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An Interactive 3D Virtual Environment to Reduce the Public Speaking Anxiety Levels of Novice Software Engineers

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Abstract:
Software engineering is a set of activities that relies no only on technical tasks but also requires abilities focused on social duties such as daily meetings and product introduction presentations. However, engineers may experience elevated levels of anxiety when required to present their work in an unfamiliar environment. More specifically, they may suffer from public speaking anxiety even though they are supposed to be effective in those social tasks as well as in their engineering activities. Fortunately, previous studies suggest that virtual exposure therapy is an effective strategy to reduce public speaking anxiety. In this study, an interactive 3D virtual environment similar to real classrooms and auditoriums was developed to examine if this might decrease the anxiety levels of novice software engineers. To compare traditional and virtual exposure therapy, the sample set (N = 14) was divided equally into 2 groups including one experimental group and one control group. For 4 weeks, the virtual exposure therapy was conducted in the experimental group whereas psychoeducation was used in the control group. The findings from our study illustrate that virtual exposure therapy may be represent an alternative solution to the traditional therapeutic intervention for software engineers seeking to overcome public presentation anxiety.

1 Introduction

Software engineering (SE) is one of the most popular profession in the world [7]. This popularity creates a competitive environment among individuals who want to work at good positions in SE field [30]. Individuals who want to be well-placed in this competitive environment must develop themselves to fulfil both the technical and social requirements of SE. The training received at the university or external sources may provide the technical development of the individuals. However, there are a limited number of sources that help people to develop themselves about social tasks of SE such as public speaking, project presentations, and daily stand-up meetings. Because of this reason, software engineers generally feel nervous and anxious when making presentation or meeting with people [3]. People who are anxious during presentation or meeting can not express themselves well even if they are very successful [15]. Hence, this situation directly affects the individuals' careers in a negative manner. In order to solve this problem, software engineers, especially novice ones, need to be trained on the social topics starting from their student days since they feel themselves inadequate when making presentations [19]. In this way, software engineering students can increase their public speaking abilities, which is one of the most important social skills sought in software engineers, before starting their careers [12].

Practicing on a topic is one of the most effective ways to reduce the anxieties and concerns of the individuals on the related topic [36]. This statement is also valid for people presenting to society. If the person has the opportunity to present in a real presentation environment or in a similar environment before the presentation, the level of anxiety felt during presentation diminishes [22]. However, real-life conditions, such as long distances, working hours and etc., may not always give people the opportunity to work in such environments. In particular, it is almost impossible to find a crowded presentation environment, which is the most important factor that increases the level of anxiety of the people during presentation [17]. At this point, virtual reality (VR) can be shown as an effective solution for this problem since it allows people to work in an environment similar to real life [41]. Due to the properties of this technology, people from many different professions such as engineering [1], medicine [42], science [28] and civil defence [5] have increased their skills and experience by practicing in virtual environments designed to be close to reality. So, they can increase their success by decreasing the rate of mistakes made in real life since they can encounter the real-life problems in the virtual environments before living them in real-life.

A preliminary study was carried out by Nazligul et al. [33] in which six novice software engineers with public speaking anxiety were exposed to a standard classroom (i.e, small size) scene. The results of the study supported possible effects of virtual reality exposure and revealed a level of decrease in anxiety rates of participants. The current study was designed to extend upon study. Thus, one of the aims of the current study was to design a training platform in which can make presentations in an environment similar to real environment to reduce their public speaking anxiety levels. In this platform, virtual auditoriums in different sizes (i.e., small, medium, large) were designed to allow participants present in front of a different number of audiences by creating a real presentation atmosphere. Through this designed environment, participants have the opportunity to overcome their concerns and anxieties by facing the events, which can affect presentation performances in real life presentations, in the virtual environment with the guidance of a specialist psychologist in this regard. Secondly, a control group was design to compare the effects of psychoeducation and virtual therapy exposure treatment. Besides, to our knowledge, there is no study designed and

implemented to investigate the effects of virtual reality exposure on level of public speaking anxiety in Turkish population.

The overall structure of this paper is formed as follows: Section two illustrates the literature review of the study. In Section three, the research process and the design of the virtual environment is explained. The following section presents the findings of the research. Finally, the last section explains the conclusion of the study by discussing the results obtained from the statistical tests.

