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## **Does the Education Degree Significantly Affect the Perception of a Virtual Reality Environment?**

Eğitim Derecesi Sanal Gerçeklik Ortamının Algılanmasını Önemli Etkiler mi?

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### **Abstract**

Virtual Reality (VR) is a software generated digital environment that is aimed to simulate a realistic experience by creating a variety of stimuli conditions. While VR existed for more than two decades, it has dramatically gained the attention of public domain in recent years due to the portability and cost effectiveness of modern head mounted display (HUD) tools. Currently, the most widely used area of VR in research is Virtual Reality Exposure Therapy (VRET) which is a method risen from the use of VR to potentially help people to treat a specific ailment. Over the last two decades, VRET has been established to be a highly effective way in various areas specifically in helping muscle control of stroke patients, treating various disorders and phobia problems.

While there are an overwhelming number of researches undertaken in using VR, to this day it is not clear whether or not the educational degree of users is an impact factor that significantly affects how users perceive a VR system. Many researchers analysed whether or not there would be noticeable differences between VRET and traditional cognitive behavioural therapies (such as VIVO). However, what makes a VR system highly usable or whether or not the educational degree of users significantly impacts the usability of a VR system is still an unexplored area.

This paper investigates whether or not there is a significant difference in experiencing a VR system specifically designed to treat acrophobia among people who have a higher education degree compared to those who do not have one. A VR environment was created using Nielsen's heuristics to treat potential subjects that suffer from acrophobia. Having done so, a quasi-experimental study was undertaken in order to identify whether or not the educational degree of participants significantly impacted their experience in using the VR system. The findings of the study suggest that the educational degree of participants did not significantly impact how they perceived the VR environment. In other words, it was found that

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educational degree of participants is not a significant influence that affect how realistic and immersive participants found their VR experiences.

**Keywords:** *Virtual Reality, Education and Virtual Reality, Virtual Reality Exposure Therapy, Virtual Reality User Experience*

## **Öz**

Sanal Gerçeklik (SG), çeşitli uyarı koşullarını yaratarak gerçekçi bir deneyimi simüle etmeyi amaçlayan dijital bir yazılım ortamıdır. SG, yirmi yıla aşkın bir süredir varlığını devam ettirirken, sanal gerçeklik başlıklarının maliyetinin düşük olması ve taşınabilirliği nedeni ile son birkaç yıldır kamuoyunun dikkatini çekmektedir. Günümüzde, sanal gerçekliğin eğlence sektörü dışında en çok kullanıldığı alan Sanal Gerçeklik Maruz Kalma Terapisi (SGMKT) olup, belirli bir psikolojik rahatsızlığın tedavi etme sürecine yardımcı olma amacını güden bir yöntemdir. Son yirmi yılda, SGMKT, özellikle kas kontrolü ile ilgili hastalıkların tedavi sürecine yardımcı olmak, ve çeşitli rahatsızlıkları ve fobi problemlerinin iyileştirme sürecini desteklemek amacıyla etkili bir yol olarak kullanılmaktadır.

SG kullanımıyla ilgili çok sayıda araştırma yapılırken, bu güne kadar kullanıcıların eğitim derecelerinin, SG sistemi nasıl algıladıklarını; ve SG deneyimlerine önemli ölçüde etki edip etmediğini ölçen bir çalışma yapılmamıştır. Birçok araştırmacı, SGMKT ile geleneksel bilişsel davranışçı terapiler arasında (VIVO gibi) farklar olup olmadığını analiz etmiştir. Ancak, bir SG sistemini son derece kullanışlı kılan etkilerin eğitim derecesiyle ilişkisini inceleyen veya kullanıcıların eğitim derecelerinin bir SG sistemine olan etkilerini ölçen istatistiksel araştırmalar yok denecek kadar azdır.

Bu araştırmada, yükseklik korkusunun tedavisini desteklemek amacı ile geliştirilen bir sistemi test eden kullanıcılar arasında yüksek bir eğitim derecesine sahip olanlarla, daha az ya da hiç eğitim derecesine sahip olan bireyler arasındaki SG deneyimleri karşılaştırılmıştır. Yükseklik korkusu (Akropobi) rahatsızlığının tedavisinde potansiyel olarak kullanılacak bir SG sistemi Nielsen'in sezgisel değerlendirmesi kullanılarak oluşturulmuştur. Mütakiben, katılımcıların eğitim derecelerinin SG sistemini kullanmadaki etkilerini belirlemek için yarı deneysel bir çalışma yapılmıştır. Yapılan çalışmanın sonucunda, araştırma bulguları, katılımcıların eğitim derecelerinin SG ortamına önemli ölçüde etki etmediği gözlemlenmiştir. Bir diğer değişle, katılımcıların eğitim derecelerinin SG deneyimlerinde ve kullanımlarında etkin bir rol oynamadığı ortaya çıkmıştır.

