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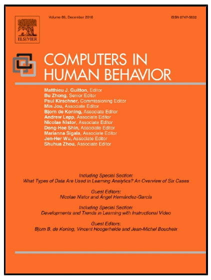


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# The Effects of Guided-Unguided Learning in 3d Virtual Environment on Students' Engagement and Achievement

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# The Effects of Guided-Unguided Learning in 3D Virtual Environment on Students' Engagement and Achievement

**Abstract**

This study aims to find whether or not there are any differences between the behavioural, affective, cognitive engagement and achievement of student groups with and without instructor avatar guidance in winter sports learning environment developed in Second Life 3D virtual platform. It also analyses the correlations between the sub-factors of engagement and achievement according to guided and unguided groups. This study was conducted on basis of quasi-experimental and relational research method. The sample was determined by purposeful sampling method and composed of 104 secondary school students (54 guided, 50 unguided). The data collected through student engagement questionnaire and achievement test were analysed to descriptive and predictive statistics. According to the results, no significant differences were found between the groups in terms of behavioural, affective, cognitive student engagement and achievement. It was found that there were correlations between cognitive engagement and achievement in the guided group but that there were no significant correlations between behavioural engagement and achievement. In unguided group there were no significant correlations between behavioural, affective and cognitive engagement and achievement. This might have stemmed from the fact that the students had experienced learning in a different environment offered by 3D virtual platform- a new technology- for the first time.

**Keywords:** 3D virtual environments; Guided-unguided learning; Students' engagement; Achievement

## 1. Introduction

Technological advances influence the domain of education as it does all other domains, and researchers, educators and educational policy-makers try several ways to integrate technologies supporting learning and synchronic/non-synchronic technologies into educational environments (Coates, 2007). In three dimensional (3D) virtual platforms, which is one of such technologies, users can simulate the real world with 3D objects. They can display realistic behaviours through 3D avatar, have realistic experiences by interacting with the platform and also have multi-channel communication with other avatars (Kapp, & O'Driscoll, 2010). Those platforms have the potential to create effective learning environments, to increase students' engagement and to facilitate learning through more visual and realistic experiences with the properties they have (Bulu, 2012; Dalgarno, & Lee, 2010; Dickey, 2005). They also help to eliminate the problems encountered in joint studies due to costs, time and physical remoteness/geographical restrictions (Jarmon, Traphagan, Mayrath, & Trivedi, 2009). For all these reasons, in recent years the use of 3D virtual platforms for several purposes has become widespread in educational environments as an approach (Reisoğlu, Topu, Yılmaz, Yılmaz & Göktaş, 2017).

3D virtual platforms can pose certain problems due to difficulties in controlling the environments (Mount, Chambers, Weaver, & Priestnall, 2009) besides providing environments for self-learning (Ibáñez et al., 2011). Guidance applied in those environments with appropriate and supportive leading can help to overcome such difficulties (Chittaro, Ieronutti, & Ranon, 2004). Thus, it is reported in the literature that guidance helps to increase students' engagement in a learning activity (Bower, Lee, & Dalgarno, 2017) and that engagement is important in supporting learning by doing and experiencing (Minocha, & Reeves, 2010). This study analyses students' engagement in learning activities related to winter sports and their achievement according to whether or not guidance of instructor avatar (GoIA) is available in 3D virtual environment (3DVE).

## 2. Theoretical Framework

### *2.1 Guided and Unguided Learning in 3DVEs*

3D virtual platforms can offer rich learning environments; thus, students can discover different places in those environments and they can learn by interacting with objects (Ibáñez et al., 2011). However, depending on the properties provided by the environment-whose control is left to students- and need for computers with advanced technical specifications, some problems can be encountered. Students can face such problems as having difficulty in activities made by interacting with objects and in controlling the environments, getting lost due to leading/finding directions (Chittaro, Ieronutti, & Ranon, 2004, Minocha, & Hardy, 2016) and experiencing inappropriate conversations in written-oral communication (Messinger et al., 2009). This situation might result in students' failure to display behaviours compatible with performing the task of learning, to discover the environments sufficiently, in losing their interest in the environments or in abandoning the environments (Nelson, 2007). Thus, students who use 3DVEs for the first time especially may need to be guided since they need adequate, suitable and supportive leading (Bower, Lee, & Dalgarno, 2017; Salt, Atkins, & Blackall, 2008). Besides, guidance system can also contribute to improving learning output (Cho, & Lim, 2017).

3DVEs include the types of guidance such as "non-verbal" which is performed through arrows and information charts, "cooperative" where students guide each other and "reflective" in which smart agents (clues, messages, etc.) responding to students' behaviours are available (Nelson, 2007). Activities were made for those types of guidance in differing branches in those environments (Goo et al., 2006; Nelson, Kim, Foshee, & Slack, 2014). It was observed that smart agents were used more in studies (Cansız, 2012; Kang, Nah, & Tan, 2012; Nelson, 2007). Yet, smart agents can be inadequate in following students' instant expressions of feelings, their reactions and their cognitive processes. At this point, instructors - who are the important elements of the educational process- can take on important roles in calling students' attention to the content and in assuring students' engagement in learning as a guide and leader by being available with their avatar in 3D virtual learning environments (Bouta, Retalis, & Paraskeva, 2012; Cho, & Lim, 2017). Hence, the instructor-student interaction (feedback, clues, affective support, etc.) is one of the key roles for engagement in learning (Furrer, Skinner, & Pitzer, 2014; Pianta, Hamre, & Allen, 2012). On the other hand Dixson (2012), stresses that more guidance offered by the instructor can reduce students' engagement and participation, that instructor's leading and warnings can detain students and affect their learning process in negative ways. The relevant literature was reviewed and it was found that the studies comparing these two opposite situations were lacking and that guidance performed with instructor's avatar was at descriptive level only. Therefore, this study investigates whether or not guidance performed with instructor's avatar in 3DVEs has any effects on students' engagement and learning.

*2.2 Students' Engagement in 3DVEs*

Engagement is considered from different aspects in the literature since a common approach or a theoretical structure is lacking in relation to students' engagement in educational environments (Coates, 2007; Fredricks, McColskey, Meli, Mordica, Montrosse, & Mooney 2011; Kuh, 2009). On the other hand the most comprehensive view emphasises that engagement is a complicated, dynamic and multi-dimensional structure and that it is composed of mutually related three dimensions (Fredericks, Blumenfeld, & Paris, 2004; Harris, 2008; Russell, Ainley, & Frydenberg, 2005). Although there are no clear-cut boundaries between the three dimensions of engagement separating them, there are differences in indicators they contain. Accordingly, engagement is a case consisting of students' feelings (affective), observable acts and performance (behavioural) and their efforts, perceptions and awareness (cognitive) (Appleton, Christeson, & Furlong, 2008; Fredricks, Blumenfeld, & Paris, 2004).

Kearsley and Shneiderman (1998) stress that engagement can be attained without technology, but that technology offers opportunities in gains difficult to attain. 3DVEs also offer opportunities to improve students' learning and engagement (Kapp, & O'Driscoll, 2010). Those platforms can assure that students deal with realistic tasks in interactive and fascinating activities; and they can also support experiential and active learning by doing, reflecting and playing roles (Minocha, & Reeves, 2010). Twinning (2009) points out that engagement will increase in parallel to the extent to which an individual is included in fascinating environments in 3D virtual platforms. This study also aims to make sure that students in 3DVEs are engaged in activities in which they can obtain information and experience.