2 Background and Related Works

During several years, conceptualizing anxiety disorders has been frequently studied by the scientific community and clinicians. Obviously, anxiety that is a common response represents a sense of tension, nervousness, and worry related with arousal of the nervous system [46]. Most people experience some anxiety during times of distress; however, some of them are likely to develop anxiety disorders during or following a frightening or stressful event. A number of empirical evidence has demonstrated that early learning histories serve as vulnerability factors which lead to increase in the emotional consequences of traumatic and stressful life events initiating anxiety disorders. It has been further noted that temperamental vulnerabilities can play a role as predisposition that make those people more susceptible to stressful experiences when it occurs with such early learning histories [32]. An optimum level of anxiety has a survival function to adapt potential threats and risks from the evolutionary perspective; however, if the perceived anxiety transformed into uncontrollable and uncertain arousal, negative consequences can appear in various domains of life such as social, occupational or academic life [31].

In a range of anxiety disorders, considerable amount of people suffers from social anxiety disorder which is delineated by cognitive biases and distortions in social-information processing and thoughts, attitudes and beliefs, resulting in social phobic affect and behaviors [39]. Public speaking anxiety, that is a highly prevalent disorder, invariably causes a feeling of intense dread in real or anticipated an oral performance situation [11]. Public speaking anxiety is commonly accepted as a distinct subtype of social anxiety disorder, but it was suggested that there are some differences as well as similarities between generalized social phobics and public speaking phobics. For instance, the findings showed that individuals with public speaking anxiety experienced more difficulty with cardiovascular arousal during the behavioral challenge [20]. Individuals with public speaking anxiety have a fear of that other people would criticize or humiliate them even if they acknowledge that their fear is irrational [37]. Social interactions make those people more self-conscious, and their heart rate and blood pressure are increased when they perform in front of the public [26]. Indeed, individuals with public speaking anxiety experience lots of physiological, cognitive and behavioral changes when anticipating or performing the event. For example, most common physiological changes are heart rate, blood pressure, sweating, gastrointestinal discomfort, diarrhea and muscle tension once the autonomic nervous system is activated [4]. Moreover, it has been suggested that those people have some types of inferences (e.g., "They will laugh at me"), or appraisals (e.g., "They must not laugh at me and it is awful if they do"), resulting in performance-related anxiety [45]. Thus, they typically try to avoid the anxiety-eliciting social situations whenever possible [37].

Past research has examined the effectiveness of some treatment models on public speaking anxiety. Literature commonly propose that three major methods (a) exposure-based treatments such as systematic desensitization, (b) negative thought interventions such as cognitive restructuring or rational emotive therapy, (c) skills training have been successfully used to reduce public speaking anxiety [38]. Especially, exposure-based treatments have been widely used in the treatment of this disorder so that individuals become to habituate fear provoking stimuli with the passage of time and realize that the expected catastrophic situation would not occur. Thus, they have a chance to reevaluate their irrational beliefs and manage appropriately their emotions [21].

Nowadays, the application of virtual reality to issues in mental health as an alternative treatment method is at the heart of the matter. A plenty of evidence has demonstrated the role of virtual reality on the treatment of many psychological disorders such as post-traumatic stress disorder or eating disorders. Compelling evidence demonstrated that virtual reality exposure treatment (VRET) is an effective method especially in the treatment of phobias including arachnophobia (spiders), aviaphobia/aviophobia (flying), acrophobia (heights), and agoraphobia (open spaces) [34]. It is also important to acknowledge that VRET is an effective therapeutic tool for public speaking anxiety [43]. For instance, in Pertaub and his colleagues' study [37], participants were asked to present 5 minutes to virtual audiences consisting of three different types (i.e., an emotionally neutral audience, a positive audience, a negative audience. The findings showed that anxiety response was elicited by the negative audience regardless of the normal level of public speaking confidence of the participant. In addition, the level of somatic response was also greater for the negative audience as compared to other groups of participants. In a similar vein, the results of another study revealed that the participants in VR group reported a decrease in anxiety symptoms and an increase in ability to cope with real world situations after 5 weekly $10 - 15$ min. sessions of a virtual reality treatment which included a virtual wooden podium and a speaker's stand; however, the participants in comparison group did not report significant changes [35].

