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# Retention and flow under guided and unguided learning experience in 3D virtual worlds

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A B S T R A C T

Whatever technology is used, instructional design and media characteristics has a significant effect on the learning experience. 3D virtual worlds allowing a broad range of instructional approaches still need to be worked on to reveal better ways to design instruction. This study investigated the effects in a three-dimensional (3D) virtual world of guidance provided by the instructor's avatar, and of user's virtual world experience on participants' retention scores and flow experiences. Additionally, relationships between retention score and flow were determined in relation to the same variables. Non-experimental, relational, and comparative methods were used. The research sample included a total of 146 undergraduate students from two different departments. Two different scales were used to measure flow and retention. The findings show that the participants' retention scores differed depending on such variables as the experience and guidance by the instructor's avatar while there is no difference in flow experience. The study implicates that instructor guidance is important to improve learning in 3D virtual worlds.



## 1. Introduction

Three-dimensional (3D) virtual worlds are now commonly used for various purposes. They provide such features as user interaction via avatars; user presence in the environment via facial expressions, gestures, and multiple communication methods; and access to a large population. With these features, 3D virtual worlds make educational environments more visual and realistic (Dede, Ketelhut, & Ruess, 2002; Kapp & Driscoll, 2010; Maher & Gero, 2002; Messinger et al., 2009). This is potentially very useful in the field of education (Dalgarno & Lee, 2010; Dickey, 2005; Ibáñez et al., 2011). Thus, virtual worlds constitute extensive interest for academicians and practitioners (Zhou, Fang, Vogel, Jin, & Zhang, 2012). In these environments, students can engage in a series of purposeful, instructional, and interactive tasks without losing their attention or deviating from the learning goals (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). The 3D environment motivates students (Omale, Hung, Luetkehans, & Cooke-Plagwitz, 2009), provides a safe and realistic learning atmosphere (Brasil et al., 2011; Dalgarno, 2002), and supports game-based learning strategies (Brasil et al., 2011; De Jong, Van der Meijden, & Von Berg, 2005; Omale et al., 2009). In recent years, investigations of the instructional uses of 3D virtual environments have increased (Omale et al., 2009). However, in order to facilitate learning in these environments, activities must be well-structured, and the roles and responsibilities of the users must be clearly determined (Kanuka, Rourke, & LaFlamme, 2007).

3D virtual worlds accommodates a broad range of educational approaches and learning outcomes (Gütl, 2010). However, if users spend too much time on learning to use a complex interface in the virtual worlds, they can lead user to leave from these environments. Thus, in virtual worlds supporting strategies for new users is required to reduce learning costs and retain interest (Zhang, Zhang, de Pablos, & Sun, 2014). One of the most complicated aspects of 3D virtual worlds is *scaffolding or guidance*. In virtual worlds a lot of knowledge is ignored if guidance is not adequate since the 3D world is very large and flexible. Moreover it is difficult to provide in-depth information without interrupting the flow experience (Bellotti, Berta, De Gloria, & Zappi, 2008). Whether guidance disturb the learning and flow is a question which should be answered in this respect. While it is possible to develop unguided applications which allow users to learn on their own, applications that feature the help of a guide are also possible. In guided cases, the purpose is to make the users focus on only one task. This type of application can be especially beneficial for new

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users (Park, Kapoor, & Leigh, 2000). This study investigates whether guidance influence flow or retention. The results of the study has a potential to provide suggestions for a better and enjoyable learning experience.

### 1.1. Guided and unguided designs in virtual worlds

Avatars, which are virtual representations of users in 3D virtual worlds, are regarded as a type of guide in guided education. These guides provide users with guidance as in real life. The purpose of these virtual guides is to allow users to develop experiences in the virtual world by interacting with other users (Kang, Nah, & Tan, 2012). However, time and effort are required to gain experience in these environments to benefit as much as possible (Zhang et al., 2014). Guidance can increase user engagement in the environment via communication and interaction, and thus may increase the users' enjoyment of their virtual experiences (Abdul Rahim et al., 2012; Kock, 2005). However, the users' satisfaction upon completing a task also influences their engagement (Mott, McQuiggan, Lee, Lee, & Lester, 2006). Flexible guidance (guided and unguided navigation) can also be provided to meet the needs of different students' learning styles and levels of knowledge. Scaffolding in virtual world differs from guidance in that it is more student-centered approach which allow student to construct their knowledge with teacher support until student perform the task without any help (Wood, Bruner, & Ross, 1976). In the case of this study guidance terms is used to describe step by step exploration of the world with the help of an avatar.