It was found in some studies concerning students' engagement in 3DVEs that engagement did not have any effects on learning (Erlandson, Nelson, & Savenye, 2010; Ketelhut, 2007; Wrzesien, & Raya, 2010). However, some other studies found that 3D virtual platforms have the potential to engage students (Ang, & Wang, 2006; Bouta, Retalis, & Parakeskeva, 2012; Gregory, & Gregory, 2011) and those studies considered engagement as an important factor in learning (Parson, & Bignell, 2017; Pellas, 2014). Besides, studies trying to determine engagement through observations and interviews (Ang, & Wang, 2006; Chen, 2016; Gordon, & Koo, 2008; Mount, Chambers, Weaver, & Priestnall, 2009; Siriaraya, Ang, & Bobrowicz, 2012), studies considering experience in the 3DVE as engagement (Jarmon, Traphagan, Mayrath, & Trivedi, 2009), and studies identifying different variables (such as self-efficacy, flow, interaction and presence) with engagement (Ketelhut, 2007; Sullivan et al., 2011; Xu, Park, & Baek, 2011; Vrellis, Avouris, & Mikropoulos, 2016) were also available. It was found that the studies mostly included the variable of cognitive engagement (Bair, 2013; Erlandson, Nelson, & Savenye, 2010; Ketelhut, 2007; Bouta, & Paraskeva, 2013) and that some studies looked at general engagement (Gregory, & Masters, 2012; Hack, 2016) or that they analyzed one or two components of engagement (Bouta, & Paraskeva, 2013; Cruz-Benito, Therón, García-Peñalvo, & Lucas, 2015). Yet, it was found that the number of studies considering behavioural, affective and cognitive engagement altogether was restricted (Bouta, Retalis, & Paraskeva, 2012; Gregory & Gregory, 2011; Pellas, 2014).

In related studies, although positive conclusions were reached in relation to engagement, it was observed that those platforms also had some restrictions, disadvantages, difficulties and problems (Mount, Chambers, Weaver, & Priestnall, 2009). Some of them, technical problems, students' lack of basic computer skills (Lim, Nonis, & Hedberg, 2006), spending time in the platforms by entertainment instead of paying attention to the content, failure to complete the task (Cruz-Benito, Therón, García-Peñalvo, & Lucas, 2015; Ibáñez et al., 2011) and difficulty in directing students in the environment. It may be stated at this point that considering the negativity probable to be encountered in all dimensions of students' engagement is important in learning. Therefore, students' engagement in 3DVEs is examined by considering all of the behavioural, affective and cognitive dimensions in this study.

### *2.3 Rationale and Significance*

Although the fact that the GoIA in 3DVEs is an important component in students' engagement (Bouta, Retalis, & Paraskeva, 2012), no studies have been found investigating the effects of this type of guidance on students' engagement. Studies on the effects of GoIA on students' engagement are very few (Cho, & Lim, 2017). A review of the literature demonstrated that the instructor was the environment administrator in all groups and that guidance was not considered as a variable in studies (Bower, Lee, & Dalgarno, 2017; Hack, 2016; Mount, Chambers, Weaver, & Priestnall, 2009). For this reason, GoIA was used in this study.

On examining the studies conducted in relation to 3DVEs, it was found that students were likely to encounter problems on different dimensions of engagement. Therefore, it may be said that engagement should be examined with its sub-dimensions in the process of students' knowledge and skill acquisition. However, it was seen that the number of studies considering all three dimensions of engagement was limited (Pellas, 2014). Therefore, this study considers behavioural, affective and cognitive student engagement altogether and it investigates whether or not engagement on those sub-dimensions is dependent on GoIA. This study also investigates the extent to which guidance influences learning, and the correlations between learning and the sub-dimensions of engagement are analysed. This study differs from others in this respect.

Negativity such as materialistic support, time and danger factors can be encountered in instilling the critical knowledge and skills in winter sports which is considered within the scope of this study. 3DVEs can eliminate those factors and thus can help to have realistic experiences. This situation indicates the importance and originality of this study in that it raises awareness in financially weak students in terms of winter sports and that it provides students with opportunities to be occupied with a subject requiring knowledge and skills. Thus, it is thought that the study will contribute to the field and it will serve as a resource to the studies to be conducted in the future. The focus of the study is shown in Figure 1.

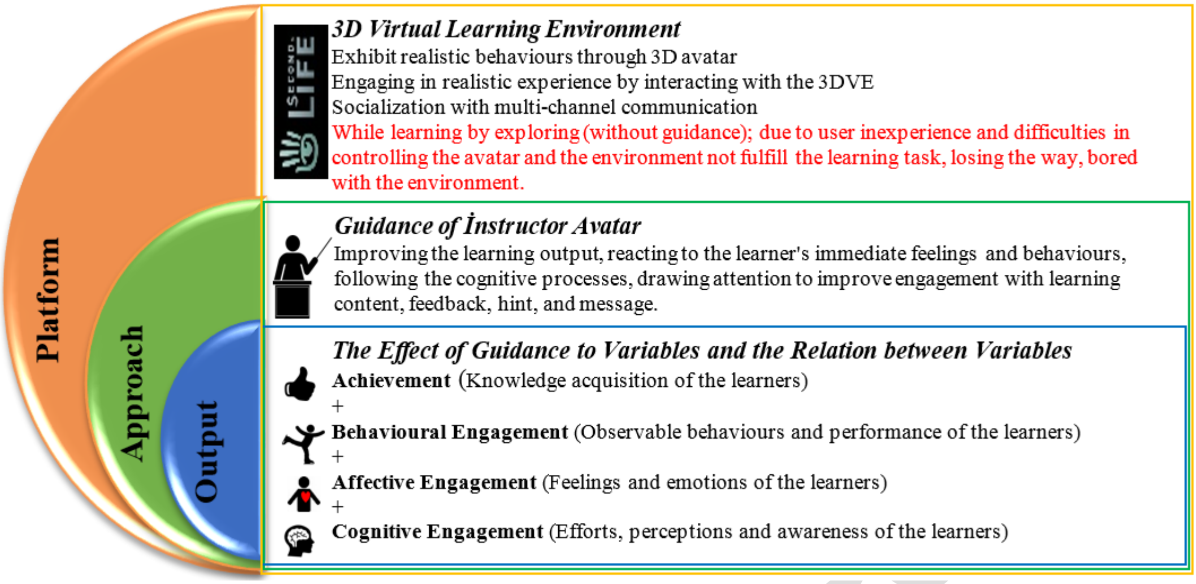



**Fig. 1.** The focus of the study.

In line with our purpose, the following research questions (RQ) are considered in this study in relation to winter sports 3D virtual learning environment:

1. Are there any significant differences between behavioural, affective and cognitive engagement in guided and unguided groups activities?
2. Are there any significant differences between guided and unguided groups in terms of achievement?
3. Are there any significant correlations between guided and unguided groups' achievement and their behavioural, affective and cognitive engagement?

## 3. Method

### *3.1 Research Design*

This study employs non-equivalent comparison groups pretest-posttest model- which is a quasi-experimental design to compare guided group (GG) and unguided group (UG) with intervention- for the first and second research questions (McMillan, & Schumacher, 2010). For the third research question, on the other hand, relational model- one of non-experimental research design- was used so as to find whether or not there were any correlations between the sub-dimensions of engagement and students' achievement in GG and UG (Fraenkel, Wallen, & Hyun, 2012). The research designs used are shown in Figure 2.

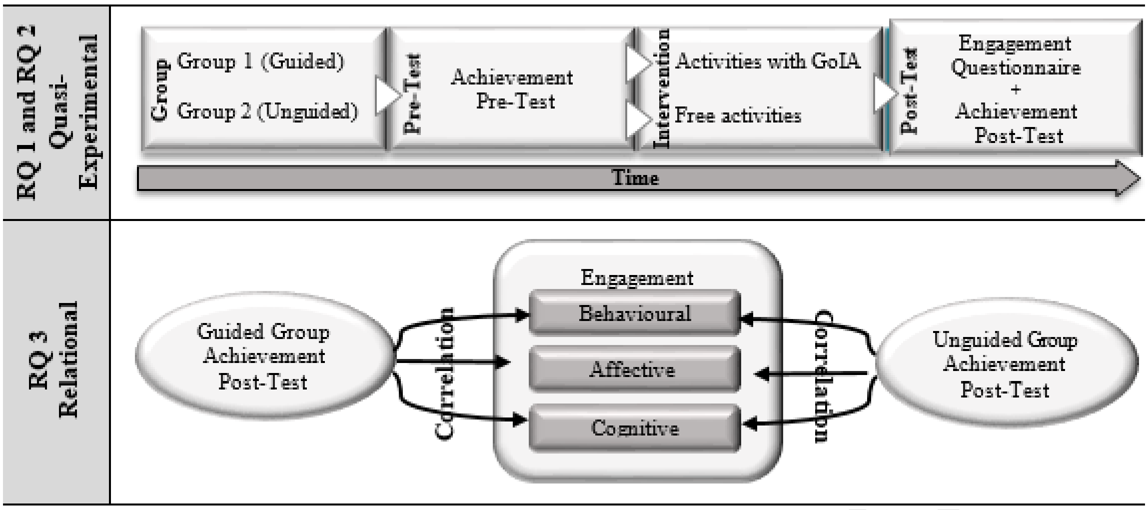



**Fig. 2.** Research designs used in the study.

### *3.2 Participants*

The study group was formed through purposeful sampling. The reason for preferring this method was to enable students with financial inadequacy to do winter sports to have the experience in 3DVE and to make sure that they are concerned with various learning activities. Hence, because the 104 secondary school students for whom the details are shown in Figure 3 had families with low income level, those students did not have the financial adequacy to do winter sports. Besides, all of the students except for 2 in the GG and 4 in the UG had experience with computer games.