Virtual reality exposure treatment allows participants to interact in real time with sounds and three-dimensional visuals created in computer environment. Both hardware and software techniques (e.g., real-time computer graphics, body tracking devices, sensory inputs) are used to immerse individuals in a virtual world [6]. This type of treatment is based on a premise of "presence response" implying that to what extent anxiety created within a VR is identical to the feeling of anxiety experienced in such a real circumstance [43]. It has been noted that people are likely to accept computer-generated audience as social actors rather than mere computers, so they show similar responses to the avatars [40]. VRET has an essential value since it enables individuals to experience an identical anxiety-producing situation in a safety environment, unlike conventional treatment methods [26]. Furthermore, participants' feelings of self-efficacy may strengthen when they perform in a virtual environment which can be controlled. In addition, the therapist is able to manipulate the experience based on the participant's anxiety hierarchy [16]. Virtual reality environment is also important to understand the both physiological and emotional processes that occur during the performance. For instance, it has been found that trait social anxiety was positively associated with startle reactivity under social-evaluative threat both before entering VR and during speech anticipation inside VR, which representing physiologic markers of pathological anxiety [9]. In general, it can be concluded that virtual reality exposure therapy may be the key as an alternative intervention to overcome public speaking anxiety. As such, both VRET and traditional therapy method have been selected to examine their effects on public speaking anxiety of a group of students in the present study.

3 Methodology

3.1 Participants

The present study was carried out with 14 (female = 10, male = 4) novice software engineers who are students with public speaking anxiety from the Çankaya University. The ages of participants ranged from 20 to 24 years old with the mean being 21.36 ($SD = 1.08$) years. The Liebowitz Social Anxiety Scale was applied to all participants and individuals who fulfilled criteria of being above cut-off 20 points on both "fear or anxiety" and "avoidance behavior" subscales. Moreover, a scale measured to determine the participants' level of anxiety about social interaction were also applied as a second inclusion criterion. One participant could not continue the study because she had another ongoing therapy process. The informed consent was provided to all participants and all interventions were done in accordance with the Declaration of Helsinki.

(a) Psychologist (b) Participant

Fig. 1: Viewpoints of both the psychologist and the participant on the standard classroom

3.2 Measures

Demographic Information Form: The demographic information form includes gender, age, education status, socioeconomic status, occupational status, and history of psychiatric and chronic illness diagnosis.

Liebowitz Social Anxiety Scale: Liebowitz Social Anxiety Scale (LSAS) [27] was used to assess the level of social anxiety including in various social situations including public performance or speaking. Participants are expected to rate each item separately for "fear or anxiety" subscale (anchors of 0: none to 3: severe) and for "avoidance behavior" subscale (anchors of 0: never and 3: usually). The internal consistency of the scale ranges from .81 to .92. The Turkish reliability and validity study of the scale was studied by Soykan et al. [44].

Subjective Units of Distress Scale: Subjective Units of Distress Scale (SUDs) was used to measure participants' baseline level of anxiety. Participants rate their anxiety level using a scale of 0 to 100, where 0 represents totally relaxed and 100 represents highest anxiety or discomfort that participant has ever felt [47].

Interaction Anxiousness Scale: Interaction Anxiousness Scale (IAS) [25] was composed of 15 items rated on a five-point Likert Scale. An example state is "I usually feel comfortable when I'm in a group of people I don't know." It was designed to measure the subjective experience of anxiety related when any social interaction occurs. It has a 0.88 internal consistency on the general scale. The Turkish adaptation of scale was studied by Çoşkun [10].

Social Appearance Anxiety Scale: Social Appearance Anxiety Scale (SAAS) [18] is an instrument developed to examine anxiety about social appearance. Respondents rated 16 Likert-type items as ranging from 1, "very uncharacteristic or untrue, strongly disagree" to 5, "very characteristic or true.". The reliability of the study was carried out with three different samples and the Cronbach's alpha was .94, .95 and .94, respectively. In addition, reliability and validity analyses showed that the scale had a satisfactory level of reliability and validity in Turkish university students [13].

Brief Fear of Negative Evaluation Scale: Brief Fear of Negative Evaluation Scale (BFNE) [24] was developed to assess fears about others' negative evaluation. Each of twelve items was scored from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). Eight items of the scale examine fears and worries about others' evaluation (e.g., "I worry about what other people will think of me even when I know it doesn't make any difference.") and the rest were reversed items. The Turkish adaptation study of the scale showed that the Cronbach's alpha for the BFNE was .84 [8].