In a study conducted by Omale et al. (2009), users in one group were asked to produce solutions to a problem without any explanation or guidance, while users in another group were provided a kind of guided learning which allowed them to contact each other via written texts in balloons. Both groups were asked to produce solutions cooperatively to a problem. The study revealed that working in cooperation positively influenced social presence, and that avatar activity, gestures, and interpersonal communication positively influenced cognitive presence. Goo et al. (2006) found that guided hints were far more helpful to users searching for undiscovered elements than unguided applications. Environments designed to make users discover materials completely on their own are harder to use and are not very effective, as they have no guidance or hints provided in the environment (Mayer, 2004). Thus, the use of guided learning environments has increased considerably in recent years (Jong & Joolingen, 1998).

One type of *guidance* is reflective guidance. In this type of guidance, hints and guiding features allow users to make their own decisions. Graphics, maps, and texts are provided in the environment (Horwitz & Christie, 1999). In an application lacking reflective guidance, users will likely find it difficult to identify where they are and when to focus their attention (Nelson, 2007). In our study, as an example of reflective guidance, directive signs, symbols, footprints, and notice boards within the environment were provided. This is called unguided learning, as no instructor is present in the environment. When guidance is provided for experienced users, their cognitive load increases; and lack of guidance for inexperienced individuals causes them to miss the focal point (Artino, 2008). Thus, our study also examined the effects on users of experience in a 3D environment.

### 1.2. Flow in virtual worlds

Flow is a theory which holds that individuals are interested in difficult tasks due to their internal motivation, and that they perform these tasks unwittingly without being aware of the time (Csikszentmihalyi, 1991). Similarly, if users are consciously engaged in an activity, they then demonstrate high performance without being aware of the environment they are in (Finneran & Zhang, 2005). The activities encourage more flow if they embody certain rules and concrete goals, trigger users' skills, clearly state what the users should do, and increase concentration (Csikszentmihalyi, 1991). Csikszentmihalyi also emphasized the balance between task difficulty and the users' skills, and said that flow is conditioned by this balance (Csikszentmihalyi, 1991). In order to facilitate flow in an activity, the difficulty level of the application should suit the users' skills (Sweetser & Wyeth, 2005). Because flow theory is heavily emphasized in the design of environments for computer games, many academic studies have been conducted on computer games. In 3D virtual worlds, as in computer games, students can explore the environment with an avatar; navigate in the environment; and interact with objects, the environment, and other avatars. This increases telepresence because students are virtually in the 3D environment and feel that they are a part of the environment (Nowak & Biocca, 2003). Enjoying the environment in this way, students are likely to become unaware of the time they spend. At this point, the flow concurrently facilitates perception and acts as an important factor that helps to increase the users' desire to be in the virtual environment (Shin, 2009). Our study also examined the influence of guided and unguided learning on users' flow in the environment. In related literature, previous studies using the flow theory demonstrated that male participants displayed higher levels of flow, and that levels of user motivation were parallel to their levels of flow (Inal & Cagiltay, 2007; Shin, 2006). Inal and Cagiltay (2007) stated that difficulty and complexity influenced students' flow more than the feedback did. Shin (2006) pointed out that flow is an important factor which affects satisfaction with the application, and that students with high levels of flow were more satisfied than those with low levels of flow.

Flow cannot be directly observed in students, as it is a psychological variable (Woszczynski, Roth, & Segars, 2002). Hoffman and Novak (2009) reported that the most important factors influencing flow include: 3D virtual worlds require certain skills and involve challenge; the user's avatar helps to reveal the physical position of the student; avatar appearances can be changed; objects can be touched; and directions can be used. In addition, the researchers stated that students can enter the environment in any place at any time, and that they are physically represented in the environment. This situation, according to the researchers, positively influences flow, as it creates a sense of being in a social environment. However, since these environments do not belong to the category of games, not so many studies have been conducted in related literature to reveal flow in 3D virtual worlds. Therefore, determining flow in these environments will contribute to the related literature. Considering these features of 3D virtual environments which influence flow, we examined whether flow differed depending on experience, or guidance.