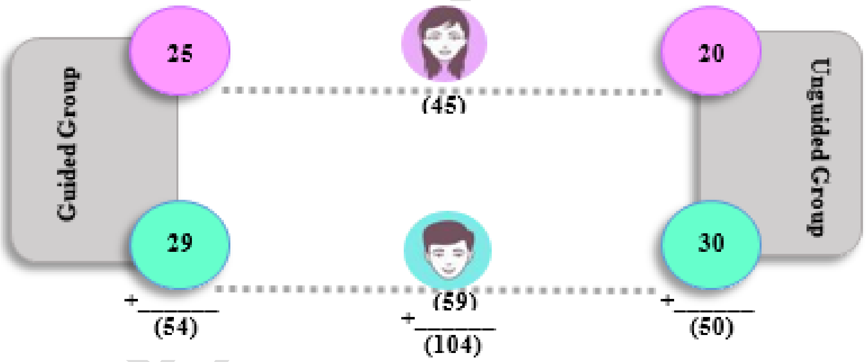
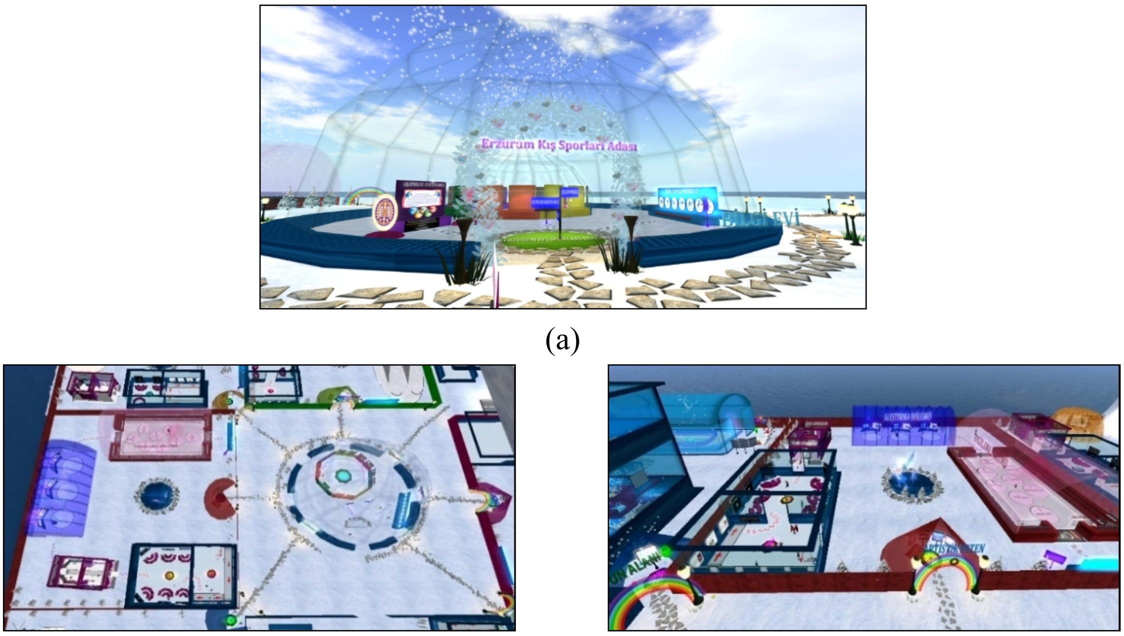



**Fig. 3.** The study group.

### *3.3 The Process of Forming a Winter Sports Island*

Because this study was conducted with a detailed project supported by Scientific and Technological Research Council of Turkey (TUBITAK) 1001 programme, the formation of winter sports island (WSI) was a nearly one year, long process involving the stages of analysis, design, development, implementation and evaluation at each stage. The official reports of the working team coming together every week, questionnaires developed on the basis of winter sports trainers' and experts' views and the scenario and story sheets prepared were taken into consideration in the process of developing the 3DVE on an island bought in Second Life (SL) platform- The reason for choosing SL platform is that it provides both server service to the user and various 3D objects as well as allowing many users to login-. In addition to that, the 3D virtual learning environment took its final shape with the modifications made in accordance with data coming from usability and pilot study results. The general view of WSI is shown in Figure 4 (a-b-c).




(a)

(b) (c)

**Fig. 4.** The general view of WSI.

The WSI basically consisted of 8 parts. The images for each part on the screen can be examined with QR code (WSI screen shots). How to use the SL platform and how to interact with the objects in the platform are explained to students in the *Help Area*. *Teleportation Centre* was formed in order for students to go easily to the branch of winter sports they wished. *Information House* presenting detailed information on each branch of winter sports was developed. The content was presented in visual materials in the *Presentation Hall* in the Information House, and it was presented with support of multi-media instruments in the *Video Hall*. A *Clothing Area* was created so that students recognise clothes specific to each branch of winter sports. Different items of clothing and skates were prepared in this area according to genders, and interactive information objects were developed for students to put on their special clothes. An *Exercise Area* - where moves and techniques specific to each branch of sport are shown in pictures, videos and animation- was prepared. A *Practice Area*- where students could see what they had learnt in other areas and which they could make practice- was developed. Racing tracks were made similar to the real ones and were created by considering important details. In addition to all those, a *Social Area*- where students' avatars could have a rest, have fun, talk to their instructor's and to their friends' avatars and they could share information about what they had learnt – was also developed.

*3.4 Data Collection Instruments*

The items for the Engagement Questionnaire- which was developed by the researcher so as to determine students' behavioural, affective and cognitive engagement-were prepared based on the literature (Appleton, Christeson, & Furlong, 2008; Bouta, Retalis, & Paraskeva, 2012; Fredricks, Blumenfeld, & Paris, 2004; Gregory & Gregory, 2011) and on the researcher's experience with 3D virtual platforms. The 52-item draft form was evaluated by 2 experts of instructional technologies, 4 doctoral students having experience with 3D virtual platforms, and 3 experts of psychological counselling and guidance. In consequence, the questionnaire was reduced to 44 items and modifications were made to some of the items in terms of expression. All the items were examined for cognitive intelligibility by 2 female and 2 male students chosen from the research population. Then, pilot study was done with 167 students. It was found by examining the normality test, skewness and kurtosis, Q-Q pilot and histogram graphs that the data set had normal distribution. Kaiser-Meyer-Olkin test results showed that the sample for the questionnaire was adequate (KMO=.682, p= .000) and Bartlett's test of sphericity showed that the correlation between items was big enough ($x^2(190)= 666.956$, p= .000) (Field, 2009). Exploratory factor analysis was done and some of the items were removed from the questionnaire because they had two factors and because some of them were not reflective of the purpose of the factor they belonged to. As a result, a three-factor (behavioural, affective and cognitive) and 20-item engagement questionnaire was formed. Cronbach Alpha reliability coefficient was calculated as α= .76. Table 1 shows the factor loads of the items of engagement questionnaire and the reliability coefficient for behavioural, affective and cognitive factors of the questionnaire items.