**Anahtar Sözcükler:** *Sanal Gerçeklik, Eğitim ve Sanal Gerçeklik, Sanal Gerçeklik Maruz Kalma Terapisi, Sanal Gerçeklik Kullanıcı deneyimi*

## **1. Introduction**

Virtual Reality (VR) is a unique way to interact with the digital world (Verg & Vance, 2017) by stimulating multiple senses including visual, auditory, and kinaesthetic communication. While the visual and auditory senses are usually delivered using a head mounted display (HUD), the sense of touch and k inaesthetic communication often delivered through special gloves in VR (Dascal, *et al.*, 2017). In recent years, VR technologies have

become a mainstream technology adaptable to many different game consoles as well as smart phones (Jackson, 2015).

Virtual Reality Exposure Therapy (VRET) is a type of psychological therapy which helps treating anxiety issues using a VR environment in order to minimise certain way of thinking or behaviours in individuals. In this kind of environment, patients often interact with virtual representations of traumatic stimuli within a harmless environment in order to reduce their fear responses. VRET has been proven to treat anxiety-related problems such as posttraumatic stress disorder (PTSD) and various phobias (Tull, 2018).

In addition to VRET, VR is also perceived as an opportunity in education particularly because it can motivate the learners and connect them with the teaching activities (Kolo *et al.*, 2017). A recent work in this area argue that VR has the potential to create the workforce of the future as 94% of teachers in the UK provided feedback that VR is potentially beneficial in their classrooms for engaging students in learning activities (Ismail, 2018). Another recent study discusses feasibility reports suggesting that VR industry is expected to cost around \$38 Billion by 2026 and that this will highly impact the education sector (Terdiman, 2018).

While virtual reality has been perceived as a tool to improve educational experiences of students (Němec, *et al.*, 2015; Ott & Freina, 2015; Howard, *et al.*, 2018), there is a dearth of evidence investigating whether or not educational background is an impact factor in how people perceive their VR experiences.

For this specific reason, this paper investigates whether or not there is a significant correlation between educational degrees of participants and their immersion in using a VR system particularly designed as a VRET for acrophobia. The paper first reviews the literature published in this area in order highlight what has been done regarding education and VR. Having done so, the methodology and study design used in this research is discussed. Finally, the findings of the study with statistical analysis are presented.

## **2. Literature review**

While the educational effectiveness of Virtual Reality (VR) has been an active research area for more almost 30 years, it has only taken public attention in the last decade (Pantelidis, 2009). VR is currently being used in wide variety of areas including but not limited to training employees to have professional skills (Ngobi, 2018), enhancing creativity and reducing stress

(Aqeel, 2018), treating phobia problems (Ayala *et al.*, 2018) and supporting educational activities (Herold, 2017).

Many studies argue that VR has the potential to enhance students' learning and engagement inside the classrooms by refining the delivery of educational content (Walsh, 2017; Babich, 2018). Various educational institutions today offer VR applications as instructional approaches in a series of fields in education particularly in New Pedagogies (James, 2014), Recruiting (Schnell, 2015), Virtual Field Trips (Babcock, 2015), Medical Uses (World first, 2016), Content Creation (Walsh, 2017), and Special Education (Herold, 2017). Recent work in this field reported that majority of students respond positively to VR active learning engagement (Kolo, 2017).

A recent survey study revealed that 93% of secondary school teachers in United States of America (USA) believe that their students are excited to use VR in their learning activities and that 83% of secondary school teachers provided feedback that VR has the potential to improve learning outcomes in education for secondary school students (Hyman, 2016). Due to the enthusiasm stimulated and the increase of students' engagement caused by VR inside the classroom environment, several teachers have reported that they got impressed by VR's impact on their students' motivation (Hentsch, 2018). As a result, VR is not only revolutionizing the traditional learning medium but it is also improving how student interact with real-world applications. The latest example to this is a recent study which underpinned that performing virtual surgeries in the medical classes via VR tools potentially prepare students for real life situations (Pamic, 2018).

New studies suggest that Virtual Reality has a unique approach in treating anxieties problems such as public speaking and sexual traumas (Melville, 2018). Virtual Reality Exposure Therapy (VRET) is recognized as a great fit for this purpose and used particularly to treat and posttraumatic stress disorder (PTSD) and phobia problems (Weir, 2018).

