



**Developing and examining a virtual
learning environment**

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Zsolt Kristóf¹ & Kitti Tóth²

Abstract

Virtual reality (VR) provides several potentials to unlock in today's world. VR is a computer interface that allows users to interact with each other or with the media in a computer-generated three-dimensional space using senses (Piovesan, Passerino, & Pereira, 2012). One of the most important VR environment is Second Life. It provides both for educators and students the opportunity to deviate from the habits, to leave the traditional framework of teaching and learning (Chen, 2016). In our research, we created a virtual learning environment in the Second Life that is called Fornax. The devices placed in the area were intended to provide a thorough introduction to the different parts of the digestive system. In a virtual space, students can easily learn about human organs, as they also can see what they are learning, which can be a huge help in acquiring information (Huang, Liaw, & Lai, 2016). Based on the results, we could state that test results of users who are more familiar with Second Life are significantly better respondents than the beginner users. However, one of the four types of questions that of multiple choices with short answers provided the same result.

Keywords: learning support, virtual learning environment, Second Life

¹ Doctoral School of Humanities, University of Debrecen, Debrecen, Hungary, Email address: zsolt.kristof@gmail.com, ORCID: 0000-0002-2108-4915

² Department of Pathology, András Jósza Teaching Hospital, Nyíregyháza, Hungary, Email address: toth.k94@gmail.com, ORCID: 0000-0002-8087-2153

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Introduction

E-learning

Nowadays, the demand for distance learning is increasingly spreading in education, especially in higher education. Distance learning or e-learning is when the teacher and the student do not connect in the traditional way, i.e., face-to-face during the educational process, and the physical gap between them is bridged by the technology (Rahman, Karim, & Byramjee, 2015). Accordingly, it is understandable that the integration of new IT tools into the process of distance learning is outstandingly important. It is important to choose tools and interfaces that provide good communication are well maintainable and easy to use for both lecturers and students.

At present, electronically available text-based learning materials, tests, data-sharing systems are widely used in education, complemented by communication interfaces such as chat or forum (e.g., MOODLE). However, there are plenty of new platforms that can meet the needs of e-learning too (Yanuschik, Pakhomova, & Batbold, 2015). These platforms provide a much more modern environment; their application is usually and can be more efficient than the more common ones, such as today's highly popular virtual environments.

Virtual reality (VR)

There are several definitions for defining virtual reality (VR) as the concept is relatively new. Linda Jacobson called the world of digital technology and the perceptual experience created by that as the virtual world with the remark that the user is also present in this space. In 1993, she distinguished four types of virtual worlds entitled immersive VR, desktop VR, projection VR, and simulation VR (Jacobson, 1993).

According to another terminology, VR is a computer interface that allows users to interact with each other and the space in a computer-generated three-dimensional space applying their senses through a specific device (Piovesan, Passerino, & Pereira, 2012). The categorization of the virtual spaces is usually based on whether the medium has been designed for game or not or whether it has been designed for one or more users. The environment can be individual or social based on how many users are present.

VR in education

The inclusion of VR in the e-learning-based processes is an enormous innovation, where the learner is able to study not only on a simple text surface but in a three-dimensional environment. This can motivate the student to learn and through expanding the scope of traditional ways, it can make learning exciting. The educational process is enriched with

the experiences. With the visual elements, the learning material becomes easier to remember, memorize, and understand. Another great advantage of a virtual environment is that it can even be formed by the students. In this way, the educational process can be customized, the tools meet the needs of the students, and their opinions can be considered in the design of the different objects. These parts can be changed later, mistakes can be corrected, and the progress can become even more efficient. One of the most unique opportunities of the virtual world is the possibility to interact with our environment. Other people, objects, and places can be known and these also can influence the events in the virtual world. These interactions can motivate the learning progress and encourage students who might not be able to communicate properly (Bautista, 2016).