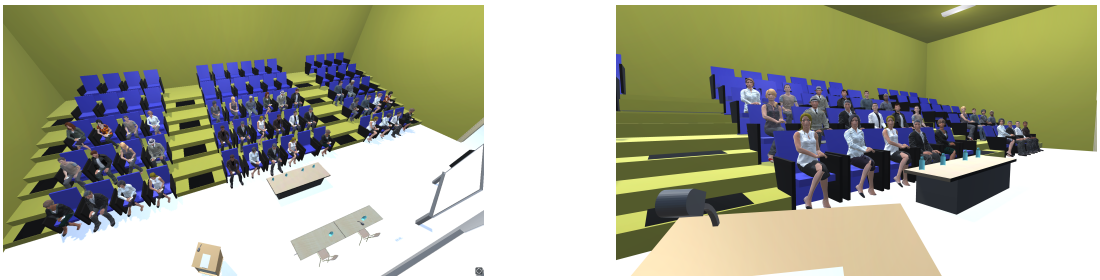
Speech Task: All participants completed a speech task so that cognitive and behavioral components of anxiety to a social stressor (i.e. public speaking) were studied at baseline, during intervention and post-intervention. The task involved an impromptu speech which required the subject to speak to a number of audiences in a standard classroom (small), blue auditorium (medium) and red auditorium (large). From the beginning of the speech, the therapist asked participants to rate their level of situational anxiety from 0 (not anxious) to 100 (extremely anxious) by using SUDs.

3.3 Procedure

All instruments and interventions were approved by the appropriate institutional review boards. Students who are a group of novice software engineers were surveyed using LSAS and IAS. Those students who volunteered to participate in the present study and whose LSAS scores were greater than 20 were randomly assigned to either the VRET group (N = 7) or to a psychoeducation control group (N = 7). A signed informed consent was obtained from all students. In addition to the LSAS and IAS, pre-testing consisted of these self-report instruments: SAAS and BFNE. SUDS ratings ($0 - 100$) were taken before, during, and at the end of each session. A comparison of SUDS ratings at the end of the 2nd and 4th sessions was analyzed. A separate analysis of the five items comprising factor 2 of the LSAS, public speaking, was conducted.

Prior to beginning the VRET, an initial interview lasting about an hour was conducted to cover the material such as components of anxiety, possible causes of anxiety and dysfunctional thinking patterns. Besides, the maintenance mechanism of avoidance strategy was discussed. This initial session was followed by brief virtual reality exposure therapy (VRET). The participants in the VRET group received three sessions of individual intervention, using software of three different sizes of an auditorium (small, medium, large) scene and a head-mounted display (Oculus RIFT). Each intervention of exposure was $8 - 10$ min. and directed by the first author, a cognitive behavior therapist. Three virtual environments were designed and each intervention corresponded to a specific size of venue: small, medium, large. In sessions, the speech task adapted from a standardized speech assessment protocol [2] was carried out. The participants were asked to talk on one or more of the 3 controversial topics such as effects of social media, education system, or being vegetarian which were blindly selected one of five note cards. After they prepared their speech about three minutes, exposure was applied and anxiety was measured using the SUDs at three points during the exposure: immediately after introduction to the audience but before the speech began (T1), a retrospective rating of peak anxiety during the speech (T2) and immediately after the exposure (T3). During the interventions, the therapist could manipulate audience reactions which include texting, yawning, predetermined asking question (e.g., "What do you think about the attitudes of our country on this topic?"), leaving class, talking with another person, or playing with phone. For all three sessions, same manipulations were used. Meanwhile, the therapist elaborated the participant's anxiety and therapeutically encouraged the participant to face with anxiety-eliciting situations. At the end of the each session, participants had the opportunity to discuss their cognitions about the experience with the therapist.

In control group, the participants were received psychoeducation about the anxiety in 3-week group sessions of 45 minutes duration. 3 didactic sessions with distinct objectives and discussion points designed to elicit group member participation; however, group members were not allow for the type of deep interpersonal sharing. Psychoeducation included an explanation of the relationship



(a) Psychologist (b) Participant

Fig. 2: Viewpoints of both the psychologist and the participant on the blue auditorium

between thoughts, behaviors, physical feelings, and about identifying and monitoring early warning symptoms in order to deal with them.

3.4 System Functions and Implementation

As it was mentioned before, this virtual training environment aims to decrease the participants' public speaking anxiety levels with the guidance of a clinical psychologist. Hence, there are two different user types of this system, one being a psychologist and the other participant. The functions that the psychologist can perform in the system are shown in Figure 3.

