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Interactivity's effect on playing versus watching a real-time strategy game: A preliminary experiment

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Abstract

Digital Game-based Language Learning (DGBLL) involves playing digital games to learn a language, utilizing game elements inducive to motivation and learning. The field has been gaining attention recently, but applications traditionally only involved users playing the games themselves. Recently, watching gameplay online has become a global sensation, yet its effectiveness for foreign language pedagogy remains unexplored. One significant difference between playing and watching a game is the inclusion or exclusion of physical interactivity, which involves utilizing a controller to manipulate the game. Studies have previously addressed interactivity in games, but predominantly utilize serious games made for educational purposes. This study includes a preliminary experiment testing the effects of physical interactivity of a commercial off-the-shelf (COTS) game where participants were assigned player or watcher roles. Eleven (n = 11) participants took part in the study, and a mixed-method approach was utilized for data collection consisting of a vocabulary test, questionnaire, interviews, and researcher observations. The results indicate a slightly higher vocabulary achievement for the watchers, while the players reported greater mental effort toward their task relative to learning English and rated their task at a higher difficulty. Conversely, players expressed better post-treatment attitudes and perceptions of playing games to learn English. Nevertheless, the interviews indicated that having low-skilled players negatively affected the experience of the watchers, and the players felt too busy controlling the game to learn English. Finally, recommendations were made for future follow-up studies.

Digital Game-based Language Learning (DGBLL) では、デジタルゲームをプレイすることで、ゲームの要素を利用して言語学習のモチベーションと学習を促進する。これは昨今注目されている分野だが、

従来の研究は、ユーザーが自らゲームをプレイするというものであった。一方で最近、オンラインで他者がゲームをプレイしているのを視聴する、いわゆるゲーム実況中継動画の視聴が世界で流行している。しかし、ゲーム視聴と外国語教育におけるその有効性はまだ調査されていない。ゲームをプレイすることと視聴することの大きな違いの1つは、コントローラーを使用してゲームを操作することを含む、物理的な双方向性を含めるか除外するかである。また、これまでの研究ではゲームのインタラクティブ性が研究されてきたが、それには主に教育目的で作成されたserious gamesが利用されている。

本研究では、ゲームの視聴が与える英語学習の影響に着目し、commercial off-the-shelf (COTS) gameをプレイ、または視聴した際に英語学習者に与える物理的な相互作用の影響を調査した。11 名 (n = 11) の参加者を、5人のプレイヤーと6人のウォッチャーに分け、語彙テスト、アンケート、インタビュー、参与観察といった複数のデータ収集を実施した。結果、ウォッチャーの語彙テストの達成度がわずかに高く、その理由として、プレーヤーは、英語の学習に比べてタスクに対する精神的労力が大きく、タスクの難易度が高い点が考えられる。一方、アンケートでは、プレーヤーは、英語学習として英語でゲームをプレイすることに積極的であり、また英語学習効果が高いと回答した。しかし、インタビューでは、ゲームスキルの低いプレーヤーはゲームの制御に忙しく英語学習を十分にできず、ウォッチャーは視聴を退屈だと感じたとの回答があった。最後に、今後のフォローアップ研究のための課題を提示した。

Keywords: game-based language learning, watching gameplay, physical interactivity, language learning

Digital game-based language learning (DGBLL) is a research field that explores facilitating language learning through playing computer games, drawing on elements of computer-assisted language learning (CALL) and game-based learning (GBL). DGBLL utilizes inherent game features designed for entertainment that work to increase user motivation. Additionally, certain aspects favorable to facilitating language acquisition are prevalent in games, and playing games has been shown to have several advantages transferrable to learning, such as providing challenge, competition, purpose, and control (Admiraal et al., 2011; Nakamura & Csikszentmihalyi, 2009; Whitton, 2014). Games can also foster learning by means of scaffolding (Sun et al., 2021) and facilitating safe (Jabbari & Eslami, 2019) and immersive environments (Johnsen et al., 2021). Within this controlled environment, feedback is given (Calvo-Ferrer, 2021), and language negotiation can take place through interaction and collaboration (Peterson, 2016). Related studies typically involve users playing games themselves through controllers, but in recent years, watching gameplay has become a popular phenomenon, especially amongst the high school and university age brackets, where almost half (41%) of the popular game streaming website, Twitch.tv's audience is estimated to be between the age of 16 and 24 (Iqbal, 2022). Given the novelty of watching gameplay, its potential for language learning remains underexplored.