**Table 1.** Engagement questionnaire factor analysis results and reliability coefficients.

| **Item No** | **Factor I (Behavioural Engagement)** | **Factor II (Affective Engagement)** | **Factor III (Cognitive Engagement)** |
|---|---|---|---|
| Item 1 | .528 | | |
| Item 2 | .588 | | |
| Item 3 | .488 | | |
| Item 4 | .514 | | |
| Item 5 | .525 | | |
| Item 6 | .696 | | |
| Item 7 | | .607 | |
| Item 8 | | .505 | |
| Item 9 | | .642 | |
| Item 10 | | .497 | |
| Item 11 | | .633 | |
| Item 12 | | .597 | |
| Item 13 | | .424 | |
| Item 14 | | | .495 |
| Item 15 | | | .411 |
| Item 16 | | | .695 |
| Item 17 | | | .491 |
| Item 18 | | | .705 |
| Item 19 | | | .591 |
| Item 20 | | | .669 |
| α | .61 | .67 | .72 |
| For all the items α .76 | | | |

An achievement test was developed by the project team so as to determine the level of knowledge that the students have in relation to "artistic skating" and "short track". Information was obtained from winter sports trainers and experts about each branch of sport, and the multiple-choice (4-choice) achievement test containing 20 items was evaluated by 2 experts of instructional technologies, 3 doctoral students and language expert. 150 students were given the pilot study to raise the content and construct validity of the test, and the item difficulties as well as discriminant indices were calculated, and the results are shown in Table 2. Internal consistency between the items was analysed so as to assess the reliability of the achievement test, and the KR-20 reliability was found to be 0.92.

**Table 2.** Achievement test item difficulty and discrimination indices.

| Item No | Item Difficulty Index (p) | Item Discrimination Index (D) | Explanation |
|---|---|---|---|
| Item 1 | 0.47 | 0.59 | An item with medium difficulty, but discriminant |
| Item 2 | 0.53 | 0.71 | An item with medium difficulty, but discriminant |
| Item 3 | 0.76 | 0.47 | A quite easy but discriminant item |
| Item 4 | 0.44 | 0.53 | An item with medium difficulty, but discriminant |
| Item 5 | 0.47 | 0.35 | An item with medium difficulty, but discriminant |
| Item 6 | 0.44 | 0.41 | An item with medium difficulty, but discriminant |
| Item 7 | 0.62 | 0.53 | An item with medium difficulty, but discriminant |
| Item 8 | 0.18 | 0.35 | A very difficult but discriminant item |
| Item 9 | 0.59 | 0.71 | An item with medium difficulty, but discriminant |
| Item 10 | 0.47 | 0.35 | An item with medium difficulty, but discriminant |
| Item 11 | 0.29 | 0.23 | A difficult and medium level discriminant item |
| Item 12 | 0.59 | 0.82 | An item with medium difficulty, but discriminant |
| Item 13 | 0.56 | 0.76 | An item with medium difficulty, but discriminant |
| Item 14 | 0.41 | 0.35 | An item with medium difficulty, but discriminant |
| Item 15 | 0.41 | 0.59 | An item with medium difficulty, but discriminant |
| Item 16 | 0.44 | 0.53 | An item with medium difficulty, but discriminant |
| Item 17 | 0.50 | 0.41 | An item with medium difficulty, but discriminant |
| Item 18 | 0.56 | 0.76 | An item with medium difficulty, but discriminant |
| Item 19 | 0.23 | 0.23 | A difficult and medium level discriminant item |
| Item 20 | 0.32 | 0.41 | A difficult and medium level discriminant item |

### *3.5 Process*

The students were taken to two computer labs in Computer Education and Instructional Technologies (CEIT) department of Ataturk University- where computers with good technical specifications were available- in the school where conducted research, since the computer and internet substructure was not sufficient for SL platform to work efficiently. The study lasted 12 hours and 2 weeks in total (2 days a week and 3 hours a day). The instructor in the GG was given the activities guide to follow and the questions to ask.

Both groups of students were offered one hour introduction and information sessions about how to use the environments prior to the activities in the first week because they did not have experience with 3DVE, and they were also given a pre-achievement test. The students in the group without GoIA were allowed to wander around the environment freely and to get informed only by using the directives in the 3DVE. The students in the group with GoIA, on the other hand, wandered around the environment with the instructor's guidance in addition to following the directives in the 3DVE. The instructor in the guided group functioned as a guide having the control in 3DVE leading students, setting a model to students and encouraging students to chat in writing and to do the activities. The instructor also took on the task of reinforcing students' learning, correcting incorrect or incomplete learning and explaining the points which were not understood by asking questions. Besides, the instructor also motivated the students to learn by giving them reinforcement and tried to prevent students from deviating from the purpose of the 3DVE by warning the ones who did not display appropriate behaviors.

On the other hand, 2 people from technical staff were appointed in each laboratory to deal with the problems students were probable to have during the activities, 2 experts controlled the laboratories and made 3DVE observations and thus they noted down their observations. 5 observers having experience with 3DVEs observed the randomly chosen students' engagement in the 3DVE in accordance with the observation form. The researcher was available in the 3DVE as an observer and controlled the 3DVE. At the end of the activities, the students were administered the engagement scale and post-achievement test, and 44 students who were randomly chosen from the guided and unguided groups were interviewed. Student computer screencasts, 3DVE camera recordings and lab camera recordings were obtained during the application. The screencast and camera recordings obtained, and the observation forms completed by the observers were also preserved for use later in analyses. The activities done in both groups during the study are shown in Figure 5, and the images for the activities process of both groups and camera recordings can be reached with QR code (GG and UG).

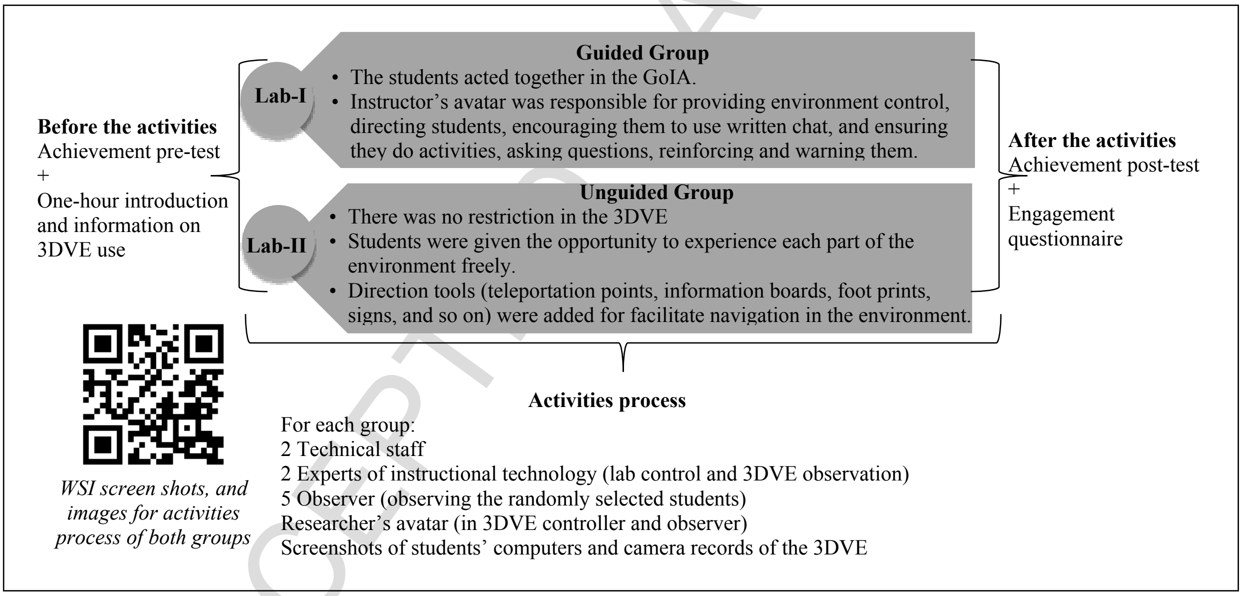



**Fig. 5.** Activities process.

### *3.6 Data Analysis*

The data were analysed on SPSS 18 programme. Prior to the analyses, tests were administered for incomplete data analysis, normality, homogeneity and equality of variances in GG and UG so as to attain internal consistency (Fraenkel, Wallen, & Hyun, 2012). Arithmetic averages and standard deviations were calculated for both groups, and intergroup difference tests and relational analysis were used.