While VR has proven to be a very effective and a promising approach to support wide variety of areas, to this day it is unclear whether or not educational degree of people has an impact on how these people perceive their VR experiences. Recent studies argue that various companies believe the skill set of their employees could be improved using VR employee training programmes (Weiss, 2018). However, these studies do not highlight if the educational background of these employees could have an impact on their perception of VR experiences. In other words, there is a dearth of evidence regarding how educational degree of people impact

on their VR experiences. In order to explore this area, this paper investigates the following research question:

*Does the educational degree of participants have a significant impact on how they perceive a virtual reality environment?*

As this paper focuses on the above question, two hypotheses were generated as the outcome of the question.

**Null hypothesis (Ho1):** Yes, the educational degree of participants has a significant impact on how they perceive a virtual reality environment.

**Alternative hypothesis (Ha1):** No, the educational degree of participants does not have a significant impact on how they perceive a virtual reality environment.

### 3. Methodology & study design

In order to investigate the research question identified above, a Virtual Reality Environment (VRE) was created using Unity3D game engine. The VRE was created as a Virtual Reality Exposure Therapy (VRET) approach in the premise of supporting people's progress of overcoming acrophobia (i.e. the fear of heights).

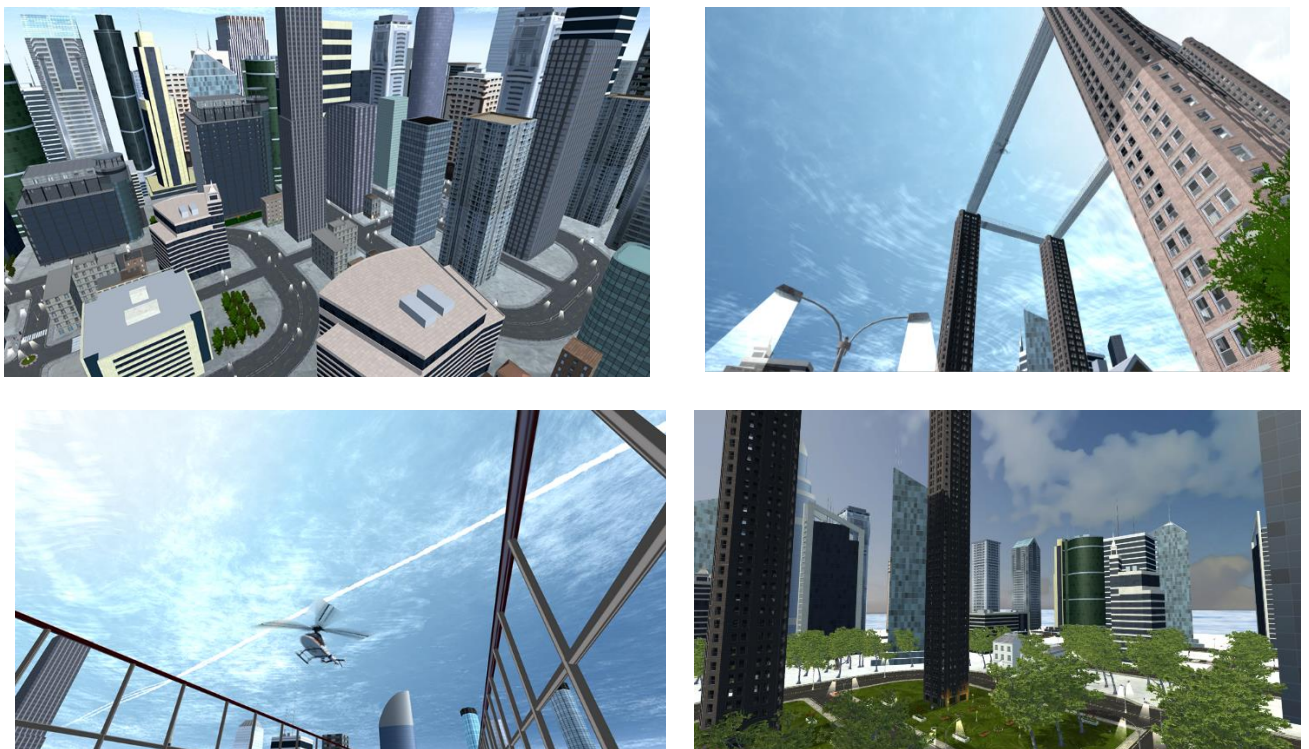


Figure 1 – showing various screenshots from the Virtual Reality Environment used as a test bed in this research

As shown in Figure 1, the VRE was designed as a virtual city where the player has to walk over long bridges interconnected at the top of the skyscrapers. There are four major skyscrapers in the city and each of these is connected to one another with long bridges. The VRE was designed using intrinsic video game motivations as players have to find their lost cat by crossing over the bridges and saving the cat from the roof tops. As there are four bridges in the VRE, each time the simulation starts the cat is pre-scripted to appear on one of the four roofs connected by narrow bridges. The idea of this simulation is to expose the users to virtual heights and support their progress of overcoming acrophobia.