Watching gameplay is the act of someone watching another person play a digital game, either live or prerecorded, through websites such as Twitch.tv and YouTube. It is "...a kind of real-time video social media that integrates traditional broadcasting and online gaming" (Li et al., 2020, p. 1). The streamers often provide commentary on the game, and users are able to communicate with the streamer and fellow viewers through a chat box during live sessions. Watching

gameplay has significantly increased in viewership and market value (Hamilton et al., 2014), often rivaling cable TV networks (Gilbert, 2018). And this has only increased during the COVID-19 pandemic (Clement, 2021) as people have sought to alleviate associated negative emotions by turning to video games (Scerbakov et al., 2022). In fact, in some cases, more people watch someone else play a game than play it themselves (Kaytoue et al., 2012; Orme, 2021). This trend is especially taking hold in Japan, as can be seen in a recent survey of middle school students' preferred future careers. For the first time, "Game Streamer" was ranked top five for males and top ten for females (Sony Life Insurance Corporation, 2021). In terms of language education, some streamers dedicate their channels to language learning, such as playing Japanese role-playing games while teaching their audience Japanese. Yet, despite its popularity, we know little about the potential for pedagogical applications in terms of vocabulary achievement, learners' attitudes toward learning a language this way, and their perceptions of its effectiveness.

Watching gameplay shares similarities to media watching, which is not new to education research, as studies have extensively looked at media applications such as movies and TV shows (see Parmawati & Inayah, 2019; Vanderplank, 2019). Nevertheless, traditional media is mostly a passive experience, whereas watching gameplay offers added opportunities for language learning through communicative interactions between viewers and streamers, something that has been shown to be conducive to language learning in game environments (Peterson, 2016).

Literature review

The rise in watching gameplay has encouraged researchers to explain the trend, primarily focusing on its social phenomenon. Typically, studies can be categorized into the subjects of online social interaction (Churchill & Wen Xu, 2016; Diwanji et al., 2020; Hamilton et al., 2014), media consumption (Jang & Byon, 2019; Sjöblom et al., 2017), and motivational appeal (Gros et al., 2017; Sjöblom & Hamari, 2017). Studies on motivational appeal, such as the two listed above, often entail quantitative surveys with predetermined categories offering limited criteria such as entertainment, communicating with others in the online community, checking out a game before purchasing it, and learning game strategies. Notably, 'language learning' is not a selectable option.

Thus, despite the recent studies, there is minimal data on the potential linguistic effectiveness of watching a game versus playing one. And in this regard, the main difference between the two is the utilization or exclusion of game physical interactivity. Interactivity can have many forms, but physical interactivity generally entails a player's physical interaction that they have with the game using a device (deHaan et al., 2010; Sims, 1997). Thus, it can be described as the act of directly manipulating gameplay via a hand-operated controller, something only a player would do while a watcher does not. This is different from social interaction with other human players. When addressing game interactivity, researchers

typically measure its effect on vocabulary acquisition, attention, mental effort and cognitive load, motivation, and flow experience (Cho et al., 2021; deHaan & Kono, 2010; deHaan et al., 2010; Ebrahimzadeh, 2017; Ebrahimzadeh & Alavi, 2016). While studies on game interactivity are not directly related to the watching gameplay phenomenon, they are nonetheless important for determining the relative effectiveness of language learning through watching gameplay.

The evidence differs regarding the effects of game interactivity. When learners are engaged in tasks that elicit a high degree of involvement, language acquisition, such as vocabulary learning, has been known to be facilitated (Peterson, 2021). In support of this notion, Ali Mohsen (2016) conducted a study on vocabulary learning for a serious game designed to teach knee surgery, with results showing the players outperforming the watchers. Nevertheless, interactivity has been negatively associated with causing split attention and overwhelming mental capacity to acquire target learning. This is because operating a physical controller "requires frequent input from the player and the input required can disrupt the player's involvement with the game space" (Taylor, 2002, p. 20). This is similar to prior studies showing instructional media applications causing split attention and extraneous cognitive load (Kalyuga et al., 1999), factors not desirable for learning. Cognitive load theory states that mental capacity is finite and, when overwhelmed with various mental tasks, can decrease learners' opportunities for target learning (Sweller, 1994). Following cognitive load theory, physical interactivity would most likely increase mental effort (Pellouchoud et al., 1999) and hamper vocabulary learning (deHaan, 2005). Overall, researchers have stated that the level of cognitive load created by physical input needs to be further addressed (deHaan et al., 2010; Plass & Jones, 2005).

