

# Serious game designed as a support tool for lexicology

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## Abstract

Serious games (SG), which are part of digital game-based language learning (DGBLL), can be perspective in game-based learning and teaching support. DGBLL has been one of the fastest-growing areas of interest in language learning in recent years. This paper describes a study of prepositions, an SG designed for participants of the 3<sup>rd</sup> year of lower primary school stages in Slovakia to improve their use of prepositions on a sample of participants (n = 30). The aim of this paper is to perform the user acceptance test and analyzing of user satisfaction with this designed SG. A secondary goal is to classify the degree to which English prepositions were problematic for participants. The results and conclusions have been summarized and graphically visualized.

**Key words:** serious game, acceptance testing, user satisfaction, digital game-based language learning, lexicology

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## Introduction

Games, technologies and training have had a long-standing position in history. In training, games are used by teachers for class instruction in social studies, sciences, humanities or for guidance counseling.

Digital technologies relate to the term electronic learning (e-learning). Kozik and Belica (2007) claim that e-learning can be seen as a way of teaching, acquiring information, knowledge and skills (Beno et al., 2019) with the use of modern information and communication technology (ICT), while it can be said that it is an alternative of classic learning (attendance-based and distance learning). Nowadays, we witness rapid and continuous ICT innovations, development and implementation in all areas of the advanced society. On the basis of the above, e-learning is not just an alternative to classical (traditional) learning, but it is an integral part of learning and teaching. In this connection, Susi et. al. (2007) claim that e-learning is rather a general concept that refers to computer-enhanced learning, computer-based learning, and commonly, distance learning, interactive technology. One of the forms of e-learning can be related to games. In connection with game and learning, there are several terms used, such as game-based learning, digital game-based learning, digital game-based language learning, serious gaming, edugam, serious game, educational game or educational gaming, etc.

One of the first authors who opened and introduced the concept and definition of SG was Clark Abt (1970). In connection with the term "serious," he states that serious is also used in the meaning of a study relating to matters of great interest and importance, raising questions not easily solved and having potential consequences. Moreover, he further shows – games may be significant without being solemn, interesting without being hilarious, earnest and purposeful without being humourless and difficult without being frustrating. Games are effective teaching and training tools for students of all ages and in many situations because they are highly motivating and because they communicate the concepts and facts of many subjects really efficiently. Furthermore, games may be used by schools to identify specific types of nonverbal abilities – cognitive problem solving, social negotiating, organizing, and communication skills (Abt, 1970). Sørensen et al. (2007) define SG as a digital game and equipment with an agenda of educational design and beyond entertainment. In the

work of Michael et al. (2006) the authors claim that SG is an increasingly important medium in terms of education, training, and social change. Arnab et al. (2011) offer a definition that SG also has the potential to enhance the user's experience through multimodal interaction. There is a broad spectrum of definitions, claims or statements on SG. However, in our meaning, we can define them as the medium of an intervention designed to develop or improve cognitive, affective or psychomotor abilities, skills or knowledge at all levels.

However, the use of games can be effective only if elements such as graphics, audio and video effects, goals, competition, challenges, animations or fantasy influence motivation and facilitate learning. The work of Choriantopoulos et al. (2014) and Nicholson (2015) shows that stimulating contexts and the game's story can motivate students to use the game. Sailer et al. (2017) and Kapp (2012) examine how different aspects of gamification (including the methods and strategies) actually affect different motivational outcomes.

