and evaluate research in education.* New York, NY: McGraw-Hill.

Fredrickson, B.L. (1998). What good are positive emotions? *Review of General Psychology, 2*(3), 300-319.

Herrington, A., & Herrington, J. (2008). What is an authentic learning environment? In A. Herrington, & J. Herrington (Eds.), *Authentic Learning Environments in Higher Education* (pp. 1-14). Hershey, PA: ISP.

Huang, C. S. J., Yang, S. J. H., Chiang, T. H. C., & Su, A. Y. S. (2016). Effects of situated mobile learning approach on learning motivation and performance of EFL students. *Educational Technology & Society, 19*(1), 263–276.

Huang, Y. M., Shadiev, R., Sun, A., Hwang, W. Y., & Liu, T. Y. (2017). A Study of the cognitive diffusion model: Facilitating students' high level cognitive processes with authentic support. *Educational Technology Research & Development, 65*(3), 505-531.

Hwang, W. Y., Chen, H. S. L., Shadiev, R., Huang, Y. M. & Chen, C. Y. (2014). Improving English as a foreign language writing in elementary schools using mobile devices in familiar situational contexts. *Computer Assisted Language Learning, 27*(5), 359-378.

Hwang, W. Y., Hsu, J. L., Shadiev, R., Chang, C. L., & Huang, Y. M. (2015). Employing self-assessment, journaling, and peer sharing to enhance learning from an online course. *Journal of Computing in Higher Education, 27*(2), 114–133.

Hwang, W. Y., Ma, Z. H., Shadiev, R., Shih, T. K., & Chen, S. Y. (2016). Evaluating listening and speaking skills in a mobile game-based learning environment with situational contexts. *Computer Assisted Language Learning, 29*(4), 639-657.

Kiernan, P. J., & Aizawa, K. (2004). Cell phones in task based learning-Are cell phones useful language learning tools? *ReCALL, 16*(1), 71-84.

Kim, K. J., & Shin, D. H. (2015). An Acceptance model for smart watches: Implications for the adoption of future wearable technology. *Internet Research, 25*(4), 527-541.

Lee, M. R., Bojanova, I., & Suder, T. (2015). The New Wearable Computing Frontier. *IT Professional*, (5), 16-19.

Liu, F., Sulpizio, S., Kornpetpanee, S., & Job, R. (2017). It takes biking to learn: Physical activity improves learning a second language. *PLoS ONE, 12*(5), 1-15.

Lungu, M. F. (2016). Bootstrapping an ubiquitous monitoring ecosystem for accelerating vocabulary acquisition. In *Proceedings of the 10th European Conference on Software Architecture Workshops* (pp. 1-4). New York, NY: ACM.

MacIntyre, P. D., & Vincze, L. (2017). Positive and negative emotions underlie motivation for L2 learning. *Studies in Second Language Learning and Teaching, 7*(1), 61-88.

Malina, R. M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology, 13*, 162–172.

Mukhopadhyay, S. C. (2015). Wearable sensors for human activity monitoring: A Review. *IEEE Sensors Journal, 15*(3), 1321-1330.

Müller, L., Divitini, M., Mora, S., Rivera-Pelayo, V., & Stork, W. (2015). Context becomes content: Sensor data for computer-supported reflective learning. *IEEE Transactions on Learning Technologies, 8*(1), 111-123.

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Positive emotions in education. In E. Frydenberg (Ed.), *Beyond coping: Meeting goals, visions, and challenges* (pp. 149 –174). Oxford, UK: Elsevier.

Pham, X. L., Chen, G. D., Nguyen, T. H., & Hwang, W. Y. (2016). Card-based design combined with spaced repetition: A New interface for displaying learning elements and improving active recall. *Computers & Education, 98*, 142-156.

Pishghadam, R., Zabetipour, M., & Aminzade, A. (2016). Examining emotions in English language learning classes: A Case of EFL emotions. *Issues in Educational Research, 26*(3), 508-527.

Reeder, B., & David, A. (2016). Health at hand: A Systematic review of smart watch uses for health and wellness. *Journal of Biomedical Informatics, 63*, 269-276.

Salinas, J. J., Messias, D. K. H., Morales-Campos, D., & Parra-Medina, D. (2014). English language proficiency and physical activity among Mexican-origin women in South Texas and South Carolina. *Journal of Health Care for the Poor and Underserved, 25*(1), 357-375.

Sallis, J., McKenzie, T., Kolody, B., Lewis, M., Marshall, S., & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport, 70*(2), 127–134.

Sen, S., Subbaraju, V., Misra, A., Lee, Y., & Balan, R. K. (2016). Smartwatch based food diary & eating analytics. In *Proceedings of the 14th Annual International Conference on Mobile Systems, Applications, and Services Companion* (pp. 118). New York, NY: ACM.

Shadiev, R., Huang, Y. M., Hwang, W. Y., & Liu, T. Y. (2018). Facilitating application of language skills in authentic environments with a mobile learning system. *Journal of Computer Assisted Learning, 34*(1), 42-52.

Shadiev, R., Huang, Y. M., Hwang, W. Y., & Liu, T. Y. (2017). Cognitive diffusion model: Facilitating EFL Learning in an Authentic Environment. *IEEE Transactions on Learning Technologies, 10*(2), 168-181.

Shadiev, R., Hwang, W. Y., & Huang, Y. M (2017). Review of research on mobile language learning in authentic environments. *Computer Assisted Language Learning, 30*(3-4), 284-303.

Shadiev, R., Hwang, W. Y., Huang, Y. M., & Liu, T. Y. (2015). The Impact of supported and annotated mobile learning on achievement and cognitive load. *Educational Technology & Society, 18*(4), 53–69.

Shadiev, R., Hwang, W. Y., & Liu, T. Y. (2018). Investigating the effectiveness of a learning activity supported by a mobile multimedia learning system to enhance autonomous EFL learning in authentic contexts. *Educational Technology Research and Development*, 66(4), 893-912.

Tam, K. W., & Page, L. (2016). Effects of language proficiency on labour, social and health outcomes of immigrants in Australia. *Economic Analysis and Policy, 52*, 66-78

The State Council Information Office of the People's Republic of China (2015, September 22). Gender equality and women's development in China. *Xinhua News Agency* (p. 1-10).

Tugade, M. M., Fredrickson, B. L., & Feldman Barrett, L. (2004). Psychological resilience and positive emotional granularity: Examining the benefits of positive emotions on coping and health. *Journal of personality, 72*(6), 1161-1190.

Uher, I., Kuchelova, Z., Cimbolakova, I., & Pivovarnik, J. (2016). Physical activity and health. *Prace Naukowe Akademii im. Jana Długosza w Częstochowie Kultura Fizyczna, 15*(3), 67-74.

Zauche, L. H. Mahoney, A. E. D., Thul, T. A., Zauche, M. S., Weldon, A. B., & Stapel-Wax, J. L. (2017). The Power of language nutrition for children's brain development, health, and future academic achievement. *Journal of Pediatric Health Care, 31*(4) 504-505.

Wankel, L. M., & Berger, B. G. (1990). The Psychological and social benefits of sport and physical activity. *Journal of leisure research, 22*(2), 167-182.