The use of VRs allows us to observe events and places that we would not be able to do in the reality or only using a huge amount of resources, for instance, if we visit the surface of the Moon or the Mars during a simulation or a distant point of the Earth. We can examine either the internal structure of a human body or really tiny things such as atoms or molecules (Höbl & Welzer, 2015). A culture-related and meaning-oriented task helps the student to engage in learning. Virtual simulations make the tasks more realistic; thus, they have a positive impact on learning outcomes and on academic achievement. If the teacher can take the students anywhere with three-dimensional videos, either on a trip to the Grand Canyon or on a boat trip to the Nile to ancient Egypt (without any costs), it would offer a huge alternative compared to traditional education. The virtual world provides both for educators and students the opportunity to deviate from the habits and to leave the traditional framework of teaching and learning (Chen, 2016). Pupils make their own decisions. If they make a wrong decision, it would have a consequence and they can learn from their mistakes. Therefore, the correct answers and decisions are not only memorized but understood as well (Hanson & Shelton, 2008).

Second Life

Our research was conducted in the virtual space of Second Life (SL). This is a three-dimensional virtual world created by the company of Linden Research (or also known as Linden Lab, San Francisco, California, USA) in 2003. At first, it was not a great success, but its popularity started to improve in 2006 and 2007. In 2011, the number of active users reached one million.

It is difficult to say how many people are covered exactly in reality, as a person can have more than one user profile. SL is not a game as there is neither a predetermined way to use nor points or levels that the user must reach. However, we also can participate in single or multiplayer games using different objects. With such games, other users also can

be met even from the other side of the world. Due to this, SL can be considered a social network because we can communicate with others through text-based, voice-based, or other interactions. SL can be accessed through a so-called viewer. This is a program that uses the technology of OpenGL technology to load the three-dimensional space. Visitors can use a variety of viewers. The most basic one is the version developed by the Linden Lab, but alternative programs can also be used, mentioning, for example, the Firestorm Viewer or the Singularity. The creators of SL support the use of the environment in education. Universities can decide to make the area accessible for everybody or only to students who have paid the tuition fee of the course. Groups for educational purposes also can be found within SL ([Hargis, 2008](#)).

When learning in the virtual space, the possibility of having comfort and fun and sharing the experience is significant. It also means that institutions, organizations, and companies working in the different areas of education can design and operate outstandingly more effective educational programs and web interfaces, which will bring them many new students and users. This provides them with the opportunity of being more prominent on the Internet ([Gallego, Bueno, & Noyes, 2016](#)). The use of virtual worlds has irreversibly changed the traditional teaching and learning habits. They can provide appropriate conditions for a novice student while they have more advantage such as good quality, low costs, safety, and remote access. Moreover, the digital environment becomes more aesthetic and efficient besides being already advanced. Another feature is that they have a clear impact on the intellectual development of the students; they increase the participation of the students in practice-oriented tasks and improve their self-management skills too ([Pellas, Kazanidis, Konstantinou, & Georgiou, 2016](#)). In the case of virtual learning, the participants highlighted the benefits of the informal environment and the joy of the learning progress, while students learning with a real teacher felt the educational situation more stressful ([Vrellis, Avouris, & Mikropoulos, 2016](#)). The teaching situations experienced in the SL world have increased the expectations of the participants toward their reality-based teaching lessons. Ata ([2016](#)) also reported that the boundaries had been expanded for students and they became more creative during the investigation.

During the test of an English language learning tool created during research, students showed outstanding development in terms of speaking and listening skills.

The environment was run by five experts (experienced users) from various universities in Turkey as educators who observed that the system is also outstanding in the development of writing and problem-solving skills. The lecturers pointed out that the use of different abilities in SL is possible. Moreover, the application tasks related to planning task and developing materials tasks can significantly improve the effectiveness of SL in teaching English language. It follows that written and audio communication done in SL is effective.

The experts have pointed out that SL should be presented to both students and lecturers for reaching higher effectiveness ([Sarac, 2014](#)).

Research questions and hypotheses

Our research questions were the following:

- Were there any differences between the results of the experienced and new users?
- What percentage of questions was optimal according to the Difficulty Index?
- What percentage of questions could be considered relevant based on the Discrimination Index?

We have formulated the following hypotheses:

- The results of the experienced users on the whole and in the different types of questions are significantly better than those of the new users.
- At least 75% of the questions were optimal according to the Difficulty Index.
- At least 90% of the questions were appropriate according to the Discrimination Index.

