



Research article

Exploring the relationship between digital gaming, language attitudes, and academic success in EFL university students

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ABSTRACT

The potential of digital games in education has been widely discussed, yet there is a significant gap in the literature regarding their influence on foreign language learning, particularly in Central Europe, and using mixed-method research designs. This study aims to fill this gap by providing empirical data from a new cultural context. Using a mixed-method research design, it investigates the impact of gaming on language learning outcomes of English as a Foreign Language (EFL) university students. A total of 99 Slovak university students of English as a foreign language were selected by convenience sampling, of which 10 were chosen for qualitative interviews to triangulate the data. The results reveal a significant improvement in vocabulary knowledge and a reported increase in positive language attitudes among gamers compared to non-gamers, with no significant difference in grade point averages between the two groups. These findings highlight the potential of digital gaming to enhance vocabulary learning and foster positive attitudes towards language learning among EFL students. Recommendations for future research are provided.

1. Introduction

Educators have long recognized the potential of games as effective tools for learning. Historical figures like John Amos Comenius, dating back to the 17th century, acknowledged the educational value inherent in games. This recognition has only intensified with the advent of digital technologies, and scholars such as Hubbard [1] and Phillips [2] have laid the foundation for understanding the educational potential of digital games. Building upon this groundwork, Prensky [3] coined Digital Game-Based Learning (DGBL) as a viable and effective educational approach. This idea was further developed by Gee [4] whose significant input emphasized digital games' potential in learning.

Many digital games popular among teenagers are not available in their native language, requiring them to use a foreign language to navigate and succeed [5]. The widespread adoption of video games for foreign language learning gained prominence in the 2010s [6], with Digital Game-Based Language Learning (DGBLL) identified as a promising approach for enhancing language skills, vocabulary, and grammatical proficiency [6,7].

DGBL has been demonstrated to be an effective tool for enhancing foreign language learning outcomes [8–10] in different contexts

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with the majority of research in Asia and Europe (e.g., Ref. [11–13]). European contributions to the topic have originated from Finland [14], France [15], and Spain [16,17].

Despite the popularity of digital gaming and the significant progress made in research on DGBL, to our knowledge, no empirical study has been conducted in Central Europe on the influence of playing digital games on EFL [18]. Furthermore, few of the research studies we found [19] explicitly explore the relationship between digital gaming and both cognitive and affective aspects of foreign language learning. This is particularly true for studies employing a mixed-method approach. The current study aims to address these gaps in the literature and provide empirical data on the impact of digital gaming on English language attitude and achievement pertaining to the Central European context.

2. Literature review

Playing digital games has become widespread across demographics and regions all over the world. According to the Entertainment Software Association [20], 65 % of all Americans play video games, with the majority being over 18 years old (74 %) and while 35 % of all players were aged 18–34. The data from the Statistical Office of the European Union [21] revealed that 58 % of Europeans aged 16–24 have used the internet to play or download video games. Additionally, a report by Video Games Europe [22] found that more than half of the European population plays video games, with the majority being over 18 years old (76 %), similarly to the USA.

Since so many people of learning age play digital games, researchers focused on harnessing the potential of digital games for learning. Most studies on DGBL have concentrated on its cognitive benefits in STEM disciplines (e.g., Ref. [23–25]). While they revealed more or less positive effects of digital games on academic achievement [26,27], the research in humanities and social sciences yielded less clear-cut results [28–30].

A positive correlation between students' involvement in gaming and their grade point average (GPA) in English-related subjects has been detected in some studies [31,32]. On the other hand, digital gaming was correlated with a reduction in time allocated to learning, resulting in a decline in academic performance [28,29,33].

Nevertheless, a consensus has emerged regarding the efficacy of digital games in enhancing foreign language learning, especially vocabulary learning [34–37]. Digital games have been found to provide distinctive opportunities for acquiring, retaining, and contextualizing vocabulary [14,17,38]. Vocabulary learning, in particular, benefits from the immersive and interactive nature of digital games, facilitating repeated exposure and contextualization [11,39,40]. The engaging nature of game environments have shown promise in fostering motivation, memory, task-switching, instant feedback, and interactivity, which can enhance learners' engagement and autonomy [38,41,42]. In language learners, it may promote autonomous learning strategies such as word lookup and contextual integration of new vocabulary [9,11,43]. These strategies can facilitate the development of foreign language proficiency beyond traditional classroom settings and nurture positive attitudes toward language learning [44].