Other studies have inadvertently tested game physical interactivity by assessing the level of technological engagement (LTE) on learning in various education fields outside of language learning. Here, a game-based application is used at the highest level of LTE since it involves users actively engaging with technologies. Secondly, a video-based treatment is implemented at the middle level. Lastly, traditional classroom teaching constitutes no LTE. These studies test whether higher technology engagement leads to better measurable learning results and encompass various subjects such as software engineering (Gordillo et al., 2022; Hsu & Lin, 2016), biology (Chang et al., 2016), science (Chen et al., 2021), intercultural learning (Busse & Krause, 2016), history (Ijaz et al., 2017), and math (Kebritchi et al., 2010; Wang et al., 2018). It is important to note that many of the video-based treatments significantly differ from watching the game-based applications. Instead, participants are usually given a separate form of media with the same target vocabulary.

Distinguishing game types: serious vs. commercial off-the-shelf games

When assessing watching gameplay for language-learning purposes, it is necessary to distinguish the two distinct game types used in DGBLL applications. Commercial off-the-shelf (COTS) games, also known as non-serious games, are

produced primarily for entertainment purposes, and researchers manipulate them to teach designated content in various fields, such as language learning (see deHaan et al., 2010; Ebrahimzadeh, 2017; Peterson, 2016). The other category of games is called serious games, and these are designed primarily for educational purposes. This distinction becomes essential when considering that, while interest in DGBLL research has grown considerably recently, the majority of studies pertain to serious games created by researchers (Boyle et al., 2016; Girard et al., 2013). In accordance with this, the cited studies in the previous paragraph testing game interactivity via LTE can be considered serious games. Conversely, the vast majority of online gameplay watching is done entirely through COTS games.

There are minimal studies looking at game interactivity with COTS games. deHaan (2005) tested Japanese students playing a baseball game, with results indicating students had their attention split between controlling the gameplay and learning the language. The author then conducted two follow-up studies incorporating vocabulary achievement and subjective cognitive load for players and watchers for a reflex-based game (deHaan & Kono, 2010) and a music game (deHaan et al., 2010). Both studies showed a higher vocabulary achievement and less extraneous (negative) cognitive load for the watchers, indicating that watching may have learning advantages over playing games because the watchers can focus on learning without the interruption of a controller. At the time of this current study, the researcher was able to find two more recent experiments, both by the same author utilizing the same game called Defense of the Ancients. The studies claim to use a real-time strategy (RTS) game, but this is actually a multiplayer online battle arena (MOBA) game made using the RTS game Warcraft III. In the first study (Ebrahimzadeh & Alavi, 2016), 136 high school students played or watched the game for five weeks and measured e-learning enjoyment and vocabulary learning. The results showed no significant difference between watchers and players. In the later study (Ebrahimzadeh, 2017), 241 male high school students were put into groups of readers, players, and watchers for five weeks. The findings indicate that players and watchers outperformed the readers. It is important to note that both of these studies included mainly short, text-only dialogues with minimal audio sequences.

In addition to the mentioned studies on COTS games, other researchers have looked at COTS games and the role of interactivity within topics unrelated to education, such as the responsibility and degree of character identification in violent games (Walter & Tsfati, 2016), cognitive load and rape acceptance (Read et al., 2018), violence, perceived difficulty, and frustration (Polman et al., 2008), and motivational processing and cognitive load (Huang, 2011).

Different games may be suitable or inappropriate for language learning (deHaan et al., 2010), so testing various game genres is essential. One important COTS game genre that has not been tested for interactivity is RTS games, a subgenre of strategy games. Unlike turn-based strategy games, RTS games involve all players moving simultaneously, thus, creating a fast-paced experience with

high player interactivity. RTS games have also been seen to be good for the flow experience (Sweetser & Wyeth, 2005).

Research questions

Given the exploratory nature of the research, this study entails a preliminary study with two purposes. The first purpose is to initially test the effect of physical interactivity on a COTS RTS game. Here, vocabulary achievement and invested mental effort can measure the relative effectiveness between playing and watching a game for language-learning purposes. In addition, this study addresses the potential feasibility for practical applications by soliciting learner attitudes toward playing and watching games for language-learning purposes and their perceptions of its pedagogical effectiveness (see Bolliger et al., 2015). The second purpose is to make observations useful for performing larger studies. The research questions are as follows.

Q1. Does watching gameplay cause higher measurable vocabulary achievement over playing games?

Q2. What are learners' attitudes towards playing or watching games for language-learning purposes, and what are their perceptions about its effectiveness for language learning?

Q3. What effect does the assigned task (play or watch) have on subjective invested mental effort?