Tools and Methods

Material and methods

Our basic idea was to assist anatomy education with a virtual device at the Health Care Management BSc training of the Faculty of Health at the University of Debrecen. The main idea was to use visual elements to help to learn of appearance and location of the organs of the digestive system, as it is an integral part of the curriculum of the course. In their study, Huang et al. stated that the effectiveness of virtual learning environments largely depends on the material to be learned. The three dimensions provide a real experience, making the given vocabulary easier to learn. However, it is not recommended to experiment with too much text. In a virtual space, learners can easily learn about human organs as they also see what they are learning and it can be a huge help in acquiring information ([Huang, Liaw, & Lai, 2016](#)). The advantage of using SL is that we can witness the conversation of others, use different avatars of the Internet, gain knowledge about the virtual world, listen to music, read printed text, participate in role plays, and can be available 24 hr a day. The benefits of SL can be really exploited if it is not a general issue but a specific topic ([Levak & Son, 2016](#)). This is the reason why we focused on a well-conceived, concrete knowledge in our investigation.

Sixty-two people were enrolled in the study, which was divided into two groups. An experienced user, i.e., an expert, is considered any user who has already started using the program earlier than he/she was involved in the experiment and uses it regularly too. During our investigation, we managed to reach 31 experts. In contrast, a new user, i.e., a newbie, is an individual who has not used the environment previously or has rarely used it; he/she is just meeting its potential and basic functions. Each of the 31 newbies involved in the research was a user who had only heard about the program but had not used it yet and had no username and password, so we provided these for them. The center of our environment, the Fornax – shown in Figure 1 – was a hospital building that was acquired from the Second Life Marketplace and adapted according to the needs. At the beginning of our virtual educational environment, a guide was placed in English and in Hungarian that the testers could receive by clicking on a picture. This included the purpose of the experiment and a brief description of the function of the device.

The first task of the participants was to read this guide considerably and then start the test of the device according to the rules described here. We also had to introduce the use of the environment for the new users. We did this personally or, in the absence of this option, using the built-in chat or voice connectivity functions. During this, we found that newbies were generally interested, followed our instructions, and tried to follow these instructions during the progress. However, it was also noticeable, especially among experts, that many people had interrupted testing or reading the items during the experiment despite our request. Some of them quitted only for a few minutes, but there was some user who exited the test and did not return later. Thus, involving experienced users in the experiment was especially cumbersome and caused problems. It should be noted that several compromises must be made during research in SL. However, research in virtual space also provides great benefits. In a study related to health behavior in SL, four of these benefits are highlighted as follows. Compared to research made in reality, the impact of physical/geographical limitations is reduced, and special groups are easily accessible. VR requires a relatively small amount of resources that provide a mixed communication channel and interface. Anonymity and



Figure 1. Entrance to the Fornax with placed guides

appearance with avatars make it easier to handle sensitive topics. Virtual worlds make it easier for people to observe their behavior during digital communication (Keelan et al., 2015).

In the next step of the research, the task of the student was to find the image of the eight main organs of the digestive system within the area of the hospital along with a designated route.

The pictures were placed in the appropriate order of the route of the food – you can see the 6th, 7th, and 8th picture on Figure 2 – and by touching them they could get the notecard containing the textual information. These texts have been developed from the appropriate medical literature in Hungarian and in English (Marieb & Hoehn, 2007; McKinley & O'Loughlin, 2011).

The participants did not have to learn the descriptions; they only had to read them carefully, or to memorize the pictures, which usually took 1–3 min per organ. After collecting the information, the route came out of the building and ended. Here, the testers could find two test tools that looked similar to digital tables. The tools can be seen in Figure 3. Clicking on the screen, they received a welcome message in the pop-up window, and later, they received the questions one by one, which could only be filled with the knowledge read in the previous texts. These test tools were purchased from the Second Life Marketplace.

One of the tools contained the test in English, whereas the other one in Hungarian.