Learning through digital gaming offers a low-risk setting for exploring various paths and problem-solving strategies without the fear of real-life consequences. Mistakes are viewed as an essential part of the learning process [36,45]. Additionally, the game environment can evoke feelings of enjoyment and security, which might reduce learners' anxiety about using a foreign language and making mistakes [15,36,40]. Foreign language learners reported an overall positive attitude towards learning a language using digital games [11,15,43,46] and often cited increased motivation as one of the key benefits [10,12,38].

Chen et al. [47] suggest that the genre of a digital game is a crucial factor in determining the effectiveness of language acquisition. Multiplayer online role-playing games have the potential to enhance English language learning due to the extensive communication required with both native and non-native English speakers [32,48,49]. Adventure game genres, in particular, can be more stimulating and motivational for students due to their requirement for complex cognitive processes such as critical thinking, problem-solving, and task engagement, compared to non-adventure game genres [47].

3. Methodology

3.1. Objectives

We aimed to find out whether playing digital games in English improves the attitude to the English language and the academic achievement of EFL students. Since vocabulary learning has been identified as the area of language most positively affected by playing digital games in literature, we focused specifically on students' English vocabulary knowledge.

The frequency of playing digital games in English was considered a predictor variable with the potential to predict the level of outcome variables [50] – English language attitude, English language academic achievement, and English vocabulary knowledge. Another assumption was that a significant relationship could be demonstrated between the predictor variable and the outcome variables. Therefore, the correlations between the data sets collected by the research instruments were calculated.

There is not much time in school curricula to include digital games in the classroom, so the current study did not use the method of experiment from a longitudinal perspective. This cross-sectional research reflects findings based on autonomous gaming outside the classroom. Data collected at one point in time on a sample of participants were analyzed by applying a mixed-methods research design based on quantitative and qualitative data obtained through the questionnaire, rating scale, test, and interview, respectively [51]. The individual scores of the respective parts were analyzed using descriptive statistics in the Statistica 9.0 Standard Plus CZ program [52].

The combination of quantitative and qualitative research methods allowed us to obtain complementary perspectives on the issue. All variables (gaming frequency, attitudes toward language, academic achievement, and vocabulary knowledge) were quantified using reliable research instruments, and the cause-and-effect relationships were validated through the participant's perspectives in the

interview.

Based on the research objectives, the following research hypotheses and questions were formulated.

Hypothesis 1. The English language attitude of digital game players is more positive than the English language attitude of digital game non-players.

Hypothesis 2. The English language academic achievement of digital game players is higher than the English language academic achievement of digital game non-players.

Hypothesis 3. The English vocabulary knowledge of digital game players is at a higher proficiency level than the English vocabulary knowledge of digital game non-players.

Hypothesis 4. There is a significant positive correlation between the frequency of playing digital games in English and English language attitude.

Hypothesis 5. There is a significant positive correlation between the frequency of playing digital games in English and English language academic achievement.

Hypothesis 6. There is a significant positive correlation between the frequency of playing digital games in English and English vocabulary knowledge.

Question 1. What is the players' self-perceived impact of playing digital games in English on their English language attitude?

Question 2. What is the players' self-perceived impact of playing digital games in English on their English language academic achievement?

3.2. Sample

A total of 99 non-native (Slovak) university students of English as a foreign language selected by convenience sampling served as participants in this study. The learners also had other variables in common, such as their level of English proficiency (B1–B2) [53] and their age (18–21 years). All participants provided written informed consent.

In terms of gender, the sample included 77 female and 22 male participants. Based on the initial questionnaire filter question (Appendix A), out of a total of 99 students, 45 were identified as gamers and 55 were identified as non-gamers. 86 % of the male participants reported playing video games, compared to 34 % of the female sample.

3.3. Instruments

3.3.1. Questionnaire

The questionnaire was designed in the participants' native language to elicit their opinions about the impact of playing digital games on their English language competence, which is understood as linguistic, sociolinguistic, and pragmatic knowledge and skills in English (www.coe.int/lang-CEFR).

In the preliminary stage of the questionnaire design, a flow chart technique was used to plan the sequencing of the questions. The pilot was then conducted with a group of 10 respondents with the characteristics of the research sample (internal consistency 0.82). The questionnaire (Appendix A) was then refined, and amendments were made to the layout and wording of two of the items. The questionnaire was self-administered by the author to enable any queries from the respondents to be addressed immediately.

The first question 'Do you play computer games in English?' served as a filter for the following contingency questions, according to which the participants were divided into the groups of players (P) and non-players (NP). To balance the response burden for both filter options [54], an equal amount of items was offered to both players and non-players. The players were asked about the frequency of gaming, the games they play, and their self-perception of the impact of gaming on their English language competence. The frequency of playing games was then coded in a 4-point descending scale (4 – daily, 3 – weekly, 2 – monthly, 1 – yearly). Non-players were asked to express their opinions on gaming and other activities that can enhance their English language competence.