Q4. What are learning points that can be considered in a larger experiment?

Method

Experiment design and participants

The experiment was designed to test the effects of game interactivity on vocabulary recall, attitudes and perceptions for pedagogy, and subjective mental effort. Following deHaan et al. (2010), interactivity was controlled by assigning participants into one of two groups: one that would play the game and another that would watch. Interactivity, or the ability to control the gameplay, was assigned as the independent variable. Dependent variables included vocabulary achievement, attitudes and perceptions, and mental effort. To eliminate social interaction influences, participants were not permitted to talk to each other during the treatment. A mixed-methods approach of both quantitative and qualitative data collection was selected based on the recommendations of deHaan et al. (2010) consisting of a vocabulary test, questionnaire, interviews, and researcher observations.

The participants were recruited from one campus at a university in Japan via convenience sampling due to necessity, and advertising was done on the campus electronic bulletin board and via sending emails. In total, 11 participants (n = 11) volunteered and took part in the experiment and received payment for their participation (Table 1).

Table 1
Demographics

ID	Gender	Major	Year	English score	Time abroad?	Wkly game play	Wkly game watch
1	F	Engineering	M 1	TOEIC 865	Australia, 2 mo	none	none
2	F	Human Science	M 2	IELTS 6.5	Denmark, 6 mo	none	none
3	M	Engineering	B 1	Beginner	none	none	none
4	M	Engineering	M 1	TOEIC 895	none	none	2–4 hrs
5	M	Human Science	D 2	IELTS 6.0	UK, Canada, 1 yr.	none	none
6	M	Literature	M 1	TOEIC 815	none	< 1 hr	none
7	M	Engineering	M 1	TOEIC 925	Australia, 1 mo.	< 1 hr	5–7 hrs
8	M	Engineering	M 1	TOEIC 770	none	2–4 hrs	2–4 hrs
9	F	Science	B 4	TOEIC 675	UK, 2 wks	none	< 1 hr
10	M	Engineering	B 3	TOEIC 585	none	none	none
11	F	Human Science	B 2	IELTS 6.5	none	none	none

A summary explanation is given as follows. Seven were males, and four were females. Six major in engineering, three in human science, one in science, and one in literature. Six participants are master's students, four are undergraduates, and one is a doctoral student. The participants self-reported their English proficiency scores as follows. Seven gave their TOEIC scores with a mean score of 790. Three elected their IELTS score, including one score of 6.0 and two of 6.5. And one participant wrote "beginner level." Next, the participants were asked about their international experience. Five participants have traveled abroad with a mean time of 17.6 weeks. For game habits, eight don't currently play games, while two play games for less than an hour, and one plays between two and four hours. They mostly play games through game consoles and smartphones. One participant has tried learning English by both playing games and watching gameplay. The typical method of studying English was through university classes, movies and videos, smartphone apps, and textbooks. Next, one participant has had some experience playing RTS games, but none have played the chosen game for this experiment (StarCraft II) before. Five participants have had some experience playing digital games on a PC using a mouse and keyboard.

Resources and procedures

The game selection criteria included a COTS RTS game with a single-player campaign. The following features were prioritized in the selection process, including sufficient audio and text dialogues (related studies typically utilize text-based dialogues only), adequate player physical interactivity during times of dialogue instead of movie-like cinematic cutscenes, and selectable missions for better control. Based on these criteria, StarCraft II: Wings of Liberty was chosen. Produced by Blizzard Entertainment and released in 2010, StarCraft II has been one of the most popular RTS games, with global multiplayer tournaments currently taking place. This study utilized a mission called Outbreak, which was suitable due to its sufficient audio dialogue. Also, as a defense map, it allows a more consistent experiment time control. The mission uses a day/night cycle where players must guard their base during the night and attack the enemy during the day. The mission is won when all surrounding enemy structures are destroyed, and mission failure occurs when all of the players' buildings are destroyed. The game difficulty was set to the lowest level of 'casual,' which is recommended for players with little to no experience playing strategy games.

Two player stations were located adjacent to each other and separated by a divider (Figure 1). The watchers were located out of sight at a nearby station. One laptop and one desktop computer were used, each equipped with an Intel i7 processor and GeForce RTX 3080 graphics card, which exceed the manufacturer's recommended specifications. Both computers were connected to a 27-inch monitor, mouse, keyboard, and stereo headphones. A video and sound splitter were used to run the simultaneous video and audio feed to the watchers. Each watcher used a 27-inch monitor and stereo headphones.