### 1.3. Problem and research questions

Virtual worlds involve many more instructional methods than all other environments. In order to decide which method is the most effective, these methods must be experienced. Therefore, there might be differences between guided and unguided teaching, and that this could be affecting our search for a different method. This study investigated the effects of guidance provided by the instructor's avatar, and of users' experience on the participants' retention scores and flow in a virtual world designed for learning purposes. Another study goal was to determine the relationships between flow and retention scores in relation to the same independent variables. The research questions that guided the study were:

1. In this 3D virtual world, are the participants' retention scores and flow in the environment influenced by
   a. Guidance by the instructor's avatar?
   b. Their experience with virtual worlds?
2. In this 3D virtual world, is there a relationship between the participants' retention scores and their flow in the environment in relation to
   a. Guidance by the instructor's avatar?
   b. Their experience with virtual worlds?

## 2. Method

### 2.1. The research design

In this study, non-experimental comparative and relational designs were used together. First, the comparative method was used. This examines differences between two or more groups with respect to certain variables (McMillan & Schumacher, 2010). We compared instructor-guided and unguided groups, and groups possessing experience with 3D virtual worlds against those lacking such experience (these were the independent variables). The focus was relationships between the participants' retention scores and flow (the dependent variables), and how these were influenced by experience with virtual worlds, and guidance by the instructor's avatar. Following this, the relational method was applied. This is used to determine relationships between two or more variables (McMillan & Schumacher, 2010). This method determines the levels of relationships without interfering with the variables in any way (Fraenkel & Wallen, 2000).

### 2.2. Participants

The participants were 70 junior and sophomore students from the Department of Computer Education and Instructional Technologies (CEIT) and 76 junior students from the Department of Science Teaching at University. Table 1 presents detailed information about the research sample.

The purposeful sampling method was used to select the participants. The sample was determined depending on experience with 3D virtual worlds. The CEIT students in the research sample already possessed related knowledge and experience. In their previous course, "Multimedia Design," these students used 3D virtual world and they were also all active users of these environments. The students in the Department of Science Teaching did not have any experience with 3D environments. However they have been taking a Computer course for two semesters. One experienced and one inexperienced group received teacher guidance in the environment, and the other two groups navigated in the environment without being provided any guidance.

### 2.3. Data collection instruments

Two different data collection tools were used. The first data collection tool was the "Flow Scale," which was based on Csikszentmihalyi (1991)'s flow theory. An adapted "Flow Scale" including 33 five-point Likert items related the factors entertainment (5 items), telepresence (4 items), engagement (4 items), focusing on task (5 items), flow of time (4 items), ability (3 items), challenge (4 items), and satisfaction (4 items) was developed by Shin (2006). It was translated into Turkish by the researchers; the translated version was checked by three faculty members from the Department of English Language Teaching to make sure there were no problems with the translation. In addition, the translated version was also revised for its use of language by a Turkish language expert. It was conducted a pilot test for validity and reliability (.87). In flow scale students were also asked about their computer and virtual world use experience.

Secondly, the "Retention Test" for winter sports was designed by researchers and two winter sports experts (short track experts). The test was made up of 20 multiple-choice items with four options. The test items were examined by two experts in the field of instructional technologies, three doctorate students and one Turkish Language expert. A pilot study of the "Retention Test" was conducted with 150 students. They were introduced to 3D environments and were asked to carry out applications in the environment. Following this application, the same "Retention Test" was applied, and for each item in the achievement test, item difficulty and discrimination indices were calculated. As a result of these calculations and in line with expert views, the test was finalized by excluding four items. In the study, the "Retention Test" was applied as a pre-test and a post-test. The test for the flow in the environment was applied to all of the groups at the end of the process.

**Table 1**
Research sample groups and the number of participants in each group.

| | Guide | Experience | *N* |
|---|---|---|---|
| | | Experienced | 34 |
| | Guided | Inexperienced | 45 |
| Total | | | 79 |
| | Unguided | Experienced | 36 |
| | | Inexperienced | 31 |
| Total | | | 67 |
| Total | | | 146 |

### 2.4. Process

The 3D virtual world "Second Life" was selected as the study environment because it not only provides users with a server and a store of 3D objects but also accommodates a larger population of users. A virtual winter sport learning areas for two different sports – "short track," "artistic skating," and were designed in the environment. For the study only short track area was used. These learning areas included the sections "Information House" to provide the basic information via texts, pictures, and videos; "Clothing" to introduce the clothes specific to each type of sport; "Exercise" to teach the movements in each sport by step-by-step instruction and with the support of pictures and animations; and "Practice" to apply all the movements. In each section, there were tasks (animating, watching videos, etc.) and actions (clicking on objects) that helped the participants to interact. In the environment, there was no restriction, so the participants were provided with the opportunity to experience each section freely. However, in order to facilitate navigation, direction tools were included in the environment (foot prints, signs, information boards, teleportation points and so on). In this respect, an integrated guidance option was also available to provide students' learning on their own as well as their learning with the guidance of the instructor.