3.3.2. Language Attitude Scale

The scale (Appendix B) used was inspired by the Foreign Language Enjoyment Scale [55] and the Foreign Language Classroom Anxiety Scale [56]. The tool used was intended to reflect the combined effect of positive and negative emotions in foreign language learning [57]. The scale consisted of 30 items with standard 5-point Likert scale ratings reflecting positive emotions towards the learning experience, peers, and the teacher (within an interval of 30–150 points), with all items positively phrased (absolutely disagree = 1, disagree = 2, neither agree nor disagree = 3, agree = 4, strongly agree = 5). In half of the items related to foreign language anxiety (each even-numbered item), a reversed scoring was used, with higher scores reflecting higher foreign language enjoyment. In pilot testing an acceptable internal consistency level and test-retest reliability were revealed (Cronbach alpha = 0.88).

3.3.3. Grade Point Average

The overall English learning achievement of each participant was expressed by a grade point average based on a 1.0 to 4.0 scale commonly used in European tertiary-level education (A = 1.0, B = 1.5, C = 2.0, D = 2.5, E = 3 and F = 4), with a 1.0 representing a "perfect" GPA. The cumulative GPA represented an average of all marks accumulated throughout the participants' bachelor's studies.

Partial GPAs were also calculated for the courses focused on English language skills (reading, writing, listening, and speaking); systems (pronunciation, grammar, and vocabulary), and the study of English-speaking countries. GPA was the only variable expressing an indirect proportion of coding (higher quality – lower number), therefore reverse coding was used for the correlation analysis.

3.3.4. Vocabulary Test

The Vocabulary Test contained 25 items (1 item = 1 point) (Appendix C) in the multiple-choice format at the level of a proficient user C2 [53]. Items typically not known by the participants at their language level were selected from several relevant sources according to the authors' teaching and gaming experience.

(<https://www.cambridgeenglish.org>, <https://www.examenglish.com>, <https://www.oxfordonlineenglish.com>, <https://www.ieltstestonline.com>).

The pilot test (internal consistency 0.87) was conducted in a group of 10 respondents with characteristics of the research sample who subsequently did not further participate in the experiment. Following an analysis, six items with little discriminability for which the respondents consistently answered correctly were identified and replaced by different items.

3.3.5. Game genre

Despite the fact that an unequivocal agreed-upon classification of digital game genres is not currently available [58,59], the authors specified eight types of game using the prevailing character of performance as the main criterion: Role-playing, Action, Action-adventure, Adventure, Strategy, Sport, Simulation, and Platformers. This classification is based on the information reflecting the current state of the gaming industry (<https://codakid.com/video-game-genres/>).

3.3.6. Interview

A semi-structured individual interview was used in conjunction with other methods to triangulate the data and further characterize the participants' self-perceptions and experiences of the impact of gaming and other activities on their English language attitude and achievement. The ten respondents with the highest frequency of gaming (several hours every day) were interviewed. As a first step, the research objectives were thematized and transformed into 8 direct form questions. The flow chart technique was used to plan the sequencing and framing of the questions: 1. the impact of playing digital games in English on the attitude to learning English (items 1–2); 2. the impact of playing digital games in English on achievement in English courses (items 3–4); 3. the impact of playing digital games in English on English vocabulary (items 5–6); 4. the impact of other activities on overall English competence (items 7–8) (Appendix D).

The interview was conducted in a face-to-face format. The interviewer (the author) informed each participant about the purpose and procedure of the interview, and each respondent was asked for permission to record the responses. If necessary, the interviewer also had the option to prompt the students to clarify the questions as well as to probe the participants to provide details for the responses. The participants were instructed to answer the questions in their own words, thus producing unstructured responses. The interviews were then transcribed and analyzed by generating and classifying the answers.

Peer debriefing and member-checking techniques were used to ensure the credibility of data collection and analysis, following the proposal by Lincoln and Guba [60] as cited in Cohen et al. [50] (p. 136). Additionally, after each interview question, the respondent's answers were repeated to confirm that the output data matched their intention. Furthermore, respondents were given the opportunity to provide additional information to their answers. The interviews were recorded exclusively for transcription purposes. Moreover, peer debriefing was utilized, similar to cross-examination, by consulting all output data with the other authors of this manuscript. This helped to review the interviews and identify any potential errors or biases.