One of the most important parts of the software engineering resp. serious game development is testing. There are various forms and types of testing. We have decided on user acceptance testing (UAT). In the work of Mohamad et al. (2016), the authors state that UAT is the last phase of the software testing process. During this process, software users test the software to make sure it can handle required tasks in real-world scenarios, according to specifications. According to userback.io (2022), in all other tests except UAT, it is the developers or quality assurance team that perform them. UAT is unique because the end-user (or client) does the testing. The portal further states that UAT is unique because the end-user (or client) does the testing. As the end-users will ultimately use the app, it is only natural that they are the ones to test it at the end. It is essential because UAT helps identify any problems that might have been missed or overlooked development team helps if the product is actually ready to be launched into the market if the product meets the specific work requirements, and many more. Another important underlying mechanism that connects satisfaction with one's performance to game enjoyment is self-esteem (Seery et al., 2004). User satisfaction in computer games seems to be influenced by game balance, and the level of challenge faced by the user (Andrade et al., 2021). Satisfaction could be defined as primarily a function of perceived service quality (Yang, 2009) and as the experience while playing a video game (Phan et al., 2016).

In connection with DGBLL, Alyaz et al. (2016) show that it has received increased attention, especially in recent decades since successful implementations have been reported in various studies. Authors claim that teachers from different subjects, including English language teachers, are integrating gaming as a learning medium to educate students in several different disciplines (Yanes et al., 2019). SG design and development are efficacious and cost-saving methods of delivering educational content (Wilson et al., 2009; Townsend, 2009), have adaptive intervention (Mulder et al., 2021, Gabriska et al., 2018), and bring true potential because the game-based nature is reflected in some particularities that the traditional learning approach does not have (Zhonggen, 2018), attract students' attention (Townsend, 2009), prolong English vocabulary retention (Alshaiji, 2015) etc.. Moreover, some of the studies offer certain findings on gender in connection with SG and English learning. In the work of Zhonggen (2018), the author claims that males significantly outperformed females in serious game-aided English vocabulary learning.

In connection with DGBLL, it is very useful to integrate SG into formal or informal educational contexts of foreign languages as well. Abt (1970) claims that since conventional English-language skills are needed to do well on these tests, we can expect a non-English-speaking foreigner to perform poorly. For this reason, it is advisable to integrate SG in order to train and help students and improve their language skills. Lexicology is one such area.

Lexicology may be defined as the study of lexis, with the meaning of stock of word or words in a particular language. This definition shows that the notion of words is central to the study of lexicology (Jackson et al., 2007). The influence of lexicology ensures the improvement in students' communication. Another definition of lexicology states that every language has a vocabulary or "lexicon", which forms one part of its grammar. Lexicology helps to understand words, analyze them and acquire the vocabulary. In the work of Saravanan (2014), it is stated that there are difficulties in the use of prepositions, particularly of place, time and direction. In this connection and according to the Oxford dictionary, a preposition is a word or group of words, such as in, from, to, out of and on behalf of, used before a noun or pronoun to show place, position, time or method.

### **Methodology**

Based on the definitions and benefits which support the above topic, the purpose of the study can be defined. The main goals are the study to assess the user acceptance testing and user satisfaction and to find out the participant's level of lexicology resp. To classify the degree to which English prepositions were problematic for participants in the SG. Improving lexicology could be a great personal growth exercise/-es that could be beneficial for future everyday life. It has been impossible to cover all possible prepositions from real life. Therefore, we have chosen the most frequent ones and also included some prepositions that may be rare. Therefore, the most common everyday life prepositions were chosen. In the few lines below, we are going to introduce some details about the participants, materials, as well as procedure and hardware. The results are summarized and graphically visualized.

#### *Participants*

This study was conducted at a primary school in the western part of Slovakia. Before the study began, we had requested the management of the school to test the SG. Having obtained the approval, we began with the preparation. Pupils of the 3<sup>rd</sup> grade (from 9 to 10 years old) of a public primary school were the participants of the study. The pupils were asked to participate and join the study by playing the SG. Those who did not want to be part of this study did not play the SG, and stayed out of the computer classroom (with another teacher in another classroom). A total of 32 participants took part in the study (16 boys, 16 girls), out of which 2 participants did not complete the SG (2 males). In addition, out of these 30 participants, 27 were Slovak, and 3 were Ukrainians. Out of the 30 pupils, there were 14 boys (47%) and 16 girls (53%) who completed the game. Approximately 22 participants (67%) stated that they lived in a city, and the remaining 8 participants (33%) reported living in villages.