The questions were divided into four types based on our literature knowledge:

1. Multiple Choice – Short Answers: This type of question is one of the closed-type questions. It consists of two parts. One of the main parts is the question itself, or the sentence we are looking for as the answer. The other main part contains the options. The options include the right answer and diverting responses can also be found here,



Figure 2. Entrance to the Fornax-placed organs in Fornax

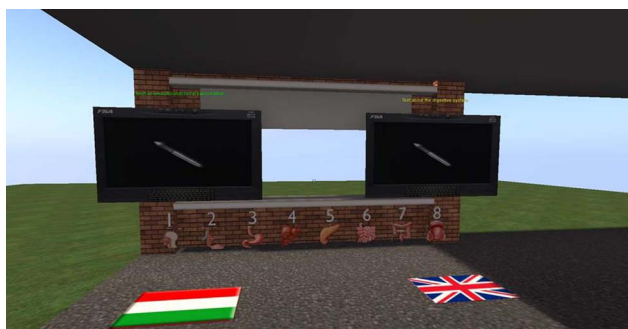


Figure 3. Controlling environment

which are created to confuse the respondent if he/she is not sure which one is the correct answer. For the quality and accuracy of our multiple-choice questions, the Difficulty Index and Discrimination Index can provide information.

2. Multiple Choice – With Visual Assistant: It is based on question type A. This was modified as the predefined short concepts were replaced with images and the user has to choose the number of the corresponding organ image. As support, the image of the organs was redisplayed during the test. With this, the ability of the recognition of the organ was also tested.
3. Short Response – Numerical: It may seem like an open question at first, but it is a closed type of question. It requires an exact numerical value from the respondent. This type is closed by the fact that the answers to the question fall into an expected interval, and the task of the respondent is only to determine the specific number within this interval. In computer tests and questionnaires, it is often possible that the answers to the question can be chosen by selecting the correct one from a drop-down menu.
4. Short Response – Complementary: Open type of question, no predefined answers as given. It asks the respondents for brief, concise information limiting the possibilities for answering. Another type of complementary questions is the complementary sentence in which category was also used in the current investigation. This is an incomplete sentence that must be completed by the respondent. It can be answered relatively quickly because it helps the respondent to determine which topic or problem she/he has to focus on. The difference between complementary questions and short answer questions lies in the length of the response. The question to be supplemented usually asks for a word or phrase, while for a short answer, some terms, sentences, or paragraphs can be given in response (Tavakoli, 2013).

During the creation of the tasks, we also put emphasis on the complexity of the questions. Tasks that also require logical thinking, in which relationships must be recognized as well,

have a better impact on the motivation of the students than examples where only simple already known information is needed to solve relatively simple tasks (Lan, Kan, Sung, & Chang, 2016).

For questions of type A and type B, the correct option could be selected by clicking on the question in the window containing the question, while for those of types C and D could be answered in the chat window after entering the “/2” channel selector without quotation marks and separated by space. During the test, they had to answer 32 questions. Eight questions were given from each type in a mixed order. We were able to enter questions into the device configuration file in notecard.

Results

Differences in the results of the experienced and new users

Table 1 shows the results of newbies, whereas Table 2 shows the results of the experts. It is obvious that, in numerical terms, experienced users reached more points in each group of questions.

Due to the results of the F-probes, the significance was evaluated in each case with two-sample *t*-tests. The complex result of the *t*-test was $p = .03511$. Therefore, in terms of total scores, it can be stated that there is a significant difference between the results of the experienced and new users. After examining the aggregated results, we also tested each group of questions. In Multiple-Choice question type, the value of p during the *t*-test was .03952, which is less than .05, thus we could say that the experts in this question group performed better than the newbie users. However, the p value of the Multiple Choice with Visual Assistant question group was .09835 when performing the *t*-test, which is higher than .05, so no significant difference was found between the results of the two groups in the given question type in this study. We could also use the mentioned methods in Short Response type question groups, based on the results of the *F*-test similarly as before, so *t*-test was applied for the measurement. In both cases, values above .05 could be obtained for p . Thus, we could say that no significant difference could be detected between the experienced and new users in Short Response Question Groups.