To analyze the data, we followed the methodology described by Hycner [61], as cited in Cohen et al. [50], (p. 471). The analysis began with listening to the recordings and transcribing each interview. During transcription, we aimed to capture not only the literal statements but also the non-verbal and paralinguistic aspects of communication. We then identified similar units within the transcripts and categorized the information into several recurring sub-categories, guided by the research questions outlined in Appendix D. We then eliminated all units that were irrelevant to our research objectives and clustered the relevant units of meaning. Finally, we synthesized and conceptualized the clustered information.

4. Results

4.1. Questionnaire

The first question 'Do you play computer games in English?', enabled the division of the participants into groups of 45 players and 54 non-players. Most players (43 respondents) indicated that playing computer games helps improve their English language competence, primarily their vocabulary (89 %) and pronunciation (31 %). The majority of these students stated that they play digital games several times a week (average frequency of playing 3.18).

Similarly, most non-players (89 %) also indicated playing computer games as helpful in increasing English language competence – mainly vocabulary (83 %). Nevertheless, they also stated a preference for other activities to improve their competence – watching audio-visual materials (films, TV series, videos, podcasts, songs) (63 %) and reading (54 %). They indicated that these activities improved to a greater degree their English vocabulary (85 %) and grammar (37 %).

4.1.1. Language Attitude Scale

The average scores obtained (within the interval 30–150) were higher in the group of players (107.18) than in non-players (101.59) (Fig. 1). The statistical difference between the groups was statistically significant at the level $\alpha = 0.05$ ($Z = 1.975$, $p = 0.048$) (Table 1) as verified by the Wilcoxon Rank Sum Test. The distribution of frequency is more or less similar in both groups (Fig. 2).

4.1.2. Grade Point Average

The average scores obtained (within the interval 1–4) were similar in both groups ($P = 1.92$; $NP = 1.91$) (Fig. 3), with the inter-group difference statistically insignificant at the level $\alpha = 0.05$ ($Z = 0.598$, $p = 0.550$) (Table 1). Regarding the GPA sub-scores (English language systems/skills/studies), the group results were only slightly different as well: systems ($P = 2.24$, $NP = 2.14$), skills ($P = 1.44$, $NP = 1.44$) and studies ($P = 1.78$, $NP = 1.69$). The distribution of frequency is more or less similar in both groups (Fig. 4).

4.1.3. Vocabulary Test

The average scores obtained (from the total 25 items) were higher in the group of players (21.04) than in non-players (18.54) (Fig. 5). The statistical difference between the groups was statistically significant at the level $\alpha = 0.05$ ($Z = 3.660$, $p = 0.000$) (Table 1) as verified by the Wilcoxon Rank Sum Test.

In a comparison of the distribution of frequency, the differences between the groups are even more distinct. While most players (73 %) achieved a score within the highest interval (21–25), the scores of non-players were distributed mostly within the highest three intervals (Fig. 6).

As the variables were scaled and did not have a normal distribution, the data obtained by the research instruments applied were also submitted to a correlation analysis using the Spearman rank correlation coefficient (R). The frequency of playing games seems to have a low predictive validity in this context, as a statistically significant weak correlation was detected only between frequency of playing and vocabulary knowledge ($R = 0.340960$) (Fig. 7). The correlations between frequency of playing and language attitude ($R = 0.177096$) as well as between frequency of playing and language achievement ($R = 0.187744$) were statistically insignificant.

$0 \leq |R| < 0.3$ – insignificant correlation. $0.3 \leq |R| < 0.5$ – weak correlation. $0.5 \leq |R| < 0.7$ – moderate correlation. $0.7 \leq |R| < 0.9$ – strong correlation. $|R| \geq 0.9$ – very strong correlation.

4.1.4. Game genre

As supplementary information, the genre of game played was related to the students' results in Vocabulary Test, Language Attitude Scale and Grade Point Average. Each gamer usually plays games of at least two different genres, with the most frequent type being role-playing games (49 %). As Table 2 shows, the highest scores for the individual variables were obtained among gamers preferring role-playing and action-adventure genres. However, a direct comparison of the average scores is rather problematic, as the groups contain diverse amounts of players, thus extreme values of the variables are often shown. Nevertheless, we observed that the action-adventure and role-playing genres had the highest mean scores in the vocabulary test. Additionally, action-adventure ranked second in terms of language attitude, with role-playing games following closely behind. Surprisingly, role-playing games ranked last in terms of GPA, while action-adventure games ranked second to last.

Additionally, the study revealed that all digital games identified were commercially available off-the-shelf titles. It is worth noting that none of the participants reported playing educational or serious games, nor did they engage with number-based games. Therefore, it can be inferred that the majority of participants preferred games that included text or voice prompts, either directly or indirectly.