During the development of VRE, the usability and user-friendliness of the environment was prioritized because of the need of an efficient human-computer interaction. In the field of human-computer interaction, usability inspection of a system is an important approach used to identify problems associated with the design of user interface. In order to apply this, Nielsen's Heuristics (Nielsen, 1994) was followed in this research. Nielsen's Heuristics is a seminal work that argues delivering 10 broad rules for user interaction design which are introduced by Nielsen (1994) as essential components to deliver an effective user interface. In the seminal work of Nielsen (1994), these set of rules are simply referred to as heuristics which are the

1. Visibility of the system.
2. Match between the system and the real world.
3. User control and freedom.
4. Consistency and standards.
5. Error prevention.
6. Recognition rather than recall.
7. Flexibility and the efficiency of use.
8. Aesthetic and the minimalist design.
9. User recognition, diagnose, and recovery from errors.
10. Documentation.

Having attempted to apply all of the above heuristics into the VRE, a pilot study was designed to assess whether or not the developed VRE is user friendly and serves its purpose.

To assess the heuristics successfully and to measure whether or not the educational degree of participants impacted on their VR experience, a quasi pre-post experimental study was undertaken. The quasi study designed involved filling a pre-study, followed by the use of the VR environment for as long as the users want, and that followed filling a post-study. The pre and the post study included almost the same set of questions asking the users about their

degree of experience in VR and if they think that the VR environment could potentially be useful for its purpose, with the exception that the pre-study also included demographic questions (i.e. education degree, age, gender, etc..). At the end of the study, the results from the post-study were compared to the results from the pre-study in order to measure whether or not the VR intervention created a difference in between the given responses.

#### **4. Study findings**

##### **4.1 Demographic data**

As discussed in the previous section, a quasi experimental design was conducted to measure whether or not the educational degree of people has impact on their VR experiences. Due to the reason that this was designed as a quasi study, the target group involved all people across different age groups with different level of educational degrees.

It was originally planned to obtain 30 or more participants from each education category identified in the study as 30 participants would be enough to undertake relevant statistical analysis for each category per se. However, due to the non-normal distribution of the population, the number of people of each category changed vastly, hence a precise sample size was not measured for the study. This is why, this study is regarded as a quasi experimental design rather than a gold standard pre and post study.

Initially, 155 participants were invited to participate in the study; however, 51 of these either dropped out or completed the pre-study but did not complete the post-study. At this point, it is important to underline that participation in the study was a voluntary work. Hence, we had no control over the participants' behaviour and they had the option to drop out without providing any reason. Due to the vast number of drop outs, the study analysis was conducted based on the responses of 104 participants.

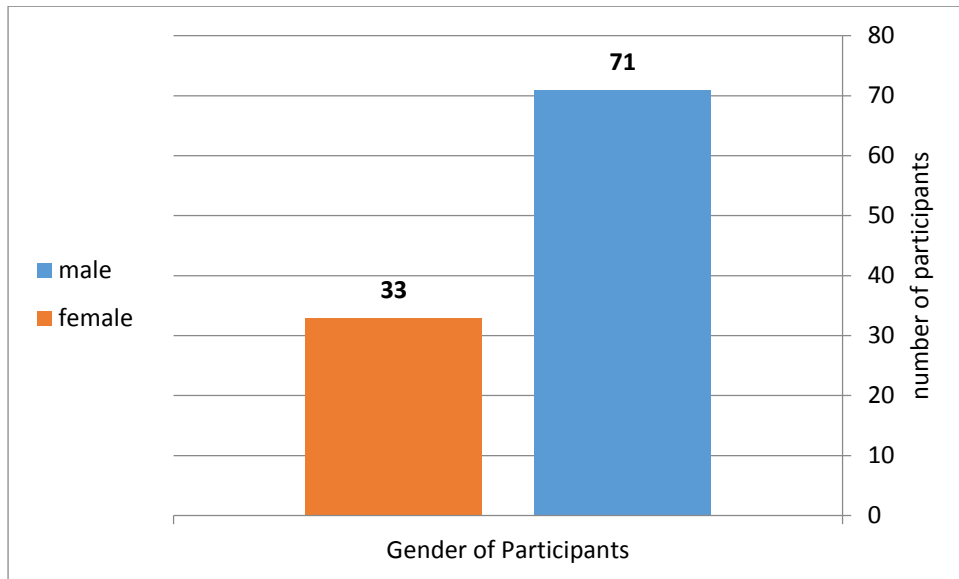


Figure1. Showing the gender of participants who participated in the study.