Figure 1

Experiment player station

The participants first completed a demographic questionnaire and inputted their availability. Based on their answers regarding English proficiency level, international experience, and game experience, they were grouped with other participants with similar responses (deHaan et al., 2010). Nevertheless, the researcher needed to also take into consideration the limited sample size and participants' availability. Five groups in total were created, four with two members and one with three members. They were then randomly assigned to the player or watcher role. The experiment needed to be conducted over three days due to the participants' availability and available computers (Figure 2).

Figure 2

Daily schedule for experiment

A week before the experiment, the participants were given prework that they completed at their leisure. This was done to minimize the necessary in-person experiment time and minimize prolonged exposure during COVID-19. The participants completed a vocabulary pre-test and attitudes and perceptions questionnaire and watched a 15-minute video on YouTube in Japanese explaining the core mechanics of the game and how to play the Terran (human) race, which the game's single-player campaign focuses on.

Efforts were made to minimize the in-person treatment time to avoid participants becoming bored (deHaan et al. 2010). Nevertheless, it was also necessary to ensure that the players were given a sufficient understanding of the complex mechanics of the game. The target experiment time was set to under 90 minutes, including the game tutorial (10 mins), 1v1 skirmish map (10 mins), mission (40 mins), post-test and questionnaire (20 mins), and interviews (10 mins). When participants arrived, they were given an explanation sheet in Japanese outlining the experiment scope, data collection, and other details. They were given the opportunity to ask questions before giving their informed consent.

The participants were then given a schedule sheet explaining each step of the experiment and assigned to their stations. The instructions were to either play or watch the mission and try to learn the language. No interaction with other participants, notetaking, or word searching were permitted. The players were not permitted to pause the game unless necessary. And in the event of mission failure or success, they were asked to await further instructions from the researcher regarding repeating the mission or finishing the experiment.

The session began with a tutorial scenario with English explanations of the game mechanics since the game does not have a Japanese language option. The participants were informed that they did not need to learn the English for the tutorial and subsequent practice skirmish scenario. Instead, these steps were only there to allow them to learn about the game. After the tutorial, the players were

allowed to do a one vs. one skirmish against a computer opponent (Terran vs. Terran) for 10 minutes on the lowest opponent difficulty (very easy) to try the game out for themselves. Once again, the watchers watched the player play this section. The participants were then informed that the experiment mission would begin, where they would play or watch the game while trying to learn the English.

To ensure a smooth and consistent treatment, the researcher acted as an active participant when necessary in certain cases, including when participants asked questions or for scenario situations (mission success or failure). Internal rules were established that the participants were not aware of, explained as follows. For mission failure, a threshold time of 45 minutes was established. If the player failed the mission prior to this time, they would be instructed to restart the mission. If this time had passed, the player would restart the mission with cheats enabled, making the game easier by increasing the players' units' life points and attack damage. If the player failed with this mode, the experiment would then be over. In accordance with this, three groups had cheats enabled, and they were then able to complete the mission.

Data collection and analysis

Vocabulary test

A written vocabulary test was created for this study and administered twice, prior to the treatment and immediately after. The creation of the test is explained as follows. Multiple-choice questions were avoided to prevent the participants from deducing the correct answer based on the given choices or simply guessing the correct answer. Instead, the participants were given an entire sample sentence in English taken from the mission script with the target word or phrase in bold. They were asked to translate only the bold section into Japanese by writing it in a text box. If they did not know the answer, they could write, 'I don't know.' A correct/incorrect system was used by assigning 1 point for correct answers and 0 for incorrect answers. The results were scored individually by the author and a native Japanese speaker with advanced English proficiency. Any discrepancies were then discussed by the two graders, and a score was mutually agreed upon.

The following steps were taken for selecting the test items. First, the entire English dialogue of the selected mission was first written out. Then individual words were selected as well as compound words such as phrasal verbs and compound nouns, excluding colloquial words or idioms that require cultural context to understand. The selection of the items was based on the following criteria. First, words relevant to the mission scenario and means of accomplishing the mission were prioritized. Additionally, there was a focus on choosing dialogue that is observable in that the prompt was given, followed by the player or watcher immediately seeing its action played out on the screen, allowing them to deduce the meaning even if they don't know the word. Finally, low-frequency words that were most likely unknown to the participants based on the author's assessment were selected. The presentation order and frequency were controlled by the game and the player. No control could be implemented on the number of times

each word was witnessed. Nevertheless, grouping the players ensured a consistent experience between each player and their associated watcher. Altogether, 33 target items were chosen, and in order to prevent 'prepping' the participants, ten unrelated distracter words were created, along with their associated sentences. Thus, the total question count was 43, arranged in random order. The participants were instructed to finish the vocabulary test in 10 minutes and not to use dictionaries or internet searches to find the answers.