4.1.5. Interview

Most of the students surveyed (8 out of 10) said that gaming was an important, but not the only factor, in their overall positive attitude toward the English language and in their motivation to learn it: "I wish I could speak English like that." They attributed some influence (30–40 %) to "having good English teachers" and "watching cool videos in English."

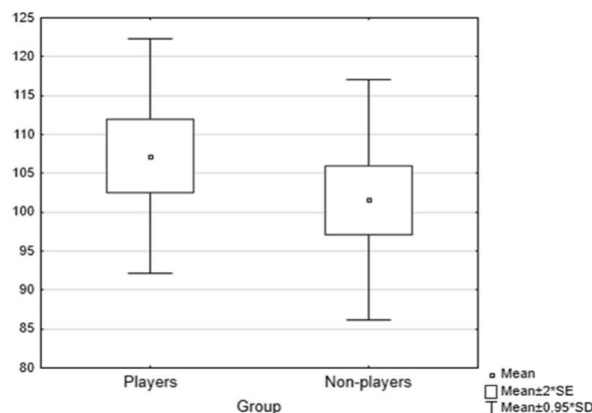


Fig. 1. Scores of the Language Attitude Scale in the groups of players and non-players.

Table 1
Scores of variables in the groups of players and non-players.

	Players				Non-players		
	Vocabulary	Attitude	Achievement	Frequency	Vocabulary	Attitude	Achievement
Mean	21.04	107.18	1.92	3.18	18.54	101.59	1.91
Standard Error	0.53	2.36	0.06	0.15	0.51	2.21	0.07
Median	22.00	109.00	1.89	3.00	18.5	100.5	1.86
Mode	24.00	118.00	1.75	4.00	18	117	2
Standard Deviation	3.57	15.84	0.40	0.98	3.76	16.21	0.55
Sample Variance	12.73	251.06	0.16	0.97	14.10	262.66	0.30
Kurtosis	3.45	-0.52	0.58	-0.11	-0.30	-0.22	1.33
Skewness	-1.78	-0.19	0.70	-0.97	-0.43	0.59	1.08
Range	16	67	1.875	3	15	68	2.563
Minimum	8	70	1.25	1	10	77	1
Maximum	24	137	3.125	4	25	145	3.563
Sum	947	4823	86.372	143	1001	5486	103.160
Count	45	45	45	45	54	54	54

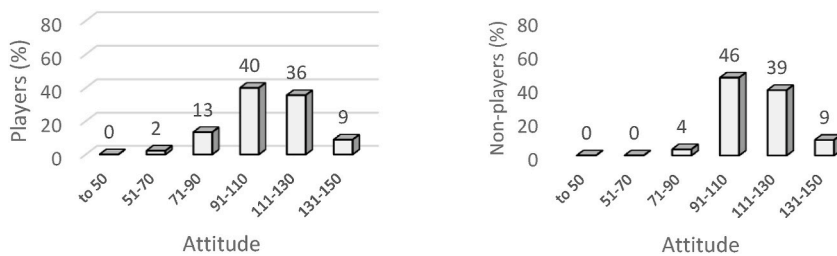


Fig. 2. Distribution of Language Attitude Scale scores in the groups of players and non-players.

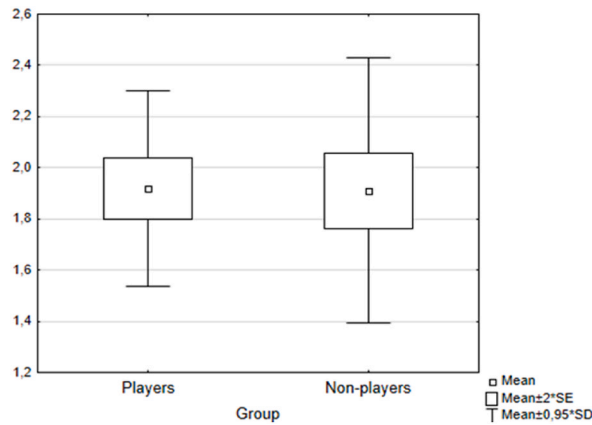


Fig. 3. Scores of Grade Point Average in the groups of players and non-players.

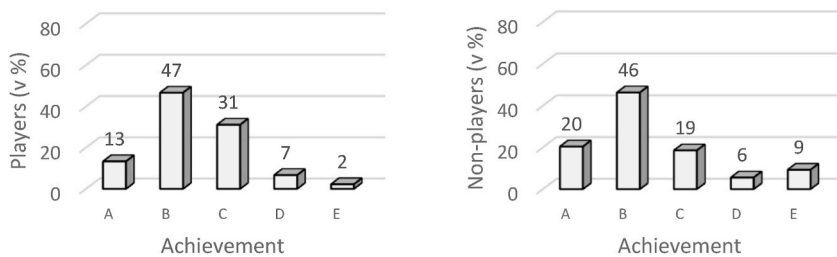


Fig. 4. Distribution of Grade Point Average scores in the groups of players and non-players.