One way MANOVA analysis was applied by using the data on behavioural, affective and cognitive engagement in both groups for the first research question. Prior to the analyses, it was found that the sample size was adequate and that dependent variable data had normal distribution in each group for univariate normality; and Mahalonobis distance was calculated for multivariate normality. Whether or not dependent variables in each group had linearity and whether the variances were equal were tested by analysing the Box's M test (p= .026) and Levene's F tests ($p_{behavioural\ engagement}$= .005, $p_{affective\ engagement}$= .501, $p_{cognitive\ engagement}$= .086). It was found that variance equality was attained for affective and cognitive engagement (p>.05), but that variance equality for behavioural engagement was not attained (p<.05). Accordingly, MANOVA test results are shown by interpreting Pillai's Trace value (Field, 2009, p. 614). The low and medium level significant correlations found between dependent variables also demonstrated that there were no multicollinearity or singularity problems (Pallant, 2005). Data coming from achievement pre-test and post-test were used in both groups for the second research question. Independent groups t-test was administered so as to find the differences between the groups for the pre-test whereas ANCOVA was performed so as to determine the differences for the post-test. It was found prior to the T-test that the dependent variables for each group and the data coming from the pre-test and pos-test had normal distribution, and the homogeneity of variances was tested. The linearity of co-variate and of dependent variables was checked for ANCOVA analysis and it was found that they were not correlated, the homogeneity of regression was tested, and variance homogeneity was obtained (p>.05). Pearson's multiple correlation test was used in analysing the correlations between behavioural, affective and cognitive engagement and achievement.

## 4. Results

### *4.1 The Effects of Guidance on Engagement*

The behavioural, affective and cognitive engagement averages were calculated for the GG and UG in 3D virtual platforms. The results are shown in Table 3.

**Table 3.** The behavioural, affective and cognitive engagement averages for the groups.

| **Groups** | **BE** | | **AE** | | **CE** | | **General Engagement** | |
|---|---|---|---|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** |
| **GG (N=54)** | 2.80 | .16 | 2.60 | .27 | 2.52 | .30 | 2.63 | .18 |
| **UG (N=50)** | 2.73 | .26 | 2.50 | .30 | 2.41 | .39 | 2.54 | .25 |

BE: Behavioural Engagement AE: Affective Engagement CE: Cognitive Engagement

According to Table 3, the students in 3DVE under the GoIA have higher behavioural, affective and cognitive engagement averages than the students with no guidance. In the same vein, the GG have higher averages in engagement in general ($M_{guided}$=2.63, $M_{unguided}$=2.54). MANOVA test was done to see whether or not there were any significant differences between groups in behavioural, affective and cognitive engagement; and the results are shown in Table 4.

**Table 4.** MANOVA test results for behavioural, affective and cognitive engagement according to groups.

| | *Λ* | *F* | *Sig. (p)* | *Partial eta squared ($R^2$)* |
|---|---|---|---|---|
| **Intercept** | .995 | 6719.51 | **.000** | .995 |
| **Group** | .043 | 1.48 | **.222** | .043 |

An examination of Table 4 makes it clear that there are no significant differences between GG and UG in terms of behavioural, affective and cognitive engagement (*Pillai's Trace*= .043, $F_{(2,102)}$=1.48, $p$>.017). This situation indicates that GoIA does not have any effects on students' behavioural, affective and cognitive engagement.

*4.2 The Effects of Guidance on Achievement*

Achievement pre-test and post-test scores were calculated for GG and UG, and the results are shown in Table 5.

**Table 5.** Pre-test and post-test results for the groups.

| **Groups** | **Pre-test** | | **Post-test** | |
|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** |
| **GG** | 37.22 | .12 | 53.61 | .16 |
| **UG** | 34.70 | .11 | 48.60 | .17 |

As is clear from Table 5, the students having GoIA in 3DVE have higher scores both in the pre-test and in the post-test than those having no GoIA in those environment. Independent groups t-test was given so as to find whether or not there were any differences between GG and UG in pre-test scores, and the results are shown in Table 6.

**Table 6.** Differences between groups in terms of pre-test scores.

| **Groups** | **N** | **M** | **SD** | **df** | **t** | **p** | **$R^2$** |
|---|---|---|---|---|---|---|---|
| **GG** | 54 | 37.22 | 12.23 | 102 | 1.083 | .281 | .011 |
| **UG** | 50 | 34.70 | 11.44 | | | | |

According to Table 6, it was found that there were no significant differences between GG and UG in terms of pre-test scores ($t_{(102)=}$1.083, p>.05, $R^2$=.011). This showed that the groups had similar properties.

Even though there were no significant differences between the groups in terms of pre-test scores in this study, it was found that the GG had higher average. Therefore, Covariance analysis (ANCOVA) was performed so as to check the effects of pre-test on post-test in determining whether there were any significant differences between GG and UG in terms of achievement post-test scores (Field, 2009). Firstly, the groups' post-test averages and their averages arranged according to their pre-test scores were calculated in order to be able to compare the groups ($M_{guided}$=52.73, $M_{unguided}$=49.55). Thus, it was found that the GG had higher corrected average scores than the UG. The results for the ANCOVA- which was performed so as to find whether there were any differences between the groups in terms of corrected achievement post-test scores- are shown in Table 7.

**Table 7.** ANCOVA results for the differences between the groups in terms of corrected achievement post-test scores.

| Source of Variation | SS | MS | df | F | p |
|---|---|---|---|---|---|
| Pre-test | 7601.59 | 7601.59 | 1 | 35.02 | .00 |
| Group | 258.83 | 258.83 | 1 | 1.19 | .27 |
| Error | 21921.24 | 217.04 | 101 | | |
| Total | 302825.00 | | 104 | | |

As is evident from Table 7, there are no significant differences between GG and UG in terms of corrected achievement post-test scores ($F_{(101)}$=1.19, p>.05). However, the post-test scores of the GG were found to be higher.

Dependent groups t-test was performed so as to find whether or not there were any differences between the groups in terms of their pre-test and post-test levels; and the results are shown in Table 8.

**Table 8.** The differences between achievement pre-test and post-test scores within each group.

| Groups | M | SD | df | t | p | $R^2$ |
|---|---|---|---|---|---|---|
| **GG Pretest-Posttest** | -16.38 | 14.22 | 53 | -8.468 | .00 | .455 |
| **UG Pretest-Posttest** | -13.90 | 15.82 | 49 | -6.213 | .00 | .477 |

On examining the results, it is clear that the pre-test and post-test scores differ significantly ($t_{(102)}$= -8.468, p<.05, $R^2$=.455) and that the difference is in favour of the post-test (pre-test $M_{guided}$=37.22, post-test $M_{guided}$=53.61). In the same vein, there are also significant differences between the pre-test and pot-test scores of the UG ($t_{(102)}$= -6.213, p<.05, $R^2$=.477) and that the difference is in favour of the post-test (Pre-test $M_{unguided}$ =34.70, post-test $M_{unguided}$=48.60). These findings indicate that the activities made in 3DVE contribute to learning in both the GG and the UG.

*4.3 The Correlations between Engagement and Achievement According to the Groups*

Pearson multiple correlation test was applied so as to find whether or not there were any correlations between GG and UG in terms of their behavioural, affective and cognitive engagement and their achievement; and the results are shown in Table 9.

**Table 9.** The correlations between groups' behavioural, affective and cognitive engagement and their achievement.

| | | BE | AE | CE | General Engagement | Post test |
|---|---|---|---|---|---|---|
| **GG** | **BE** | 1 | | | | |
| | **AE** | .071 | 1 | | | |
| | **CE** | .295* | .265 | 1 | | |
| | **General Engagement** | .488** | 712** | .817** | 1 | |
| | **Post Test** | .264 | -.281* | .342* | .123 | 1 |
| **UG** | **BE** | 1 | | | | |
| | **AE** | .408** | 1 | | | |
| | **CE** | .416** | .322* | 1 | | |
| | **General Engagement** | .717** | .741** | .822** | 1 | |
| | **Post Test** | .232 | .255 | .068 | .220 | 1 |

BE: Behavioural Engagement AE: Affective Engagement CE: Cognitive Engagement
*$p < .05$ **$p < .01$

On examining Table 9, it is clear that there are positive, medium level correlations (r=.342, p<.05) between the cognitive engagement and achievement post-test scores in the GG, negative and weak correlations between affective engagement and achievement (r=.-281, p<.05) but that there are no significant correlations between behavioural engagement and achievement. Besides, it is also clear that there are no significant correlations between behavioural, cognitive and general engagement and achievement in the UG.