#### *Materials*

In this paper, we investigate the user acceptance testing and user satisfaction and find out the participant's score in lexicology, focusing on the use of English prepositions. It was used the mini SG focuses on practicing prepositions in the English language. This SG is more suitable for students of English as a second language rather than native speakers. The SG named "Looking for Prepositions with Me" is a so-called single-player serious game, which means that the SG does not offer a multiplayer mode. In addition, this SG is a stand-alone interactive computer game-based application. The first version of the SG was developed in autumn 2015. Some of the features, the design process and development stage, including procedures, programming and details, are introduced and described in the publication of Hostovecky and Cicka (2015). A few years later (2019), the SG was modified, as some new items have been modeled and textured, as well as the new environment at level two, and the gameplay

have also been modified. The SG uses cartoon graphics (fun-oriented animations), and the game challenges the player to deal with a series of 20 tasks – situations. A set of instructions comes with each situation. The player uses the keyboard and mouse to control the game.

### Procedure

Data were collected in early spring 2022. The study was conducted for 2 days. The participants were informed about the goals of the study, and all essential details were explained. The study always began at the same time in the morning during the 2<sup>nd</sup> and 3<sup>rd</sup> lessons.

Each participant was asked to play the SG. It was a computer classroom with 20 PCs. The SG was played on 17" monitors, with full HD resolution (1920 x 1080) in full-screen mode. Computers had the following configuration: Intel i5 processor, 8GB RAM, 512 GB SSD and MS Win 10<sup>th</sup> operating system. The game was controlled by a keyboard and mouse. Every computer was connected to the LAN. No hardware or software problems were detected during SG testing.

Before the study began, the participants had been instructed on how to play the SG. The "New game" button starts the game with a preposition task to be solved. A set of instructions comes with each situation so that the player always knows what the objective is. When the game starts (Figure 1a), a dialog box with a label to enter the name appears (Figure 1b). After that, the player had the opportunity to edit some settings in the Options menu as e.g. the volume intensity (turn up, turn down or turn off music and sounds).



**Figure 1a, 1b.** Splash screen of the SG and name entry dialog box (Source: Host'ovecký and Čička (2015)).

Let's start the game! The aim of the game is to look for highlighted items (Figure 2), such as a ball, umbrella, pillow, star, lamp so on.



**Figure 2.** Highlighted Objects in the SG (Source: Host'ovecký and Čička (2015)).

These items are situated in three different separated rooms (bedroom, bathroom and kitchen (Figure 3)). The character can move from one room to another. As the serious game progresses, the participants get new experiences and skills. The game is controlled with just a keyboard and nothing else. A computer mouse is used to choose the option when three prepositions are displayed.



**Figure 3.** Three separated rooms – kitchen, bedroom and bathroom (Source: Host’ovecký and Čička, 2015).

When the character comes to the item, the serious game stops and shows a label with an English sentence with blank space for choosing the preposition. The player can choose one of three options (Figure 4).



**Figure 4.** English sentence with blank space for choice of the preposition (Source: Host’ovecký and Čička, 2015).

The game finishes when the player finds all 20 items in 3 rooms or when the brown balls (enemies) take away 100% of the player's health (in the health bar). The player must then play the SG again. The brown balls – enemies are objects which chase the main character. The player can have a rest for a while, and the participant does not need to concentrate at this stage of the game. The "enemies" move around the room freely, and their movement is unpredictable.

One of our main goals was to realize acceptance testing, specifically User Acceptance Testing (UAT). Because it was necessary to verify the effectiveness of the SG by UAT, for the UAT, the end-user must take this test as it talks about the experience with the product as a whole. Acceptance test cases are performed based on the test data, and then the results are compared with the expected ones. This UAT was realized by the paper and pencil method, which affords a degree of namelessness, respectively anonymity of the participants. It allows more candid responses to our questions about the SG. We are aware that online questionnaires are more user-friendly, comfortable, and offer a more secure method (Campos et al., 2011), but the reason did not disturb the participants through playing the SG and not switching windows on the screen.