Figure1 shows the gender distribution of participants who participated in the study.

As it can be observed from the figure 1, 71 (68.2%) out of 104 participants were male and 33 (31.8%) out of 104 were female.

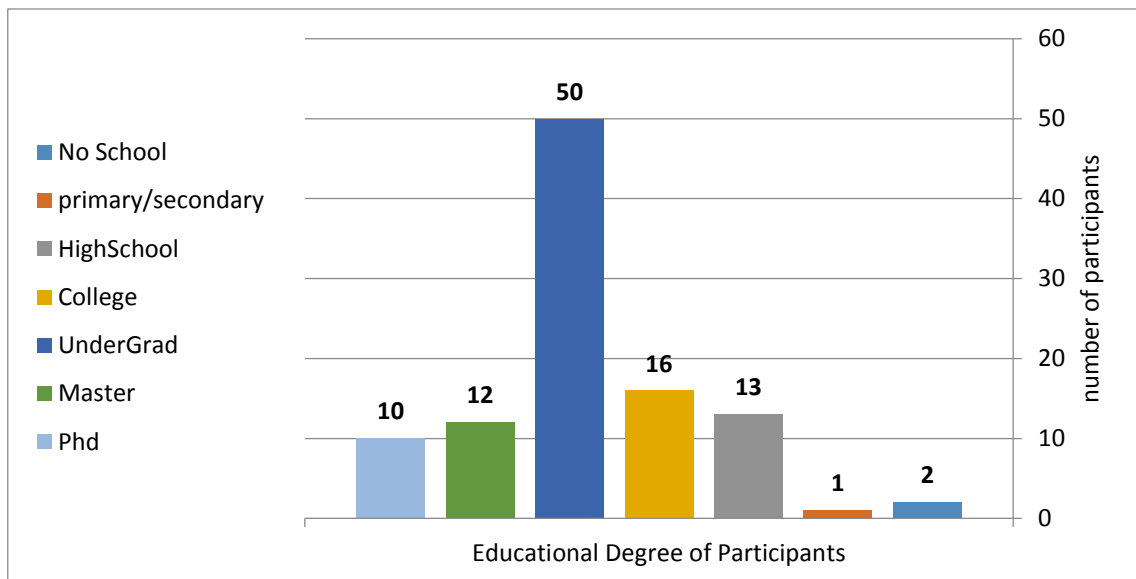


Figure 2. Showing the educational degree of participants who participated in the study.

As shown from Figure 2, 10 (9.6%) out of 104 participants who participated in the study were registered to a PhD programme. Additionally, 12 (11.5%) participants were studying a master/post-graduate degree and 50 (48%) participants were studying an undergraduate degree. While 16 (15.4%) of the participants were enrolled in a college or a vocational school, 13



(12.5%) participants were studying in a high school. Finally, 1 (1%) participants were registered to a primary/secondary school and 2 (2%) participants had no educational degree at all.