## 5. Discussion

This study has revealed the effects of GoIA in 3DVE on behavioural, affective and cognitive engagement and on achievement and demonstrated the correlations between variables according to the groups. This part of the study discusses the findings by relating them to the literature within the framework of research questions.

### *5.1 The Effects of Guidance on Engagement*

It was found that the students in the GG had higher behavioural, affective and cognitive engagement. Ang and Wang (2006) also reached similar conclusions and stated that this was attributed to student-centred environment and to interaction. It was found that the GG had higher engagement on all dimensions than the UG. This situation indicates that GoIA contribute to students' engagement, and it is also compatible with the finding that guidance supports engagement-which was obtained in Bower, Lee and Dalgarno (2017) and Nelson (2007). On the other hand, Lim, Nonis and Hedberg (2006) found that engagement was low despite high achievement. Those differing findings reported in the literature might have stemmed from the design of 3DVE, from the purpose of the platforms and from students' characteristics. Yilmaz and Cagiltay (2016) also stressed the importance of the design of virtual environments.

Both groups had higher behavioural engagement than affective engagement and higher affective engagement than cognitive engagement. The fact that behavioural engagement was higher than the other types of engagement can be indicative of the fact that the platform was designed in a way that students could participate actively. It is also stressed in the literature that platforms should be designed well to ensure student participation (Bouta, Retalis, & Paraskeva, 2012; Tüzün, & Özdinç, 2016). Apostolellis (2017) also points out that engagement is influenced by how much students participate in activities. In both groups, cognitive engagement was found to be lower than the other types. Erlandson, Nelson and Savenye (2010) also reached similar conclusions, and they found that there were no differences between groups in terms of cognitive. This situation might have stemmed from the fact that technical problems such as videos not working occasionally or animations freezing during activities despite support offered by the technical team made it difficult for students to set up connections between pieces of information. Therefore, the results obtained can be analysed in future studies to be conducted by using different learning materials so as to increase cognitive engagement. Despite these findings, Nelson, Kim, Foshee and Slack (2014) found that there were significant differences between groups in terms of cognitive. Traphgahan et al. (2010) also pointed out that guidance to students raised their cognitive levels in positive ways and that obtaining knowledge from others in the environment resulted in higher cognitive engagement. Although studies conducted are similar to this study in comparing the groups cognitively, this study differs from the others in aiming to assure behavioural, affective and cognitive engagement in winter sports skills.

Goo et al. (2006) found that more mental awareness was available in attaining the objective in guided groups and that guidance was more influential in focusing on the learning content. In a similar way, Cho and Lim (2017) pointed out that guidance to students would diminish cognitive load and thus would make it easier for students to perform their task, but this study found that there were no significant differences between groups with and without GoIA in terms of engagement. This might have stemmed from the fact that the subject of winter sports was considered interesting and intriguing since it had not been presented in such a learning environment before, that the 3DVE developed was new to both groups and that it was a well-designed platform in which students could learn on their own. Besides, as Gordon and Koo (2008) and Ibáñez et al. (2011) also point out, the fact that 3DVE are seen as games- although they are not games- can also be the cause of this. In addition to that, the fact that technical staff and observers were available for problems that students could encounter and that they helped students when needed might also have been the cause for not having differences between the groups.

*5.2 The Effects of Guidance on Achievement*

Burigat and Chittaro (2016) found that guidance affected knowledge acquisition and performance in positive ways, Goo et al. (2006) found that guidance was more influential in focusing on learning content and that there was more mental awareness in users to achieve a purpose in guided activities. Despite this, no significant differences were found between the groups' achievement post-test scores in this study just as in Erlandson, Nelson and Savende (2010) and as in Nelson (2007). This might have stemmed from the potential of 3DVEs' design to increase the motivation of students in both groups to learn the subject of winter sports, and from their active participation in the learning activities in the platform. Gregory and Gregory (2011) and Gregory et al. (2015) state that students' learning increases to the extent that they practise and actively take part in the process. On the other hand, seen guidance as an environment of wasting time by students who are accustomed to the innovative environment (Warden, Stanworth, & Chang, 2016; Wrzesien, & Raya, 2010) might have also caused no differences between the groups. Dixson (2012) states that for an instructor to be available in an environment too much would reduce students' engagement and participation, instructor's guidance would waste students' time and would influence learning in negative ways. In this study, perhaps navigation tools available in the 3DVE (such as arrows, information signs, etc.) was sufficient; and the availability of instructor's avatars in the 3DVE was a cognitive burden to students (Goo et al., 2006), offering guidance lowered achievement, and perhaps for all these reasons there were no differences between the groups. The fact that cognitive engagement was lower than the other types of engagement can also be regarded as the evidence for this situation. Therefore, it may be recommended for future studies that the level of guidance should be balances according to learning activities and 3DVE design (Hack, 2016). Apart from that, the fact that the students in the UG interacted not only with navigation tools but also with their friends and with learning content might have affected learning in positive ways (Erlandson, Nelson, & Savenye, 2010) and for this reason no differences might have been found between the groups. The future studies could also consider the fact that alternative assessment methods apart from using pre-tests and post-tests could be used in measuring achievement in 3DVE.

Due to the fact that significant differences were found between pre-test and post-test achievement within the groups, it may be said that these activities contributed to both groups' learning in 3DVE. These results show that students consider the 3DVE as a learning environment in both cases (guided and unguided). This situation might be the result of "innovation effect". Accordingly, it may be said that because 3DVE was an innovative, different and interesting learning environment; the students made efforts to attain bigger success and therefore they probably learnt better in this way (Gregory, & Gregory, 2011). Besides, having higher achievement post-test scores in the group with GoIA than the group with no guidance indicated that guidance contributed to learning by preventing students' distraction and motivating students (Burigat, & Chittaro, 2016; Goo et al., 2006; Nelson, 2007).

### *5.3 The Correlations between Engagement and Achievement According to Groups*

Positive, medium level and significant correlations were found between cognitive engagement and post-test achievement in the GG. Cho and Lim (2017) and Traphagan et al. (2010) also found that cognitive engagement was an important indicator in learning and that guidance raised students' cognitive levels positively. Accordingly, instructor's avatar might have tried to prevent students' distraction and to increase their motivation through clues, warnings and feedback and thus he/she might have ensured cognitive engagement and affected achievement in positive ways while students acquire knowledge from differing channels in 3DVE. In fact it is also reported in the literature that motivation is an important element contributing to the gains in learning environments and to student engagement (Pellas, 2014) and that cognitive engagement is an important indicator in determining the needs and values between learning and achievement (Annetta, Minogue, Holmes and Cheng, 2009). It was found that there were no significant correlations between behavioural engagement and achievement in this group. In contrast to this, Mount, Chambers, Weaver and Priestnall (2009) point out that behaviors such as students' participation 3DVEss, their interaction with peers and appropriate feedback are influential in students' engagement. Fredricks, Blumenfeld and Paris (2004), however, state that the interaction between the three dimensions of engagement has positive effects on learning output. These opposite situations might have stemmed from the restriction of students' behaviours due to more number of students and the problems experienced in internet connection and in SL platform in spite of the technical support (Ghanbarzadeh, & Ghapanchi, 2016; Kapp, & O'Driscoll, 2010).

It was found that there were no significant correlations between behavioural, affective and cognitive engagement and achievement post-test in the UG. In parallel to this finding, Finneran and Zhang (2005) also point out that students display high performance without being aware that they are in the platform if they are concerned with one activity consciously, but that this situation does not guarantee achievement despite increasing performance. This situation might stem from students' failure to share information depending on the restriction in students' behaviors, distraction in interest and disruption in oral communication due to problems in internet connection in using the SL platform despite technical support. The absence of correlations between engagement and achievement might have stemmed from the fact that students acted freely since they had the complete control and that they spent time in the 3DVE having fun rather than learning as a result of this in the UG. Finding supportive of this are also available in the literature (Cruz-Benito et al., 2015; Pellas, 2014; Tüzün, 2007). Thus, Kang, Nah and Tan (2012) state that students see those 3DVEs as instruments for socialising and entertaining. It is recommended that the studies to be conducted in the future should take this situation into consideration in designing 3DVEs so that students do not miss the learning tasks given for the intended learning outcomes.