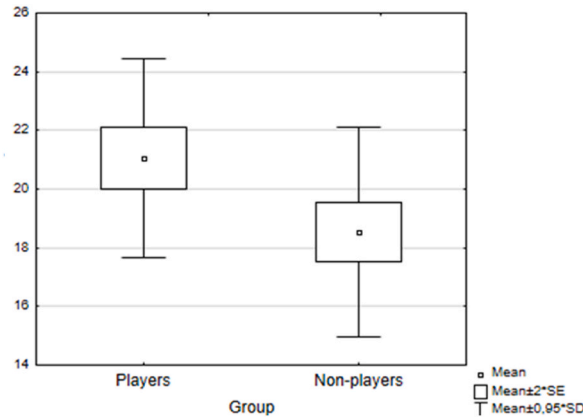


Fig. 5. Scores of the Vocabulary Test in the groups of players and non-players.

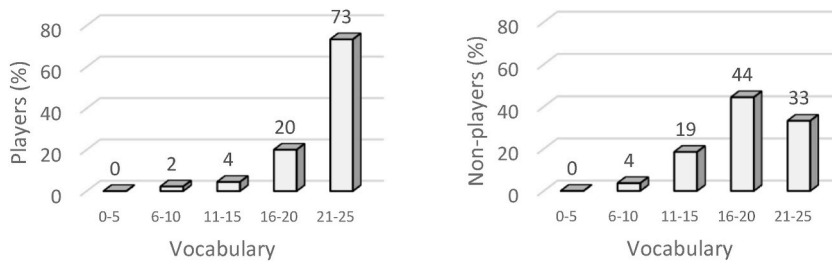


Fig. 6. Distribution of Vocabulary Test scores in the groups of players and non-players.

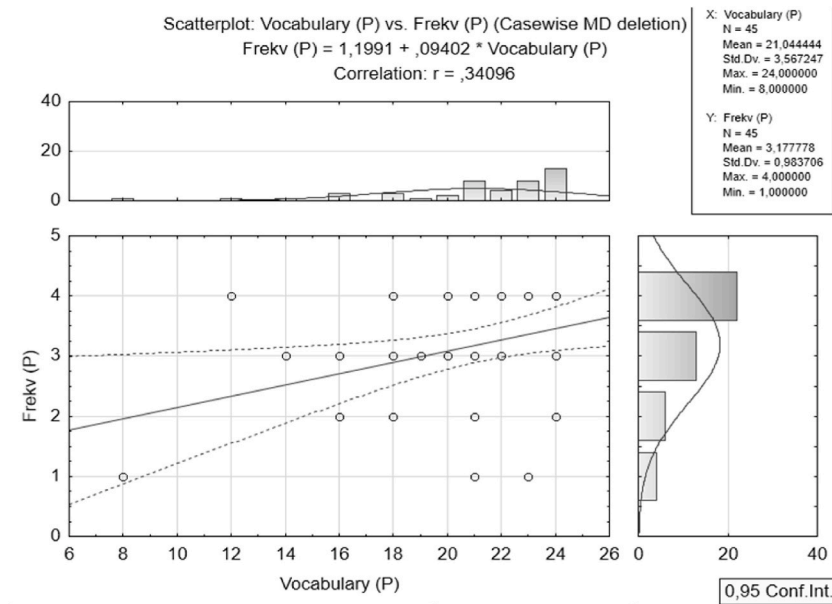


Fig. 7. Correlation between frequency of playing and vocabulary knowledge.

“Mainly thanks to the games, but I have also watched a lot of videos. I would say 60 to 40 for games.”

The learners’ results reflected the impact of games on reducing English speaking and listening apprehension. Especially in multiplayer games, they were put in situations where they had to communicate intensively with other players. More than half of the participants declared that a pretend virtual identity helped them feel less afraid of being ridiculed if they made mistakes:

Table 2
Scores of the variables in different game genres.