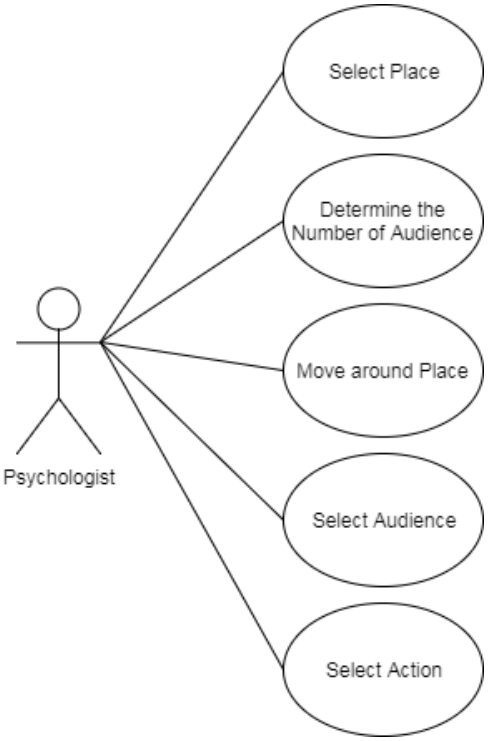


Fig. 3: Use case diagram of the psychologist

According to the use case diagram of the psychologist, users who use the system in the psychologist role generally perform functions related to system administration such as setting up the environment, determining the number of audience in the environment, moving around the venue in order to select the audience and choosing the event that the audience acts. The events selected by the psychologist are seen simultaneously by the participant since both the psychologist and participant use the virtual environment at the same time.

When the functions that are performed by the participant are analyzed, there is only one function that can be performed by the participant as shown in Figure 4.

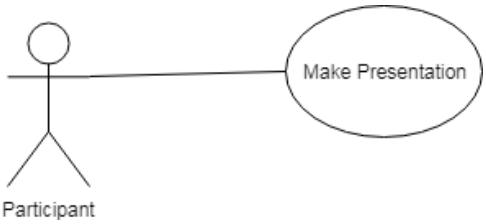


Fig. 4: Use case diagram of the participant

The participant can only make presentations in the venue selected by the psychologist. This training platform consists of 3 different venues with different physical dimensions and different audience capacities. These are:

- Standard Classroom
- Blue Auditorium
- Red Auditorium

The reason for designing 3 different venues is that after the first intervention with the participants, it has been understood that the size of the presentation environment and the number of audience in the environment are causing anxiety for the participants. For this reason, the capacity of the standard classroom was designed to be 32 (Figure 1), the capacity of the blue auditorium to be 70 (Figure 2), and finally the capacity of the red auditorium to be 117 people (Figure 5). These venues were designed on the basis of the classes and auditoriums on the central campus of Çankaya University.

When the systematic flow of the platform is explained, firstly the psychologist connects to the system and selects the venue in which participants will present as shown in Figure 6.

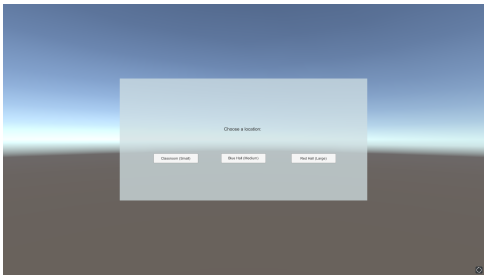
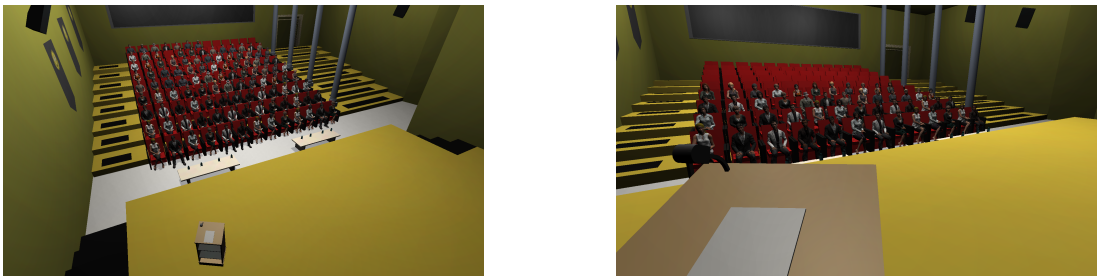


Fig. 6: Venue selection screen

After choosing the venue, the psychologist should enter the number of audience that should be in the environment as shown in



(a) Psychologist (b) Participant

Fig. 5: Viewpoints of both the psychologist and the participant on the red auditorium

Figure 7. On this screen, 4 different text-boxes were placed to allow the psychologist enters the number of formal male, formal female, informal male and informal female separately since the participants indicated in the first intervention that they are concerned due to audiences' clothing style and gender during the real presentation. Hence, the psychologist has ability to control the characteristics of audiences in the environment according to the situation of the participant who will make the presentation. In order to increase the realism of the designed environment, 8 different audience models were used in the venue.