Attitudes and perceptions questionnaire

The same attitudes and perceptions questionnaire was conducted before and immediately after the treatment. It consisted of 25 Likert items derived from prior surveys, as existing questionnaires can be considered more reliable as they have been tested for validity and reliability (Alqurashi, 2016). The survey solicited attitudes and perceptions toward playing games and watching gameplay for language learning purposes. This was derived from Bolliger et al. (2015) (α = .72) and Bourgonjon et al. (2010) (α > .70), who tested students' perceptions and attitudes regarding playing digital games. These questionnaires were based on the traditional Technology Acceptance Model (TAM) by Davis (1989) and include the four criteria of ease of use, learning opportunities, experience, and preference. As with Bolliger et al. (2015), the survey included a 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree) to prevent the participants from choosing a neutral option, as has been an issue with Japanese students (Wang et al., 2008). The items were translated from English into Japanese by a native Japanese speaker with advanced proficiency in English.

Invested mental effort and perceived difficulty

The participants answered four questions after the treatment regarding their subjective invested mental effort and perceived difficulty of their assigned task. These questions were based on deHaan et al. (2010) (mental effort α = .551, material difficulty α = .565), who used the prior surveys of Kalyuga et al. (1998) (α = .4583) and Paas (1992) (α > .85), and are shown as follows.

Q1. How much mental effort did you invest in your assigned task (playing/watching)? [9-point Likert scale ranging from extremely low to extremely high mental effort]

Q2. How much mental effort did you put into learning English through your assigned task (playing/watching)? [9-point Likert scale ranging from extremely low to extremely high mental effort]

Q3. How difficult was your assigned task (playing/watching)? [7-point Likert scale ranging from extremely easy to extremely difficult]

Q4. How difficult was it to understand the English in the game? [7-point Likert scale ranging from extremely easy to extremely difficult]

Interviews

The post-treatment interviews were conducted individually in Japanese or English and structured on the questionnaire items (attitudes and perceptions, invested mental effort, perceived difficulty) (see Appendix). Nevertheless, they allowed the flexibility for participants to elaborate on their overall ideas. The conversations were recorded with permission and later transcribed and translated into English by a native Japanese speaker with advanced English proficiency. The transcripts were then coded to reveal trends.

Researcher observations

During the experiment, the researcher took notes on the physical actions of the participants (e.g., body posture, eye attentiveness, and signs of fatigue) and the in-game decisions the players were making throughout the mission. These were collected to offer suggestions for future studies regarding running them smoothly.

Results

Quantitative data

The vocabulary test and invested mental effort questions assess comparative effectiveness while the perceptions and attitudes survey examines participants' feelings towards pedagogy.

Vocabulary Test

The descriptive statistics of the pre and post-vocabulary tests are displayed in Tables 2 and 3.

Table 2

Descriptive statistics of the vocabulary pre-test

	N	Min	Max	Mean	Std. deviation
Players	5	9	20	13.8	4.02
Watchers	6	13	21	15.17	3.97

*max possible score = 33

Table 3

Descriptive statistics of the vocabulary post-test

	N	Min	Max	Mean	Std. deviation
Players	5	13	19	16.4	2.19
Watchers	6	14	26	19.67	3.89

*max possible score = 33

Both groups scored similarly in the pre-test, with the watchers having a slightly higher mean score (watchers = 15.17, players = 13.8). The results for the post-test show both groups increased in means. The watchers' increase in points was slightly higher (mean increase of 4.5) than the players (mean increase of 2.6). Additionally, while the watchers group increased both their minimum and maximum points, the players group had lower minimum and maximum scores on the post-test. In these cases, the participants gave correct answers on the pre-test but incorrectly changed them after the treatment.

Attitudes and perceptions

The results of the attitudes and perceptions questions are displayed in Tables 4 and 5. The players' mean scores increased slightly in all three categories (ease of use, learning opportunities, preference) after the treatment. Conversely, the watchers had the same mean score for ease of use, and both learning opportunities and preference decreased post-treatment.