### *Scoring*

The score is set as follows. The player can obtain max. of 20 points, 1 point for each task = situation = preposition. There are 20 different situations in all three rooms. The score is divided into two numbers: blue and red. The blue score adds a point only if the participant chooses the correct option, preposition (at the first attempt). If the player chooses an incorrect preposition, the participant gets 1 red score point. If the player answers correctly, i.e. choose the correct preposition at the first attempt (out of three options), the participant receives 1 point for that task. However, if the participant answers incorrectly (i.e. chooses a wrong option at the first attempt), the participant gets 1 point for the incorrect answer. If the participant does not select the correct option on the first attempt but chooses the correct answer on the second attempt or even at the third attempt, the participant does not get another point for the correct or incorrect answer.

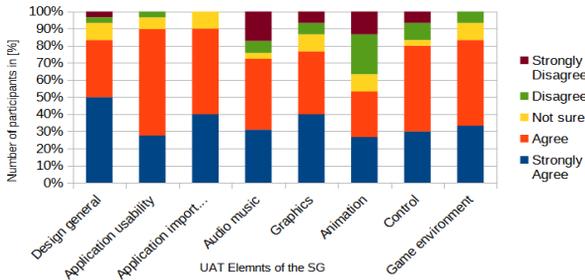
*Statistical analyses*

A Violin plot was applied to investigate the association among participants' correct answers. This graph was created in R. R language, one of the most popular open-source programming languages. It is used for statistical analysis. Scientists, data analysts, and statisticians do analyze statistical data in this programming language.

**Results and Discussion**

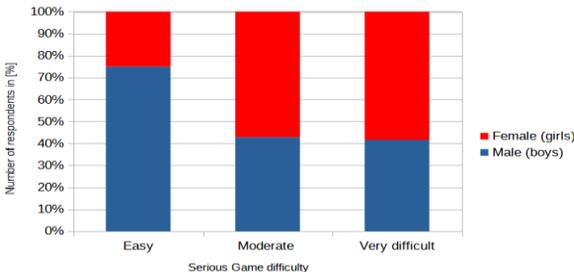
The study presents and illustrates our findings, results, and discussion with interpreting in the field of user acceptance testing, user satisfaction, and analyzing problematic English prepositions. The participants were aged from 9 to 10. Out of 30 participants, there were 14 boys (47%) and 16 girls (53%).

The first type of testing was user acceptance testing – UAT. Based on the results (Figure 5) from all 30 participants best rated among UAT elements application usability 26 participants (86.7%), application importance (90%), control (80%), and design general (83.3%). Participants rated the worst the following elements, including animations (36.7%), audio music (23.3%), and control of sprite (16.7%).



**Figure 5.** Proportion of participants' user acceptance testing (Source: Research results of the author (2022)).

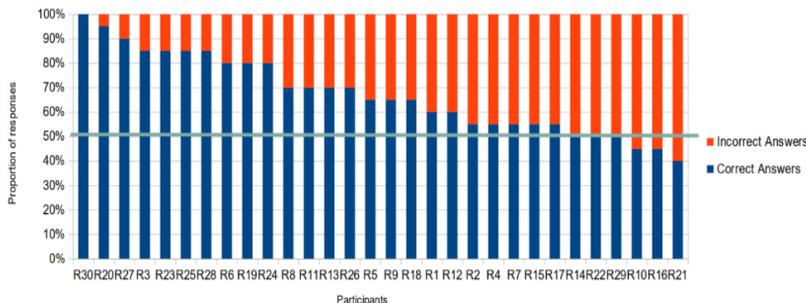
Another important part of this study was to explore the satisfaction with the SG. The participants were asked to answer how they rate the difficulty of SG: *easy, moderate or very difficult* (Figure 6). On the basis of the results of the participant, we can confirm that only 1 girl reported that the SG was easy, 8 girls reported as moderate, and 7 girls reported the SG as very difficult. In comparison with boys, 3 of them reported this SG as easy, 6 of them as moderate and 5 boys reported as very difficult.