## 6. Conclusions and Recommendations

This study was conducted with 104 secondary school students who did not have opportunities to do winter sports due to financial reasons- who were chosen through purpose sampling. Since the school they attended did not have the necessary technical sub-structure, the study was performed in two computer labs at the University. The students in the groups had to be in the same laboratories and altogether even though the groups were in different laboratories. This was a restriction in this study. However, it provided a good picture to see the effects of GoIA on students' engagement in 3DVEs. Besides, this was a comprehensive study in that it considered engagement with all of the behavioural, affective and cognitive dimensions and that it determined the correlations between those dimensions and GoIA. In consequence, whether it is guided or unguided, besides being together with peers, the characteristic properties of the task assigned to learn and individual needs may affect engagement- as Fredricks, Blumenfeld and Paris (2004) also point out. This situation should be taken into consideration in determining the differences and correlations between engagement and achievement in guided and unguided activities in 3DVEs.

The following suggestions are made to instructional designers and platform developers, practitioners and researchers by considering what are experienced prior to during and after the study:

- 3DVE control and free use of the platform granted to the students in the UG and the activities rules set for the students in the GG so that they can act with the GoIA should be announced beforehand so that the study can be performed as planned
- It is necessary to give the guide instructor an activity guide and a list of questions so that the activities can be performed efficiently.
- The number of students should be kept at a level that the guide instructor can control since having a great number of students in the same environment at a time can hinder healthy guidance.
- A specialist technical team should be available during the study so that the process can be completed with no problems, and the necessary precautions should be taken so as to minimise the problems stemming from internet sub-structure and 3DVE prior to the study.
- Comparative studies can be conducted in relation to the levels of leading and guidance offered to students.
- New studies comparing the guided groups with smart agents and with instructor's avatars can be conducted.
- The extent to which learning materials of different types affect students' engagement in platforms can be analysed in details.

**References**

Ang, K. H., & Wang, Q. (2006, December). A case study of engaging primary school students in learning science by using Active Worlds. In *Proceedings of the first international LAMS conference,* (pp. 5-14).

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M. T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers and Education, 53*(1), 74-85. doi: 10.1016/j.compedu.2008.12.020

Apostolellis, P. (2017). *Evaluating group interaction and engagement using virtual environments and serious games for student audiences in informal learning settings*. Doctoral dissertation, Virginia Tech.

Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school: Critical conceptual and methodological issues of the construct. *Psychology in the Schools, 45*(5), 369-386. doi: 10.1002/pits.20303

Bair, R. A. (2013). *3D virtual reality check: Learner engagement and constructivist theory.* Unpublished doctoral dissertation, Capella University.

Bouta, H., & Paraskeva, F. (2013). The cognitive apprenticeship theory for the teaching of mathematics in an online 3D virtual environment. *International Journal of Mathematical Education in Science and Technology, 44*(2), 159-178. doi: 10.1080/0020739x.2012.703334

Bouta, H., Retalis, S., & Paraskeva, F. (2012). Utilising a collaborative macro-script to enhance student engagement: A mixed method study in a 3D virtual environment. *Computers & Education, 58*(1), 501-517. Doi: 10.1016/j.compedu.2011.08.031

Bower, M., Lee, M. J., & Dalgarno, B. (2017). Collaborative learning across physical and virtual worlds: Factors supporting and constraining learners in a blended reality environment. *British Journal of Educational Technology*, *48*(2), 407-430. doi:10.1111/bjet.12435

Bulu, S. T. (2012). Place presence, social presence, co-presence, and satisfaction in virtual worlds. *Computers & Education, 58*(1), 154–161.

Burigat, S., & Chittaro, L. (2016). Passive and active navigation of virtual environments vs. traditional printed evacuation maps: a comparative evaluation in the aviation domain. *International Journal of Human-Computer Studies*, *87*, 92-105.

Cansız, Y. (2012). *Effects of way finding affordances on usability of virtual world environments in terms of users' satisfaction, performance, and mental workload: Examination by eye-tracking and fnir device.* Unpublished master's thesis, METU, Ankara.

Chittaro, L., Ieronutti, L., & Ranon, R. (2004). Navigating 3D virtual environments by following embodied agents: A proposal and its ınformal evaluation on a virtual museum application. *PsychNology Journal*, *2*(1), 24-42.

Chen, J. C. (2016). The crossroads of English language learners, task-based instruction, and 3D multi-user virtual learning in Second Life. *Computers & Education, 102*, 152-171.

Cho, Y. H., & Lim, K. Y. (2017). Effectiveness of collaborative learning with 3D virtual worlds. *British Journal of Educational Technology*, *48*(1), 202-211. doi:10.1111/bjet.12356

Coates, H. (2007). A model of online and general campus-based student engagement. *Assessment and Evaluation in Higher Education, 32*(2), 121-141. Doi: 10.1080/02602930600801878

Cruz-Benito, J., Therón, R., García-Peñalvo, F. J., & Lucas, E. P. (2015). Discovering usage behaviors and engagement in an educational virtual world. *Computers in Human Behavior*, *47*, 18-25.

Dalgarno, B., & Lee, M. J. W. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology, 41*(1), 10–32. doi:10.1111/j.1467-8535.2009.01038.x_

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: two case studies of Active Worlds as a medium for distance education. *British Journal of Educational Technology 36(*3), 439-451.

Dixson, M. D. (2012). Creating effective student engagement in online courses: What do students find engaging? *Journal of the Scholarship of Teaching and Learning*, *10*(2), 1-13.

Erlandson, B. E., Nelson, B. C., & Savenye, W. C. (2010). Collaboration modality, cognitive load, and science inquiry learning in virtual inquiry environments. *Educational Technology Research and Development, 58*(6), 693-710. doi: 10.1007/s11423-010-9152-7

Field, A. (2009). *Discovering statistics using SPSS.* (3rd Ed.). London: Sage.

Finneran, C. M., & Zhang, P. (2005). Flow in computer-mediated environments: promises and challenges. *Communications of the Association for Information System, 15*, 82–101.

Fraenkel, J. R., Wallen, N. E., & Hyun, H.H. (2012). *How to design and evaluate research in education* (8th Ed.). New York, NY: McGraw Hill.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59-109. doi:10.3102/00346543074001059

Fredricks, J., McColskey, W., Meli, J., Mordica, J., Montrosse, B., & Mooney, K. (2011). Measuring student engagement in upper elementary through high school: A description of 21 Instruments. *Issues & Answers Report, Regional Educational Laboratory, 98*(098).

Furrer, C. J., Skinner, E. A., & Pitzer, J. R. (2014). The influence of teacher and peer relationships on students' classroom engagement and everyday motivational resilience. *National Society for the Study of Education, 113*(1), 101-123.

Ghanbarzadeh, R., & Ghapanchi, A. H. (2018). Investigating various application areas of three-dimensional virtual worlds for higher education. *British Journal of Educational Technology,49*(3), 370-384. doi:10.1111/bjet.12538

Goo, J. J., Park, K. S., Lee, M., Park, J., Hahn, M., Ahn, H., & Picard, R. W. (2006). Effects of guided and unguided style learning on user attention in a virtual environment. In *Technologies For e-Learning and Digital Entertainment*, 1208-1222.

Gordon, E., & Koo, G. (2008). Placeworlds: Using virtual worlds to foster civic engagement. *Space and Culture, 11*(3), 204-221. doi: 10.1177/1206331208319743

Gregory, S., & Gregory, B. (2011). Do virtual worlds have a role in increasing student engagement as measured by their higher academic grades? In M. Dochertyand M. Hitchcock (Eds.), *CreateWorld 2011 Proceedings* (pp. 40–50). Brisbane, Australia: Griffith University.

Gregory, S., & Masters, Y. (2012). Real thinking with virtual hats: a role-playing activity for pre-service teachers in Second Life. *Australasian Journal of Educational Technology, 28*(3), 420–440.

Gregory, S., Scutter, S., Jacka, L., McDonald, M., Farley, H., & Newman, C. (2015). Barriers and enablers to the use of virtual worlds in higher education: An exploration of educator perceptions, attitudes and experiences. *Educational Technology & Society, 18* (1), 3–12.