Table 4

Means and standard deviations for perceptions and attitudes (players)

Item		M	SD
Ease of use	before	2.10	0.65
	after	2.30	0.27
Learning opportunities	before	2.65	0.38
	after	2.85	0.29
Preference for learning English this way	before	2.00	0.41
	after	2.33	0.47

*n = 5; max is 4

Table 5

Means and standard deviations for perceptions and attitudes (watchers)

Item		M	SD
Ease of use	before	2.42	1.07
	after	2.42	0.66
Learning opportunities	before	2.30	0.72
	after	2.40	0.96
Preference for learning English this way	before	2.27	1.00
	after	2.17	0.92

*n = 6; max is 4

Invested mental effort and difficulty

The results of the participants' subjective invested mental effort and difficulty of the task are displayed in Table 6. The players experienced a higher mental effort for their assigned task of playing (M = 7.00, SD = 1.58) than the watchers (M= 5.17, SD = 2.04). They also had less mental effort dedicated toward learning the English (M = 4.00, SD = 1.58) than the watchers (M = 6.00, SD = 2.37). Finally, the players felt their assigned task was more difficult (M = 5.60, SD = 0.55) than the watchers (M = 4.67, SD = 1.37), and the players felt they had slightly more difficulty understanding the English (M = 5.4, SD = 0.89) compared to the watchers (M = 5.17, SD = 1.17).

Table 6

Means and standard deviations for invested mental energy

Item		M	SD
Q1 Mental effort of assigned task	player	7.00	1.58
	watcher	5.17	2.04
Q2 Mental effort in learning English	player	4.00	2.24
	watcher	6.00	2.37
Q3 Difficulty of assigned task	player	5.60	0.55
	watcher	4.67	1.37
Q4 Perceived difficulty of understanding the English	player	5.4	0.89
	watcher	5.17	1.17

*Q1 & Q2: max = 9
*Q3 & Q4: max = 7

Qualitative data

The interviews and researcher observations provided additional explanation to the above quantitative data.

Interviews

The eleven interviews lasted approximately 15 minutes and yielded the following trends.

Trend 1: Most players and watchers feel watching is more effective for learning English. Four of the five players felt watching is more effective for learning English. One stated, "For sure I could have learned more English if I was watching today's game." Another reiterated, "When it comes to playing the game, it was quite difficult to learn the English since I had to concentrate on playing. Overall, … I think it's more effective to watch it." The one player who felt playing is more effective explained, "if I watch the games, maybe I cannot focus on the games. Maybe I will … (get distracted)." Nevertheless, all five reported difficulties concentrating on the language because they were too busy playing. One participant elaborated, "I couldn't understand what it was saying, and it was difficult for me to understand it properly because I was distracted by the game." Even the player who felt playing is more effective said, "I didn't care so much about the English. Just attack." One player made an interesting observation when he likened this experience to a flight school training program he is currently undergoing. One task involves him taking turns between flying a plane and watching a fellow trainee fly it in a computer simulation. The directions are simultaneously explained in English, and he described the experience by saying, "… when I watch other students do the simulation from behind, the content of the flowing English is absorbed quickly … but when I was actually holding the control stick, I was desperate to control it, and no (English) was absorbed in the end."

For the watchers, two of the six felt watching is more effective for learning English. One stated, "I think it's better to just watch while studying English. Overall, if you play the game yourself, you have to think about how to play the game. But if you just watch it, you will watch the game with the intention of listening to English and understanding it." Another agreed, "Well, I can concentrate on the subtitles in English. If I do the game, I think I can't focus on the English subtitles." Additionally, one watcher felt both watching and playing are effective for people interested in games, while another had mixed feelings. Only one watcher felt playing is more effective.

Trend 2: The skill of the player determines the viewing experience of the watcher. Both the watcher who felt playing is better for learning English and the one with mixed feelings reported their experience being ruined by boredom from the player having low skill. "It's a little bit irritating because this was a strategy game but the player … had no strategy," one complained. "I think I know better than him regarding the rules." The other stated, "I was more tired than expected … I felt like

it was repeating the same thing, and I was a little sleepy." In these cases, the mission runtime ran over an hour.

In addition to the trends, other notable findings recorded from the interviews are listed as follows. Two participants regularly watch gameplay but don't play games themselves, an occurrence found in other studies, as mentioned previously (Kaytoue et al., 2012). One player felt that it would have been more effective if he could pause the game to look up unknown words.

Researcher observations

The following observations were found by the researcher regarding areas of potential improvement for future follow-up studies.

Observation 1: Players require more training for the game beforehand. Despite receiving various opportunities to learn the game (online tutorial video, in-game tutorial scenario, and 1v1 skirmish scenario with a computer player), some players showed signs that they could not fully operate the game. Some observed examples of the players' actions include: not realizing the game's 'fog-of-war' mechanic, not creating Supply Depots to increase the maximum army size, relying on mouse clicks only without using keyboard shortcuts, and spending significant amounts of time before attacking the enemy base.