**Figure 6.** Satisfaction of participants with SG difficulty (Source: Research results of the authors (2022)).

The last part of the study was to investigate which are the most and the least problematic prepositions. Prepositions may be defined as short words or compound words, and the majority of the most common prepositions have one syllable, such as *at, in, on* etc...

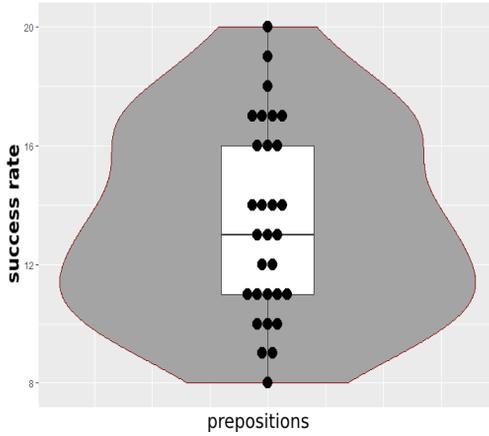
All participants got scores for preposition detection tasks. Based on the results (Figure 7) the proportion of the participants who correctly and incorrectly answered prepositions is shown. The results the researcher has obtained from that are as follows: Out of all 30 participants, 27 scored more than or equal to 50% of all prepositions. Only 3 participants of all did not score at least 50%. The partial results of the 2 participants who did not complete the SG are missing.



**Figure 7.** The proportion of participants' correct and incorrect answers (Source: Research results of the authors (2022)).

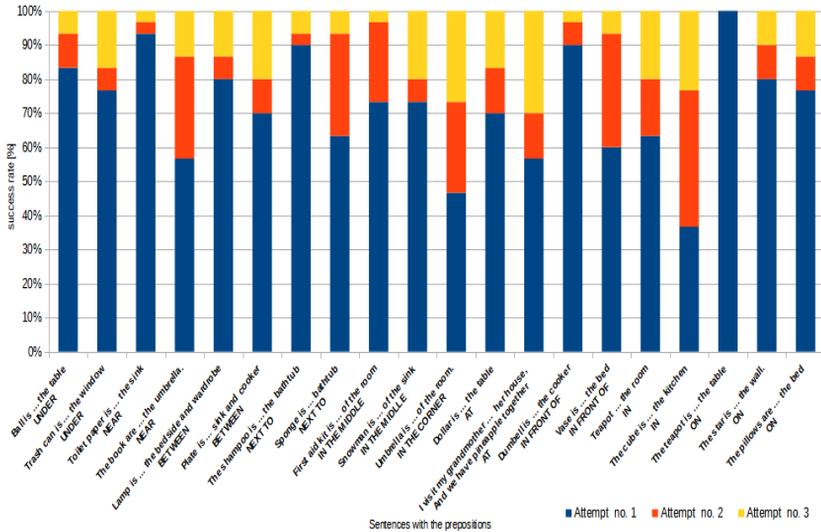
In the work of Postma et al. (2019), it is stated that reporting the actual data in graphs and plots increases transparency and enables independent evaluation. The authors also state that data summaries are often used in graphs because they aid interpretation. In connection with the data analysis, the raw data can be combined with any of four data summaries, i.e., mean, median, box plot, and violin plot. For our purpose, we have decided to apply the violin plot for the result analysis and processing. Hintze et al. (1998) claim that the violin plot is basically a smoothened histogram rotated by 90° that provides the data density estimation. The violin plot adds information to the simple structure of a box plot.

In the figure (Figure 8), the violin plot indicates the number of participants with correct answers. The data of the respondents are shown as black dots. The results show the success rate of all participants, which means how many prepositions were chosen correctly. The figure also shows that out of the 30 participants in the study, 21 chose 11-17 correct prepositions, 3 participants (10%) scored between 18-20 correctly answered questions. Only 1 participant had a full score, i.e. all the prepositions were chosen correctly by the participant at the first attempt. The remaining 6 participants had between 0 and 10 correct answers. None of the participants scored 0 correct answers (on the first attempt).