With the guidance by the instructor's avatar, the experienced group and the inexperienced group were able to obtain the information provided in the sections, while the other two groups tried to find this information solely by using the directions in the environment. Because the inexperienced group of students lacked technical knowledge, they were informed after two hour about how to use the environment. The other group directly used the environment without instructions.

The guidance by the instructor's avatar started when the instructor entered the Second Life environment from a different place. At this time, the students were ready in their places in the environment. First of all, the environment was introduced, and general written and oral questions regarding how to use the environment were directed to the students. Following this, they were provided with written and voice directions. Next, they were asked

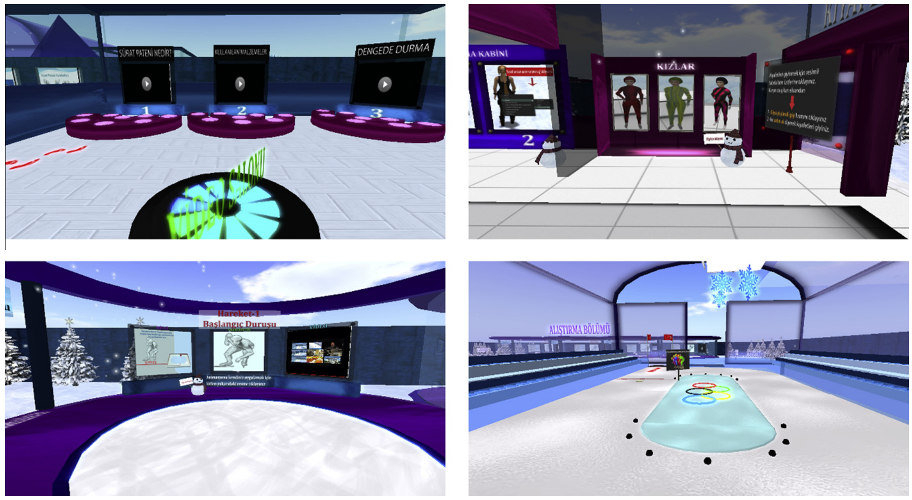

**Fig. 1.** Screenshots of the 3-D virtual environment in this study.

to follow the instructor's avatar, and teleportations were made into the basic areas in the environment. Afterwards, the students were asked special questions relating to the contents of the presentations and videos in the Information House. The students were also asked questions in the Clothing, Exercise, and Practice sections. Screenshots of the 3D virtual environment are presented in Fig. 1. When the students left each section, the instructor's avatar helped to gather and guide all the students and clarified the points that the students failed to understand.

### *2.5. Data analysis*

Since there was a difference between the pre-test scores, a multi-way MANCOVA was applied to determine the difference between the participants' retention scores and flow in the environment in relation to experience and guidance by the instructor's avatar. In order to determine the relationship between retention and flow in relation to the independent variables, Spearman correlation was used.

## 3. Findings

### *3.1. Influence of experience and guidance on retention and flow*

The measurement of the participants' flow in the 3D virtual world was organized into eight sub-dimensions. The participants responded with "I agree" to the sub-dimensions of telepresence, engagement, focus attention, satisfaction, enjoyment, and skill. Their pre-test scores ($M = 2.66$) and post-test scores ($M = 4.66$) for retention scores were also calculated. Table 2 presents averages of dependent variables.

A comparison of the pre-test and post-test retention scores revealed a difference ($t = 9.333$, $p < .05$). In addition, the mean scores for the participants' post-test retention scores and their flow were calculated for each independent variable. Fig. 2 presents the related results in detail.

In order to determine the influence of experience and guidance by the instructor's avatar on the participants' retention scores and flow in the environment, a multi-way MANCOVA was conducted. Because the research groups were not equal in terms of their retention scores, their pre-test scores were determined as covariances. Following this, the assumptions of the test were checked. The covariances were found to be homogenous (Box's $M = 22.77$, $p > .05$); and the variances were equal ($F_{flow} = .50$, $F_{post\text{-}test} = .1{,}67$, $p > .05$). There was a difference with respect to the guidance by the instructor's avatar (Wilk's Lambda ($\Lambda$) = .951, $F = 3.47$, $p < .05$). In addition, guidance, experience, and guidance * experience influenced all of the participants. Table 3 presents the related results in detail.