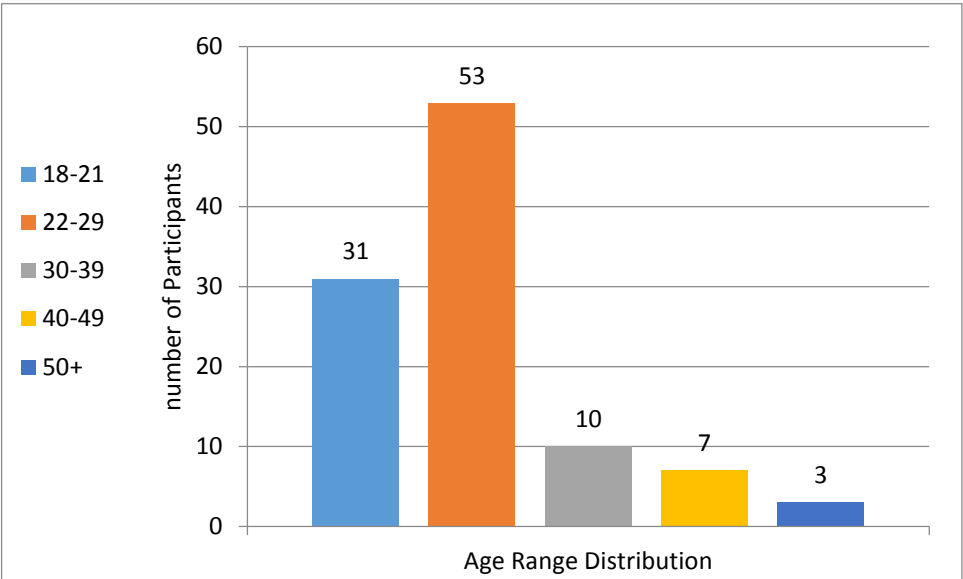


Figure 3. Showing the age distribution of participants who participated in the study.

Figure 3 shows the distribution of age groups of participants who participated in the study. According to the figure, most of the participants were in the 22-29 age group as 53 (51%) out of 104 responses came from this group. While 31 (29.8%) participants were in the 18-21 age-group, 10 (9.6%) participants were within the 30-39 age range. Finally, 7 (6.7%) responses came from the 40-49 age group and only 3 (2.9%) responses were obtained from 50+ years old participants.

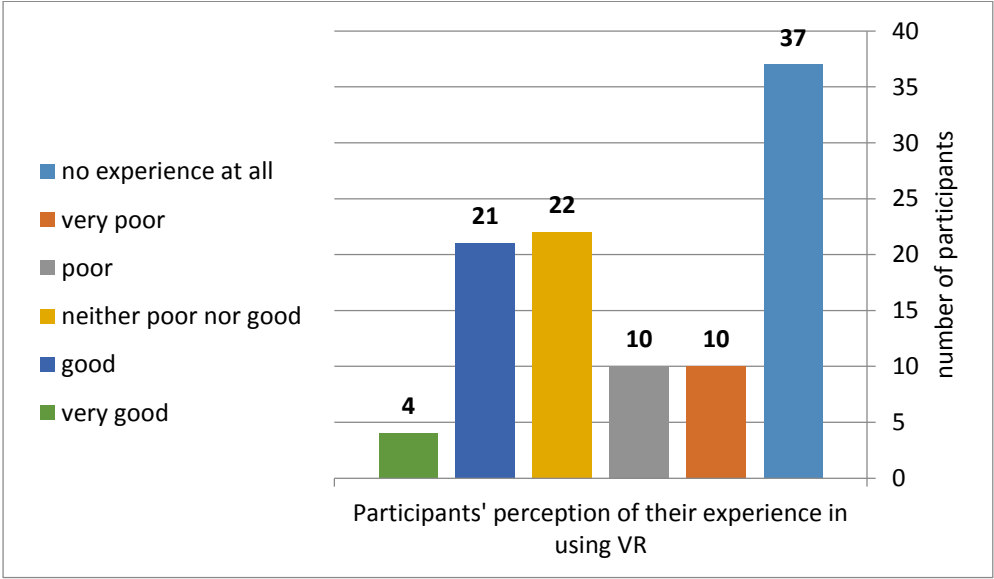


Figure 4. Showing participants' perception of their experience in using VR.

The final figure (i.e. Figure 4) shows participants' perception of their experience in using VR systems. All participants were asked to rate their experience in using VR based on a 5 point Likert scale which changed from very poor (1) to very good (5). Those who absolutely had no prior experience in using VR also had the option to choose no experience (shown as 0) to indicate that they were never exposed to a VR environment before.

As shown in Figure 4, 37 (35.6%) out of 104 participants indicated that they had no prior experience in using VR. While 10 (9.6%) participants ranked their experience as very poor; 10 (9.6%) more indicated their own experience as only poor. 22 (21.2%) out of 104 participants expressed that their perception of experience in using VR is neither poor nor good; and, 21 (20.2%) participants indicated that their perception of experience is only good. Finally, 4 (3.8%) participants ranked their perception of experience in using VR as very good.

## **4.2 Results and discussions**

Having collected the pre-study questionnaire from the participants, it was essential to identify whether or not the data set came from a normally distributed population. Identifying the distribution of data was the key in defining which statistical method would be fitting to analyse the collected data. If the data set was found to be collected from a normally distributed population, Pearson correlation coefficient (PCC) would be used to analyse the data. On the other hand, if the data set was found to be collected from a non-normally distributed population, Spearman's rank correlation coefficient would be used to investigate the correlations.

In order to analyse whether or not the data came from a normally distributed population, two different methods were used which were the a) Histogram; b) Test of Normality.