Game genre	No. of players	Vocabulary Test		Language Attitude Scale		Grade Point Average		Frequency of playing	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Role-playing	22	22.27	1.96	108.5	16.44	1.82	0.34	3.41	0.85
Strategy	16	21.06	3.09	112.81	16.83	1.94	0.46	3.5	0.63
Action	12	21.67	2.39	101	13.22	1.93	0.31	3.17	1.11
Action-adventure	9	22.33	2.6	109.44	15.64	1.86	0.45	3.22	0.67
Simulation	7	20	3.61	106.43	11.07	2.05	0.22	2.86	0.69
Adventure	5	15.8	6.02	105.2	26.44	2.05	0.43	2.4	1.52
Sport	3	17.67	4.93	109.33	9.87	2.56	0.51	2.67	1.53
Platformers	2	14.5	9.19	81.5	16.26	2.04	0.01	1.5	0.71

“The games may be a virtual world, but the language is real.”

Students felt that digital games facilitated their academic performance in English language subjects/courses at all levels of education, from primary to tertiary. Most respondents perceived the greatest facilitating effect of digital games during their secondary education. They also mentioned that because they used English as a primary language to communicate in the games, even though they spoke the same mother tongue, they often communicated in English outside of the gaming environment, such as at school during breaks. One student expressed this by saying:

“Me and my friends used to communicate in English during games and even used English words in everyday communication outside of games.”

In addition, all but one of the respondents felt that they were ahead of their peers in terms of English language competence, particularly during their primary (8/10) and/or secondary (7/10) education. Surprisingly, one student who did not feel that he stood out mentioned that he had represented his class in a recognized English competition.

All respondents said that this advantage they had during their school years was mainly (8/10) or partly (2/10) due to digital games.

Eight respondents appreciated the frequent repetition of words and phrases in the digital games, which made them easier to memorize. Six students indicated that playing digital games helped them a lot in English phonetics and phonology classes due to improved listening comprehension and four of them reported that in reading comprehension classes they understood “*more complex vocabulary than the other peers*.” Other courses mentioned by the students included a special English seminar, creative writing, and history.

All interviewees agreed that games increased their English vocabulary mainly because of the strong motivation to look up the words and phrases in a dictionary to continue playing. They found the visualization of vocabulary and subtitles in both their native language and English very useful. Additionally, they explained that their primary motivation for learning new words stemmed from the necessity to comprehend in-game texts, which often contained deliberately concealed or ambiguous instructions. For example, one participant stated:

“I wanted to understand the texts in World of Warcraft, so I often needed to look up the vocabulary while playing. The more the particular vocabulary item appeared, the better I could understand it.”

Furthermore, two interviewees highlighted their exposure to diverse regional accents while playing a particular action-adventure game. They remarked, “*I heard many different accents in Assassin’s Creed, for example, the British accent*”. Participants identified role-playing (multiplayer online), strategy, action, action-adventure, and simulation (sandbox) as game genres most beneficial for language skill development.

In addition, all but one respondent identified themselves as “gamers”. One participant commented: “*I know that some people take this term negatively, they see the stereotype of a ‘gamer’ – overweight who does nothing but play games. I do not agree with that. I am in contact with other gamers and I know that they are normal, capable people.*” However, other respondents disagreed with this stereotype and mentioned that for them being called a “gamer” was a compliment.

5. Discussion

Our research confirms the popularity of digital gaming. The trend identified by the Statistical Office of the European Union [21] is reflected in our study, where 45 % of undergraduate EFL students reported playing video games, compared to 58 % in the EU report.

Consistent with most related research (e.g., [11] [15,43]), attitudes toward English were more positive among the players than among the non-players (Hypothesis 1 was confirmed). The respondents indicated that games were one of the factors that promoted positive attitudes toward English, along with having a good English teacher and watching interesting videos in English. The immersive experience provided by games gives players the opportunity to travel virtually [15], potentially increasing their interest in studying foreign languages and cultures.

The desire to speak native-like English seemed to be one of the strongest motivations for the respondents (cf. [10,12,38,41]). Therefore, the motivation of common players to learn a language for games could be enhanced by intrinsic motivational models of language learning among EFL learners [62].

The comparison of overall English academic achievement during undergraduate study, expressed by grade point average, revealed similar scores for the players and non-players, even for the sub-scores calculated in courses focusing on English language systems, language skills, and cultural studies (*Hypothesis 2* was rejected). This finding neither concurs with the results of other research demonstrating the facilitative effects of gaming on foreign language achievement (e.g., Ref. [63,64]), nor with the results showing that exam grades are negatively correlated with gaming frequency [28,29].

Nevertheless, a broad generalization of this finding should be made with caution, as the current sample (English majors) was rather homogeneous in terms of their English language competence. In addition, our interview findings were inconsistent with the quantitative results regarding GPA, as participants reported outperforming their peers in English-oriented classes primarily due to their engagement with digital games.