**Figure 8.** Violin plot of the participants' correct answers (Source: Research results of the authors (2022)).

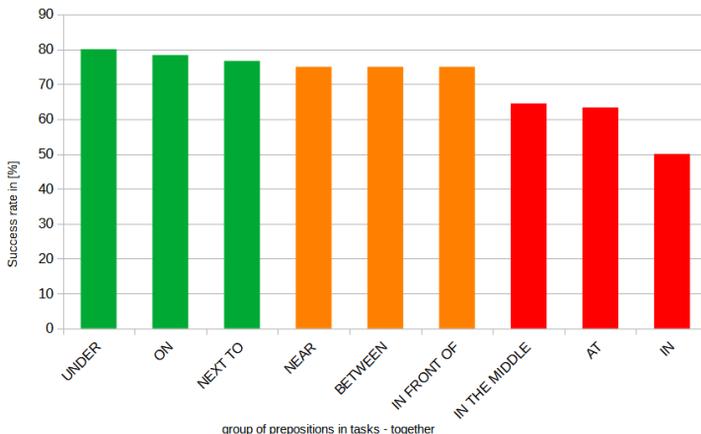
The following figure (Figure 9) declares which prepositions were problematic more or less for participants. The SG focused on English prepositions is the type of test which checks understanding of the common prepositions in English.



**Figure 9.** % Success rate of participants by attempts in SG (Source: Research results of the authors (2022)).

In figure (Figure 10) shows the percentage success rate of correct answers of participants. The results show that the highest success rate between all prepositions has had prepositions (the green columns) *under* (80%), followed by *on* (78%) and *next to* (77%). Between medium-difficult prepositions (the orange columns) belong *near* (75%), *between* (75%), and *in front of* (75%). On the other hand, between the

most challenging prepositions (the red columns) with the lowest score belong the following prepositions: *in the middle* (64%), *at* (63%), and *on* (50%).



**Figure 10.** % Success rate of all prepositions in SG – together (Source: Research results of the authors (2022)).

### Limitations

The study has its limits. The sample size is one of the most important factors of well-designed research. The sample size of this study was 30 (2 participants did not finish the game) participants. Large sample size is expected in order to have parameters that are closer to the population parameters. Furthermore, the larger the size of the sample, the more accurate the data, as a small sample size may lead to inaccuracies in the data and conclusion/s. Moreover, the sample was from one school in the western part of Slovakia only. It would be beneficial to obtain data from different parts of the country and to compare the results.

Different factors might have affected the score of the participants. Further research is necessary in order to evaluate the divergent validity of the findings. Of course, the validity of the participants' answers (their quality) may be questionable due to the fact that if a participant lacked internal motivation, they only clicked the game and were motivated (forced) only by external motivation, i.e. the teacher during the lesson.

### Conclusion

The SG offers several English prepositions tasks. The SG was designed for primary school attendants. Nowadays, the issue of integrating serious games into the study experience of pupils, students, or even adults belongs to the most increasing innovative approaches to training. The main goal of this study was user acceptance testing (UAT), analyzing user satisfaction (focused on the difficulty of the SG), and finding out the participant's level of lexicology. In connection with the UAT, participants gave lower scores to the following elements: animations (36.7%), audio music (23.3%) and control of sprite (16.7%). On the basis of these results, it will be necessary to change the graphic of some objects, change the style of background music and sounds and improve the control of sprite as well. Currently, for change to be beneficial, more detailed tests should be carried out. From the lexical perspective, among the most difficult prepositions for participants were: *in the middle* (64%), *at* (63%), and *on* (50%). Perhaps, more situations – tasks with the above prepositions should be integrated into the SG. In this connection, some important issues that

serious games researchers and developers deal with include how and by what participants are motivated and what engages them, which will be an area of our further investigation.

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