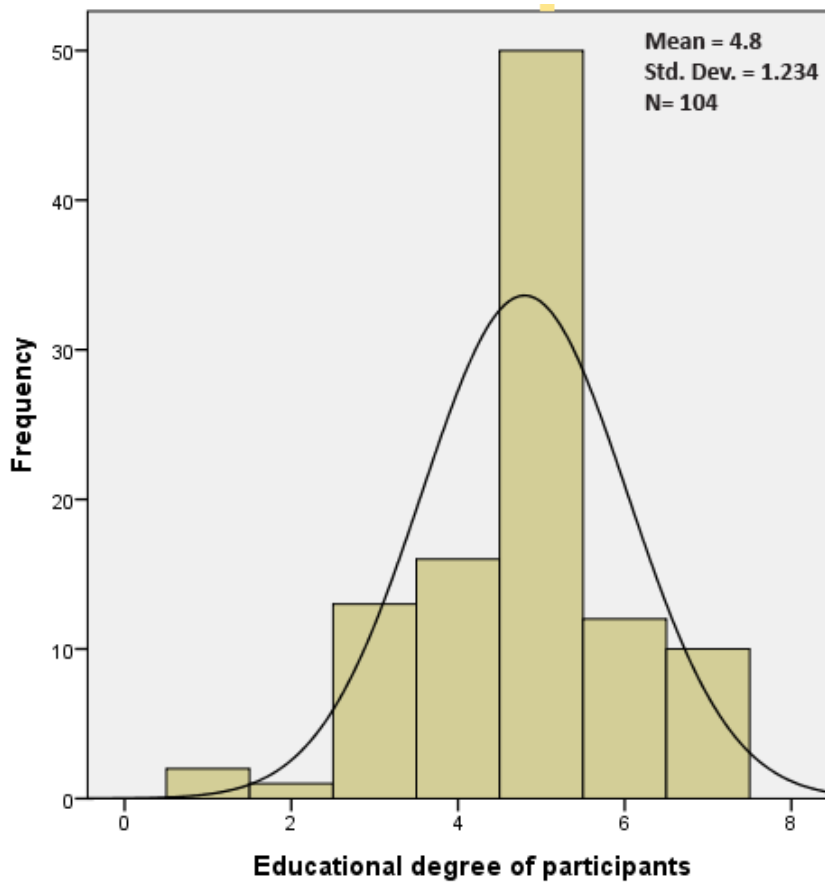


Figure 5. Showing the histogram of data distribution among educational degree of participants.

Figure 5 shows the histogram of the data distribution came from participants regarding their educational degrees. As shown from the figure, the histogram is skewed to the right dramatically. This shows that majority of the responses came from people who were studying an undergraduate or above degrees. In other words, the histogram suggests that the responses were not distributed normally among the educational degree groups and that the overall data came from a non-normally distributed population.

In order to ensure that the evidence obtained from the histogram is correct, a test of Normality was conducted. The test of normality included Kolmogorov-Smirnov and Shapiro-Wilk normality tests which are popular tests used in frequency statistics.

Table 1. Test of Normality undertaken on the educational degree level of participants

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Stat	Degree of freedom	Significance	Stat	Degree of freedom	Significance

Educational degree of participants	0.226	104	<b>0.000</b>	0.845	104	<b>0.000</b>

As shown in Table 1, both in Kolmogorov-Smirnov and Shapiro-Wilk test results show that the significance value was found to be less than 0.05 ( $p < 0.05$ ). In this case the null hypothesis (i.e. the data came from a normally distributed population) was rejected and the alternative hypothesis was accepted, that is the data significantly deviating from a normal distribution.

At this point, it is important to mention that the Histogram and the Test of normality were not only used to investigate the distribution of data on educational degree of participants but also used for each and every question asked in the pre and the post study. In other words, each question was analysed individually in order to ensure a correct interpretation regarding the normality of data distribution. These however, were not presented in this paper due to the repetitiveness of the undertaken procedure of looking into histogram and test of normality for every single question.

Having identified that the data came from a non-normally distribution, it was obvious that Spearman's rank correlation coefficient is the fitting statistical method for investigating the correlations among the collected data set.

Spearman's rank order correlation				
			Educational degree	How useful participants found the VR environment
	Educational degree	Correlation Coefficient	1.000	0.88
		Sig. (2-tailed)	.	<b>0.372</b>
		N	104	104

Spearman's rho	How useful participants found the VR environment	Correlation Coefficient	0.88	1.000
		Sig. (2-tailed)	<b>0.372</b>	.
		N	104	104

Table 2. Spearman's rank order Correlation between the educational level of participants and how useful they found the VR environment.