Despite contradicting some studies suggesting that the cognitive load of digital games may hinder vocabulary retention (e.g., Ref. [65,66]), our research highlights the undeniable benefits of digital games for vocabulary acquisition (e.g., [34–36]). The participants' belief that playing digital games facilitates foreign language vocabulary learning was supported by the results of our study. Specifically, the vocabulary test scores of gamers were significantly higher than those of non-gamers (*Hypothesis 3* was confirmed). In addition, qualitative interviews revealed that gamers attributed their success to visualization, repeated exposure, and contextual repetition of words and phrases during gameplay. These findings are consistent with Rasti's [38] study, which emphasizes the importance of these elements in learning foreign language vocabulary through digital games.

Thus, it seems that playing digital games might represent an effective means of vocabulary proceduralization, as this activity presents opportunities for several varied types of exposure to lexemes in authentic contexts [39]. Nevertheless, our efforts to develop a reliable instrument to measure this variable proved to be quite complicated. Although the selection of test items was based on the authors' teaching and gaming experience, the wide variety and rapid development of digital games prevents the creation of a universal vocabulary test for digital game players [12,14].

Regarding supplementary materials, the study found that the most popular genres were role-playing games and adventure games. These genres were also found to be more effective in improving cognitive abilities, particularly in vocabulary tests where they achieved the highest scores. This indicates that the game genre might have played an important role in the effectiveness of digital games on cognitive outcomes as suggested by previous results [47]. The findings presented are consistent with previous research indicating that the role-playing game genre may stimulate the highest cognitive domain [32,48,49], as evidenced by the highest vocabulary test scores.

Surprisingly, despite the vocabulary gains, role-playing games scored the lowest in terms of GPA, with adventure-action games scoring the second lowest. This implies that while players may increase their vocabulary, this does not necessarily translate into academic success. One contributing factor may be that students neglect academic responsibilities to spend more time gaming [28,29]. However, it is important to interpret these conflicting findings with caution due to the small sample size, which may have led to extreme results.

Comparing the learners' scores in the domain of attitude, achievement, and vocabulary, it was found that the frequency of game playing as determined by the questionnaire was significantly correlated only with the results of the Vocabulary Test (*Hypothesis 6* was confirmed, *Hypotheses 4* and *5* were rejected). Most players indicated a preference for multiplayer role-playing games, which were seen as not only more attractive but probably also beneficial to their language competence and attitude. Such games offer storylines that can be highly controlled by the player and create situations that require a high degree of interaction and communication. On the other hand, single-player platform games may have less of an impact on foreign language development [67].

6. Conclusion

The results of this study confirm the authors' assumption that playing digital games is an effective complementary activity that can be easily used in foreign language learning across diverse educational contexts. It has been shown effective in increasing learners' positive attitudes toward learning a foreign language and expanding their foreign language vocabulary.

By providing additional time for practicing the material, gaming can complement traditional foreign language instruction, which often takes place in limited contact hours. Nevertheless, game playing cannot serve as a universal substitute for real-life communication practice. Interestingly, most respondents considered learning with a good English teacher to be an equally important motivator for learning English.

It is hoped that this research project will serve to contribute useful empirical data that can be applied in the further study of digital game-based foreign language learning in unexplored cultural contexts. However, these findings must be interpreted in the light of several limitations. First, the size limit of one academic article precludes publishing data on all parts of this research within a single text. Overall, the data gathered in this study may very well offer additional perspectives on the issue. A second limitation is the sample size and structure: although the results from the groups showed clear tendencies in terms of data, the use of larger and more diverse populations may allow group distinctions to emerge more clearly as EFL students seem to be quite specific in this context. They seem particularly receptive to and can benefit from the language side of games.

Future studies may also choose to examine the variables analyzed here over longer periods, develop a classification system for digital games based on the specific perspective of language learning, design and validate tests for foreign language competencies related to gaming, and/or investigate other affective variables related to digital game-based foreign language learning.

Ethics declarations

This study was reviewed and approved by Ethics Committee of Constantine the Philosopher University in Nitra, with the approval number: UKF/74/2024/191013:003.

All participants provided informed consent to participate in the study.

All participants provided informed consent for the publication of their anonymized case details.

Data availability statement

The data are not publicly available due to the sensitive nature of the research. After some modifications (removal of sensitive information), data may be shared by the corresponding author upon reasonable request.

CRediT authorship contribution statement

Gregor Vnucko: Writing – original draft, Visualization, Resources, Investigation, Formal analysis, Conceptualization. **Zdena Kralova:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Data curation, Conceptualization. **Anna Tirpakova:** Software, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e33301>.

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