Table 1. Percentages of correct answers of the newbies per question group

Question groups	Percentage of correct answers (%)
Multiple-Choice – Short Answers	53.63
Multiple-Choice – With Visual Assistant	57.66
Short Response – Numerical	45.56
Short Response – Complementary	47.58

Table 2. Percentages of correct answers of the experts per question group

Question groups	Percentage of correct answers (%)
Multiple-Choice – Short Answers	66.94
Multiple-Choice – With Visual Assistant	65.73
Short Response – Numerical	56.45
Short Response – Complementary	56.05

Difficulty Index and Discrimination Index

The results of analytical statistical methods showed interesting experience according to which some types of questions can differentiate expert and new users while others cannot. As a result of this new knowledge, we wanted to examine how well-formulated the individual questions were and how effective they were. This was measured by examining the question difficulties and the discrimination abilities of the questions.

During the application of the methods, experienced and new users were not distinguished while the questions were examined individually and we were interested in the independent efficiency and correctness of the questions.

Difficulty Index

The Difficulty Index shows how difficult or easy it is to answer a given question. Its calculation is simple as the number of correct answers was divided with all of the received answers. The closer the value is to 1, the easier it is. Similarly, the closer it is to 0, the harder it is to answer. Certainly, a question can be bad not only if it is too difficult for the user to answer, but even if it is too easy. The optimum continuum of the Difficulty Index is between 0.25 and 0.75 (Tavakoli, 2013). To summarize these, we created a table that shows for each question how much the calculated value was. Appropriateness was marked in Table 3.

As Table 3 shows, the difficulty level of the questions is not within the optimal interval for 7 questions, but it was optimal in 25 cases. It can be stated that 78.125% of the questions are within the expected limits. By observing the data thoroughly, we can also see that most of the values show a difference of 0.01–0.02, and only three questions show a significant difference from the optimal interval. In the further application of the educational environment, we consider it important to reformulate or replace these items; therefore, the tool can be used more effectively during the learning progress.

Table 3. Difficulties of the questions and appropriateness of their difficulty

	Questions										
	1	2	3	4	5	6	7	8	9	10	11
Difficulty Index, Appropriateness ($0.25 \leq x \leq 0.75$)	0.60	0.63	0.50	0.73	0.68	0.48	0.52	0.61	0.98	0.61	0.55
	Questions										
	12	13	14	15	16	17	18	19	20	21	22
Difficulty Index, Appropriateness ($0.25 \leq x \leq 0.75$)	0.58	0.77	0.23	0.42	0.77	0.74	0.61	0.55	0.42	0.50	0.58
	Questions										
	23	24	25	26	27	28	29	30	31	32	
Difficulty Index, Appropriateness ($0.25 \leq x \leq 0.75$)	0.47	0.24	0.90	0.56	0.65	0.52	0.10	0.56	0.42	0.50	

Note: Shaded cells represent appropriateness of values (x), which lies in the limit $0.25 \leq x \leq 0.75$.

Discrimination Index

This indicator measures how well each question can distinguish between respondents with better and worse abilities. During the measurement, first, the data of the individuals are placed in descending order based on their score, and then they are divided into three equal groups. Participants reaching the highest scores, which means 21 users in our case, will be the group of those with higher capability, while the third group involving the worst 21 participants will be placed in the lower capability group. The middle third of the population is not taken into account in this study. The aim is to create the questions in a way that the right answers could be given by the group of those having better abilities while the wrong answers could come from the lower capability group. The indicator is calculated by subtracting the score of the lower third from the top third of each question, and then by dividing the difference by the half of the total number of two groups. Unlike the Difficulty Index, the Discrimination Index does not have an optimal interval ([Tavakoli, 2013](#)). The results are shown in Table 4 similar to the results of the Difficulty Index.

During the evaluation, a limit of 0.10 was applied based on the literature. Questions with a value less than 0.10 were not considered correct; these were marked in the row of Appropriateness. It can be seen that 30 questions have reached or surpassed the limit of 0.10, which covers 93.75% of the questions. It should be emphasized that question 9 was also problematic in the question difficulty analysis, but the low value of question 10 also raises problems. We would also reformulate these questions to apply the modified questions in the further application at the course as the tool could be even more efficient.

Conclusions and Meanings

Based on the statistical tests used for the question groups, it can be concluded that while some types of questions are equally effective in both groups, there are some that have not the same efficacy in both groups. Most problems among the new users of SL were based on motion, but the ability to control the avatar and the use of the space are easy to learn. This is supported by the fact that the newbies can quickly become accustomed to move and communicate in the virtual space. Although SL relies on the existing experiences in electronic communications (chat, messages, voice calls, etc.), research shows that new users are able to easily adapt to the possibilities that do not exist in reality (e.g., flight and teleportation; [Locher, Jucker, & Berger, 2015](#)).