Table 2 shows the Spearman's rank correlation coefficient in between the educational degree of participants and how useful they found the VR environment. Having exposed to the VR environment, each participant ranked their perception regarding how useful they found their VR experience after using the developed VRE with a head mounted display (HUD). The results given regarding the use of VR in the pre study and the responses given in the post study were compared with one another. These results were then analysed and correlation coefficients are presented in Table 2.

As shown from the Table 2, the correlation between the two groups was found to be not significant ( $r=0.88$ ;  $n=104$ ;  $p=0.372$ ). As the p value was over 0.05 ( $p=0.372$ ), the Spearman's rank order correlation indicated that there is no statistically significant relationship in between the educational degree of participants and how useful they found their VR experience. This result clearly underpins that the educational degree of participants did not play a significant role in deciding whether or not they found the VR environment useful. In other words, participants' perception of how useful they found the VR environment was not judged based on how educated participants were. The results provide strong evidence that those who not have a higher educational degree could find a VR environment useful as much as those who have a higher educational degree. In other words, it was found that the educational degree is not an impact factor in deciding whether or not a VR environment is useful.

Finally, this study investigated whether or not participants were engaged in the VR environment according to the Nielsen's heuristics.

How much participants found the VR environment immersive		Educational Degree	How much participants found the VR environment <b>Interesting &amp; Appropriate</b>	How much participants found the VR environment <b>Immersive</b>	How much participants found the VR environment <b>Realistic</b>	How much participants found the VR environment <b>Interactive</b>	How much participants found the VR environment <b>User friendly</b>	How much participants felt the <b>sense of presence</b>
Correlation Coefficient	0.110	<b>0.394</b>	1.000	<b>0.475</b>	<b>0.294</b>	<b>0.382</b>	<b>0.474</b>	
Sig. (2-tailed)	0.265	<b>0.000</b>	.	<b>0.000</b>	<b>0.002</b>	<b>0.000</b>	<b>0.000</b>	
N	104	104	104	104	104	104	104	

Table 3. Spearman's rank order Correlation in between participants' immersion and other heuristics integrated in the VR environment.

Table 3 shows how much participants' perception of immersion in the VR environment correlated with other heuristics identified from Nielsen's work (1994). In other words, the study investigated how much participants found the VR environment:

- a) Interesting and Appropriate
- b) Immersive
- c) Realistic
- d) Interactive
- e) User Friendly
- f) Reflecting Sense of Presence

As shown from the Table 3, all of the categories were found to have statistically correlated. In other words, in all cases the P value is always less than 0.05. While the correlations were found to be statistically significant, in none of the cases a very strong relationship was identified as the r value varied in between the 0.294 and 0.474 range. This shows that there is definitely a correlation among the heuristics applied to the VR environment and that participants found their experience in the positive way rather than the negative. However, none of the correlations were very strong which indicated that participants' immersion with the environment was not very strong.

An important result that could be obtained from Table 3 is that none of the categories were actually correlated to the educational degree of the participants. This provided further

evidence that educational degree did not impact on how much participants found the environment interesting and appropriate, immersive, realistic, interactive and user friendly.

As a result, this research presented strong and statistical evidence that educational degree of participants did not significantly impact to how they perceive their VR experiences. In other words, the alternative hypothesis of the research question that is “*the educational degree of participants does not have a significant impact on how they perceive a virtual reality environment*” is accepted. Moreover, the research results put forward strong evidence that participants significantly found their Virtual Reality Experience realistic, interesting, and interactive, user friendly, and have a sense of presence. Although none of the correlations was found to be very strong, they were all found to be statistically significant.

## **5. Conclusion**

This paper investigated whether or not the educational degree of participants is an impact factor in deciding how participants perceive their Virtual Reality experience. A survey study undertaken by 104 participants clearly demonstrated that the educational degree of participants did not impact on their decisions over whether or not they found a VR environment interesting and appropriate, immersive, realistic, interactive, user friendly and reflecting a sense of presence.

Having analysed the results collected from the participants’ questionnaires in a pre-post study, the alternative hypothesis of the proposed research question was accepted meaning that the educational degree do not significantly affect the participants’ perception of a VR environment. Moreover, this research suggests that participants found their Virtual Reality experience realistic, interesting, interactive, user friendly, and had a sense of presence.

As future work, we plan to expand the VR environment with more options and game elements. We believe that this will increase the strength of the correlations among the heuristics identified in the study. Having done so, a gold standard experimental study would be conducted with an actual sample size in order to observe whether or not similar outcomes would be obtained.

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