The participants' retention scores differed depending on the guidance by the instructor's avatar ($F = 6.70$, $p < .05$, $R^2 = .04$), experience ($F = 17.64$, $p < .05$, $R^2 = .11$), and guidance * experience ($F = 22.57$, $p < .05$, $R^2 = .14$). According to guidance by the instructor's avatar, retention scores had an higher score in the unguided group ($M_{guided} = 4.14$, $M_{unguided} = 5.19$). According to experience,

**Table 2**
Descriptive data for the sub-dimensions of flow experience ($N = 146$).

| Sub-dimensions | *M* | SD |
|---|---|---|
| Ability | 3.92 | 0.96 |
| Enjoyment | 3.66 | 0.92 |
| Satisfaction | 3.63 | 1.03 |
| Focus on task | 3.49 | 0.73 |
| Engagement | 3.43 | 0.84 |
| Telepresence | 3.40 | 0.82 |
| Time distortion | 3.10 | 0.87 |
| Challenge | 2.19 | 0.97 |
| FLOW | 3.35 | 0.56 |
| Pre-test | 2.66 | 1.77 |
| Post-test | 4.66 | 1.48 |

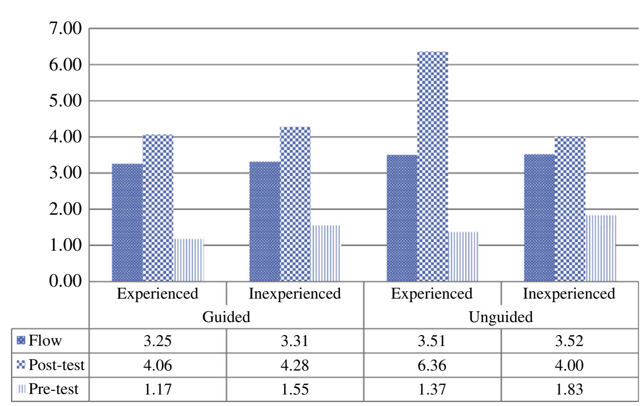


**Fig. 2.** The participants' post-test scores and their flow in the environment in relation to the independent variables.

**Table 3**
MANCOVA results for the participants' retention scores and flow in the environment.

| Effect | $\Lambda$ | $F$ | Sig. ($p$) | Partial eta squared ($R^2$) |
|---|---|---|---|---|
| Intercept | .078 | 608.215 | .000 | .922 |
| Pre-test | .989 | .565 | .570 | .011 |
| Guidance by the instructor's avatar | .896 | 5.967 | .004 | .104 |
| Experience | .884 | 6.731 | .002 | .116 |
| Guidance * experience | .890 | 6.385 | .002 | .110 |

**Table 4**
Differences in retention scores and flow experience in relation to the independent variables.

| Independent variables | Dependent variables | SS | MS | df | $F$ | Sig. ($p$) | Partial eta squared ($R^2$) |
|---|---|---|---|---|---|---|---|
| Corrected model | Flow | 1.533 | .383 | 4 | 1.681 | .160 | .061 |
| | Post-test | 118.926 | 29.731 | 4 | 10.940 | .000 | .296 |
| Intercept | Flow | 276.081 | 276.081 | 1 | 1211.635 | .000 | .921 |
| | Post-test | 458.085 | 458.085 | 1 | 168.560 | .000 | .618 |
| Pre-test | Flow | .040 | .040 | 1 | .177 | .675 | .002 |
| | Post-test | 1.913 | 1.913 | 1 | .704 | .403 | .007 |
| Guidance | Flow | 1.407 | 1.407 | 1 | 6.176 | .015 | .056 |
| | Post-test | 24.234 | 24.234 | 1 | 8.917 | .004 | .079 |
| Experience | Flow | .062 | .062 | 1 | .271 | .604 | .003 |
| | Post-test | 31.216 | 31.216 | 1 | 11.486 | .001 | .099 |
| Guidance * experience | Flow | .031 | .031 | 1 | .138 | .711 | .001 |
| | Post-test | 34.158 | 34.158 | 1 | 12.569 | .001 | .108 |

**Table 5**
Relationships between retention and flow.

| | Flow – retention correlation |
|---|---|
| Overall | .309** |
| Guided | .146 |
| Unguided | .423** |
| Experienced | .335** |
| Inexperienced | .320** |

** $p < .01$.

retention scores had an higher score in the experienced group ($M_{experience} = 5.25$, $M_{inexperience} = 3.96$). On the other hand for any independent variable there is no difference in terms of flow experience as seen on Table 4.