Observation 2: Participants appeared bored when the experiment runtime was long. In addition to some watchers complaining in the interviews of mental exhaustion and boredom from players' low skill level, the researcher also observed participants from both groups stretching their arms and backs and yawning multiple times, especially when the mission ran for over an hour. Selecting this defense-type mission did not ensure a consistent experience as intended since it would not end until the enemy base was destroyed. The researcher underestimated the time needed for players to achieve the objective, and consequently, the treatment runtime exceeded the intended time.

Discussion

The results of the vocabulary test show that the watchers performed slightly better than the players in the mean total score and the minimum and maximum scores. This supports the findings found in reflex games (deHaan & Kona, 2010) and music games (deHaan et al., 2010) while differing from the serious game used by Ali Mohsen (2016). And, since both groups performed better on the post-test, the results may also provide some support for Ebrahimzadeh (2017) despite this current study not implementing a reading group for comparison.

Next, the results of subjective invested mental effort also support the findings of previous studies (deHaan & Kona, 2010; deHaan et al., 2010) in that the players reported comparatively higher mental effort put into their tasks, less mental effort allocated to learning the English, and rated their task as more difficult. When

combining this result with the higher vocabulary scores for the watchers, this study supports assertions that physical interactivity may have an adverse effect on vocabulary learning (deHaan et al., 2010) in RTS games.

Furthermore, the attitudes and perceptions survey shows that the players' feelings improved after the treatment while the watchers' scores stayed the same or decreased. Yet, the interviews contradicted this in revealing that most players felt watching is more effective for learning English, while the watchers were less certain. One explanation for this may be that, as stated by two of the watchers, the lack of skill or insufficient preparation time of the player may have negatively influenced the watchers' overall experience. This was also seen in the researchers' observations, as some players appeared to not have adequately understood the game mechanics despite receiving prior preparation time and playing the game at the lowest difficulty setting. Overall, the players felt overwhelmed while some of the watchers felt bored, and this may have led to different results had the players been allowed more time to master the complex mechanics apparent in RTS games. Indeed, the viewership for online game watching is significantly higher for professionals than amateurs, and many viewers watch tournaments to witness the best players compete. This has not been considered in related studies testing interactivity and may have implications for studies and merit future investigation. Experiments also may need to be adjusted based on their affiliated game's learning curve to ensure an appropriate level of functionality that does not interfere with the experiment results.

Conclusion

Watching gameplay has become an international sensation, which opens up the importance of considering its merits for pedagogy and the effects of physical interactivity on COTS games. This study was conducted as an exploratory and preliminary step for testing the physical interactivity of an RTS game. The findings indicate adverse effects on interactivity, raising the prospect of the potential for watching gameplay for language-learning purposes.

While this study provides initial evidence for an RTS game, there are several limitations that prevent us from making claims or generalizations. Mainly, the sample size is small, and the treatment and test were conducted only one time. Additionally, different game genres have varying degrees of player interactivity and thus may yield different results. Therefore, future experiments can consist of larger sample sizes and longitudinal studies with delayed post-tests (Peterson, 2010) testing different genres (deHaan et al., 2010). It is hoped that the results of this study can assist in developing such studies.

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Appendix

Interview questions framework

Note: This template was used as a guide to ensure the dialogue stayed on topic. Nevertheless, the interviewees were allowed to elaborate on their ideas, and the researcher could pursue other lines of inquiry.

Overall experience and preference

- How was the overall experience today? Do you feel your English level has improved?
- If given a choice, which task (play/watch) would you have liked to have been assigned today?
- Do you play video games or watch gameplay?
- What is your usual way of studying English?

Ease of use (accessibility)

- If you were to continue doing this method (play/watch) by yourself to learn English, how difficult would it be?

Learning opportunities (perceived effectiveness)

- Before the experiment, how effective did you think your assigned task (playing/watching) was for learning English? Has this changed?
- Which (play/watch) is more effective for learning English?

Motivation and attitudes

- Before the experiment, how motivated were you to try your assigned method (playing/watching) to learn English? Did your opinion change?
- How motivated are you to continue learning English this way?
- Do you plan on continuing to study English this way?

Perceived difficulty and mental effort

- How difficult did the game itself seem (unrelated to language learning)?
- How difficult was your assigned task (play or watch while learning English)?
- How much of your mental concentration was used on performing your task versus learning English?
- Which task (play/watch) do you think would generally demand more of your mental effort?

Author's bio

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