Hack, C. J. (2016). The benefits and barriers of using virtual worlds to engage healthcare professionals on distance learning programmes. *Interactive Learning Environments*, *24*(8), 1836-1849.

Harris, L. R. (2008). A phenomenographic investigation of teacher conceptions of student engagement in learning. *The Australian Educational Researcher, 5*(1), 57-79.

Ibáñez, M. B., García, J. J., Galán, S., Maroto, D., Morillo, D., & Kloos, C. D. (2011). Design and Implementation of a 3D multi-user virtual world for language learning. *Educational Technology and Society*, *14* (4), 2–10.

Jarmon, L., Traphagan, T., Mayrath, M., & Trivedi, A. (2009). Virtual world teaching, experiential learning, and assessment: An interdisciplinary communication course in Second Life. *Computers & Education, 53*(1), 169-182. doi: 10.1016/j.compedu.2009.01.010

Kang, Y., Nah, F., & Tan, A., (2012, December). Investigating intelligent agents in a 3D virtual world. *Proceedings of the International Conference on Information Systems (ICIS)*, Orlando, Florida.

Kapp, K. M., & O'Driscoll, T. (2010). *Learning in 3D: Adding a new dimension to enterprise learning and collaboration.* San Francisco, CA: Pfeiffer.

Kearsley, G., & Shneiderman, B. (1998). Engagement theory: A framework for technology-based teaching and learning. *Educational Technology*, *38*(5), 20-23.

Kuh, G. D. (2009). What student affairs professionals need to know about student engagement. *Journal of College Student Development*, *50*(6), 683-706.

Lim, C. P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multiuser virtual environment: engaging students in Science lessons. *British Journal of Educational Technology, 37*(2), 211-231. doi: 10.1111/j.1467-8535.2006.00531.x

McMillan, J. H., & Schumacher, S. (2010). *Research in education: Evidence based inquiry* (7th Ed.). London: Pearson.

Messinger, P. R., Stroulia, E., Lyons, K., Bone, M., Niu, R. H., Smirnov, K., & Perelgut, S. (2009). Virtual worlds — past, present, and future: New directions in social computing. *Decision Support Systems, 47*(3), 204-228. doi: 10.1016/j.dss.2009.02.014

Minocha, S., & Hardy, C. (2016). Navigation and wayfinding in learning spaces in 3D virtual worlds. In Sue Gregory Mark, J.W. Lee, Barney Dalgarno, Belinda Tynan (Eds), *Learning in Virtual Worlds: Research and Applications* (pp.3-42), Athabasca University Press.

Minocha, S., & Reeves, A. J. (2010). Design of learning spaces in 3D virtual worlds: An empirical investigation of Second Life. *Learning, Media and Technology, 35*(2), 111-137. doi: 10.1080/17439884.2010.494419

Mount, N. J., Chambers, C., Weaver, D., & Priestnall, G. (2009). Learner immersion engagement in the 3D virtual world: principles emerging from the DELVE project. *ITALICS*, *8*(3).

Nelson, B. C. (2007). Exploring the use of individualized, reflective guidance in an educational multi-user virtual environment. *Journal of Science Education and Technology, 16*(1), 83-97. doi: 10.1007/s10956-006-9039-x

Nelson, B. C., Kim, Y., Foshee, C., & Slack, K. (2014). Visual signaling in virtual world-based assessments: The SAVE Science project. *Information Sciences, 264*, 32-40. doi:10.1016/j.ins.2013.09.011

Pallant, J. (2005). SPSS survival manual: A step by step guide to data analysis using SPSS for Windows (Version 12). Retrieved April, 24, 2014. http://www.academia.dk/BiologiskAntropologi/Epidemiologi/PDF/SPSS_Survival_Manual_Ver12.pdf

Parson, V., & Bignell, S. (2017). An investigation into cooperative learning in a virtual world using problem-based learning. *Online Learning*, *21*(2).doi: 10.24059/olj.v21i2.796

Pellas, N. (2014). The influence of computer self-efficacy, metacognitive self-regulation and self-esteem on student engagement in online learning programs: Evidence from the virtual world of Second Life. *Computers in Human Behavior*, *35*, 157-170.

Pianta, R. C., Hamre, B. K., & Allen, J. P. (2012). Teacher-student relationships and engagement: Conceptualizing, measuring, and improving the capacity of classroom interactions. In *S. L. Christenson, A. L. Reschly & C. Wylie (Eds.), Handbook of research on student engagement* (pp. 365-386). *New York: Springer.* Retrieved November, 21, 2013. https://books.google.com.tr

Reisoğlu, I., Topu, B., Yılmaz, R., Yılmaz, T. K., & Göktaş, Y. (2017). 3D virtual learning environments in education: a meta-review. *Asia Pacific Education Review*, *18*(1), 81-100. Doi: 10.1007/s12564-016-9467-0

Russell, V. J., Ainley, M., & Frydenberg, E. (2005). Schooling issues digest: Student motivation and engagement. *Canberra: Australian Government, Department of Education, Service and Training*.

Salt, B., Atkins, C., & Blackall, L. (2008). Engaging with Second Life: real education in a virtual world. Retrieved June, 17, 2014. http://piensl.pbworks.com/f/slliteraturereviewa1.pdf

Siriaraya, P., Ang, C. S., & Bobrowicz, A. (2012). Exploring the potential of virtual worlds in engaging older people and supporting healthy aging. *Behaviour and Information Technology, 33*(3), 283-294. doi: 10.1080/0144929x.2012.691552

Sullivan, F. R., Hamilton, C. E., Allessio, D. A., Boit, R. J., Deschamps, A. D., Sindelar, T., . . . Zhu, Y. (2011). Representational guidance and student engagement: Examining designs for collaboration in online synchronous environments. *Educational Technology Research and Development, 59*(5), 619-644. doi: 10.1007/s11423-010-9178-x

Traphagan, T. W., Chiang, Y.-h. V., Chang, H. M., Wattanawaha, B., Lee, H., Mayrath, M. C., . . . Resta, P. E. (2010). Cognitive, social and teaching presence in a virtual world and a text chat. *Computers & Education, 55*(3), 923-936.

Tüzün, H. (2007). Blending video games with learning: Issues and challenges with classroom implementations in the Turkish context. *British Journal of Educational Technology, 38*(3), 465-477.

Tüzün, H., & Özdinç, F. (2016). The effects of 3D multi-user virtual environments on freshmen university students' conceptual and spatial learning and presence in departmental orientation. *Computers & Education*, *94*, 228-240.

Twining, P. (2009). Exploring the educational potential of virtual worlds—Some reflections from the SPP. *British Journal of Educational Technology*, *40*(3), 496-514.

Vrellis, I., Avouris, N., & Mikropoulos, T. A. (2016). Learning outcome, presence and satisfaction from a science activity in Second Life. *Australasian Journal of Educational Technology, 32*(1).

Warden, C. A., Stanworth, J. O., & Chang, C. C. (2016). Leveling up: Are non-gamers and women disadvantaged in a virtual world classroom? *Computers in Human Behavior, 65*, 210-219.

Wrzesien, M., & Raya, M. A. (2010). Learning in serious virtual worlds: Evaluation of learning effectiveness and appeal to students in the E-Junior project. *Computers & Education, 55*(1), 178-187.

Xu, Y., Park, H., & Baek, Y. (2011). A new approach toward digital storytelling: An activity focused on writing self-efficacy in a virtual learning environment. *Educational Technology and Society, 14*(4), 181–191.

Yilmaz, T. K., & Cagiltay, K. (2016). Designing and Developing Game-Like Learning Experience in Virtual Worlds: Challenges and Design Decisions of Novice Instructional Designers. *Contemporary Educational Technology, 7*(3), 206-222.

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**Research Highlights**

- Students’ engagement in 3DVE is examined by considering all of the behavioural, affective and cognitive dimensions.
- Students consider the 3DVE as a learning environment in both cases (guided and unguided).
- The guidance of instructor avatar in the 3DVE did not affect students' engagement and achievement.
- In the guided group there were correlations between cognitive engagement and achievement.
- In the unguided group there were no correlations between all of the engagement dimensions and achievement.