### 3.2. Relationships between retention and flow in relation to experience and guidance

Among the group of students who were guided by the instructor's avatar, no relationship was found between retention and flow in relation to the independent variables ($r = .146$, $p > .05$). Among all the other groups, a relationship was found. Table 5 presents the related results in detail.

As seen on Table 5, only in guided case retention scores has no significant relationship with flow although retention and flow is normally expected as correlated.

## 4. Discussion

This study reveals the influence of experience, and guidance by the instructor's avatar on retention scores and flow. A difference was found between the retention of the participants in favor of the unguided group. This result may be due to the fact that the participants found all the information in the environment without feeling any obligations. Goo et al. (2006) found that higher mental work load was required to achieve the purpose in guided applications, regardless of the task order. In our study, because guidance by the instructor's avatar increased the cognitive load of the students, providing that guidance might have decreased their retention. Goo et al. (2006) also demonstrated that guided hints and directions were more effective for revealing undiscovered elements. They pointed out that users assigned more importance and paid more attention when they were given special guided and purposeful tasks. Thus, reflective guidance was used in the winter sports environment by including signs, voice directions, and teleportation points for direction purposes in addition to the guidance by the instructor's avatar (Horwitz & Christie, 1999). The directions already existing in winter sports environment might have been sufficient for the students, but the existence of the instructor's avatar may have caused a cognitive load for the students.

A difference was found in the retention scores of the groups with respect to the variable of experience. This difference possibly resulted from the fact that experience with 3D virtual worlds facilitated navigation in the environment. Chen and Wang (2009) found that in non-linear system structures, experienced students were able to navigate more easily in the environment. Thus, experience with the learning platform can be regarded as a factor which influences retention of the content. On the other hand, Zhang et al. (2014) emphasized that inexperienced students can focus to learn and decrease learning complexity. Besides, they state that experienced students tend to use virtual worlds as a social networking.

In the study, there was also no influence from guidance by the instructor's avatar on flow experience. This means instructor guidance or available guidance of the environment has similar experience for students. It was assumed that the availability of guidance by the instructor's avatar would lead to a possible negative influence on flow with respect to student management and awareness of learning. One explanation might be that no strict rules were established for any of the students in the environment, flexible structure of virtual worlds allowed students to construct their own discovery experience in any case. One of the striking findings in our study was that the students easily lose their attention in the areas where students got information about winter sports, but they displayed very high levels of communication and satisfaction in the sections designed as social areas and application areas. The students regarded the environment as a learning environment in both cases, did not find the environment sufficiently challenging, and were able to recognize the flow of time in both cases. In addition, the fact that this virtual world did not induce the sense of playing a game could have caused the participants to be aware of the passage of time. To re-examine this difference, a new study might be conducted in a virtual world in which there are problems to be solved, there is a factor of competition, and insufficient direction is deliberately provided. Similarly, experience with 3D virtual worlds had no influence on flow. In fact, participants with low levels of experience were expected to have higher levels of flow due to the new technology effect. On the other hand, game play, different 3D environment experiences might reduce the novice effects. Besides, virtual worlds are very easy-to-use environments in a short time students become familiar with the environment.

The study is important to show how a in 3D virtual world influence the experience of the students. Retention and flow differ in relation to various variables in 3D virtual worlds. If individuals are consciously engaged in an activity, they demonstrate higher performance without being aware of whether they are in the environment (Finneran & Zhang, 2005). Considering that flow depends on the tasks assigned in the environment, it can be investigated in task-based environments as well as in environments with no tasks assigned. Future studies could also further examine the different effects of the presence and non-presence of guidance by the instructor's avatar in the environment.

The study already shows that step by step guidance might be helpful to achieve the learning goals in the environment. On the other hand, this implications might change regarding the purpose of the environment. In this study students had to follow certain steps for an optimum learning experience, some environments might not be in a similar structure. Additionally some technical issues might cause some limitations to use this guidance. Connection speed and voice infrastructure might prevent students take directions from guide effectively. In the study problems with certain headphones, which partly affected the voice directions provided by the instructor's avatar. In addition, some of the inexperienced students encountered problems, first while opening an account to Itureenter the environment and then afterwards when using the environment., as vocal communication tools used by the students caused sound conflict, the students were not allowed to establish oral communication in the platform. Practitioners should take all these limitations into consideration.

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