With regard to the negative points mentioned by the users that too much information had to be memorized and remembered in a short time, we would like to mention that, during the further use of Fornax, the items could not only be read by the users, but they will also have time to learn them thoroughly. This negative result originates from the limited time of testing; therefore, this problem will not persist in real and everyday use.

Table 4. Discrimination Indexes of the questions

	Questions										
	1	2	3	4	5	6	7	8	9	10	11
Discrimination Index, Appropriateness ($0.10 \leq x \leq 1.00$)	0.52	0.62	0.62	0.19	0.29	0.62	0.43	0.71	0.05	0.05	0.62
	Questions										
	12	13	14	15	16	17	18	19	20	21	22
Discrimination Index, Appropriateness ($0.10 \leq x \leq 1.00$)	0.52	0.10	0.29	0.52	0.48	0.52	0.57	0.38	0.33	0.52	0.10
	Questions										
	23	24	25	26	27	28	29	30	31	32	
Discrimination Index, Appropriateness ($0.10 \leq x \leq 1.00$)	0.62	0.29	0.14	0.29	0.48	0.19	0.29	0.62	0.57	0.62	

Note. Shaded cells represent appropriateness of values (x), which lies in the limit $0.10 \leq x \leq 1.00$.

Occasionally, graphical errors also occurred during the use. Unfortunately, these arise due to the low performance of the hardware components of the used computers. Thus, it should be taken into account that some resources will be needed to use this kind of system, but it is worth investing in these for providing the conditions. Some of the problems emerging during testing can be easily remedied and the impressions of the users during the use are quite positive as a high proportion of them interested in the environment that was found as intriguing by them. As we hoped during the creation of Fornax, users are really motivated to learn by the fact that they do not have to learn with the traditional method; thus, the effectiveness of distance learning can be improved.

In the case that someone would like to create a test system within SL, we recommend for them during the formation of the questions to consider how experienced the targeted user group. Regarding new users, it is strongly recommended to introduce the basic functions and modules of the program either in the form of real-time communication or by a training material placed in the space of SL, since the use of the environment may be difficult for these users at first. However, it is definitely worthwhile for these users to insure the application of the interface as the review revealed that newbies were also eager to use the program, they found the opportunities to be exciting, and this motivated them to learn. When using such a system, it is important to check ourselves as well, i.e., whether the system has been designed properly. User opinions and results should be continuously monitored. Accordingly, malfunctioning questions or tools must be modified or replaced and should be adapted to the needs of the users. Thus, students' interest in virtual learning tools can be maintained. Educational tools created in virtual spaces can have a key role in the future as modern technologies are increasingly preferred by the members of the new generations. In our fast-moving world, the role of distance learning is also increasing and the role of introducing new methods is great here as well. Since no real contact is maintained between the instructor and the student, the attention is hard to be kept so there is a need for methods that tie students in and increase interest and students can learn more effectively from the instructors using them. Educational tools created in the virtual space provide an excellent way to realize this.

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About the Authors

KT earned a bachelor degree in Health Care Management from the University of Debrecen Faculty of Health at 2017. She is currently working in the András Jóna Teaching Hospital at

Nyíregyháza as a healthcare manager. She is studying at the University of Debrecen Faculty of Public Health in Health Care Management MSc. Her research topic is artificial intelligence in healthcare. KT involved in study concept, statistical analysis, and interpretation of data.

ZsK graduated as a teacher of BSc in mathematics and physics from the University of Nyíregyháza at 1997. Then, he earned a Master's degree as an Information Technology Teacher from the University of Debrecen at 2000. He is currently working at the University of Debrecen Faculty of Health. He is studying at the Doctoral School of Humanities in the University of Debrecen as a PhD student. His research topic is the application of virtual environments in education. ZsK contributed to study design, study supervision, and interpretation of data.

All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Ethics

The Institutional Review Board of the Institute of Educational and Cultural Sciences (University of Debrecen) approved the study.

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