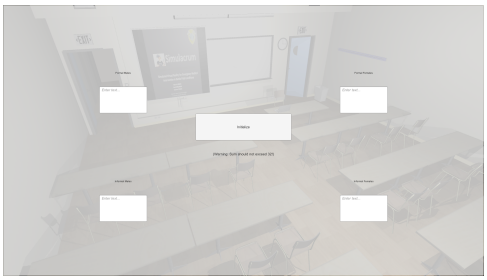


Fig. 7: Number of audience input screen

After the selected venue is ready with the audiences, the participant can connect to the system in order to make a presentation on the topic determined by the psychologist. When the participant connects to the system, both the psychologist and the participant use the system simultaneously. This means that when the psychologist triggers an event in the venue by selecting an audience, the participant see this event at the same time. However, while using the psychologist and the participant system concurrently, the viewpoints of them in the system are different from each other as shown in Figure 3-5. The participants look the environment as the first person since they are presenting, while the psychologist identifies the environment from the top in order to control the audiences in the venue. In order to make it easier for the psychologist to select people in the environment, the psychologist has been able to move around using the keys w, a, s, d on the keyboard and the mouse. The psychologist must press on the audience to select him/her. Then, a pop-up window is brought to the screen with a list of all the behaviors in the system in order to make the selected audience acts one of the behaviors that would increase the participants' concerns as shown in Figure 8.

These 9 behavioral patterns on this screen, which are *texting, message sound, ring phone, raise the voice request, audiences' questions, yawning, laughing, talking* and *leaving from auditorium during presentation* were determined after the first intervention with participants. When the participant makes a presentation, the psychologist chooses one of the audience in the venue to make an action from this list so that the participant can face the concerns. In this way, the participants have an opportunity to reduce their worries and anxiety levels by facing the events that increase their level of anxiety during presentations in real life before living them in real life.

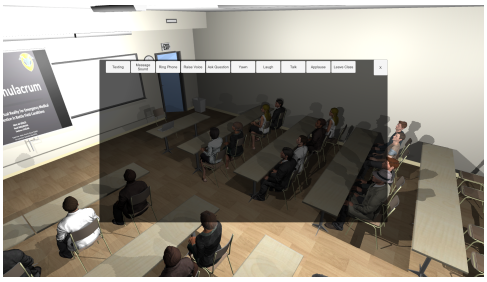


Fig. 8: List of behaviors

4 Results

The SUD scores of each participant in VRET group were measured at 3 time points (i.e., T1 = immediately after introduction to the audience but before the speech began, T2 = a retrospective rating of peak anxiety during the speech and T3 = immediately after the exposure) as shown in Figure 9 - 11.

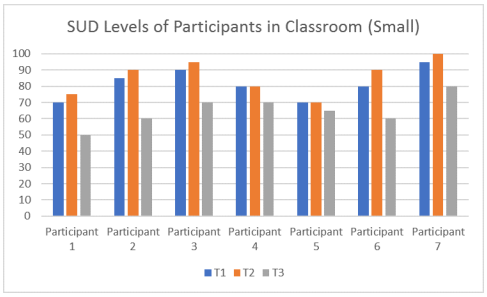


Fig. 9: SUD levels of participants in classroom (small)

For classroom, the average anxiety level of participants is 81.43 ($SD = 9.45$) at before the speech began, 85.71 ($SD = 10.97$) at peak during the speech and 65.00 ($SD = 9.57$) immediately after the exposure. For blue auditorium, the average anxiety level of participants is 75.00 ($SD = 10.80$) at before the speech began, 82.14 ($SD = 11.85$) at peak during the speech and 58.57 ($SD = 12.49$) immediately after the exposure. For red auditorium, the average anxiety level of participants is 70.00 ($SD = 11.55$) at before the speech began, 77.14 ($SD = 10.75$) at peak during the speech and 56.43 ($SD = 11.80$) immediately after the exposure.

For VRET group, the Wilcoxon signed-rank test, which is suitable analysis for small subject numbers and repeated measures [14], was used to compare for both pre-test and post-test scores of LSAS, IAS, SAAS and BFNE. There were significant differences between pre-testing and post-testing on LSAS scores ($z = -2.37$, $p < .05$), on IAS scores ($z = -2.41$, $p < .05$), on SAAS scores ($z = -2.38$, $p < .05$) and on BFNE scores

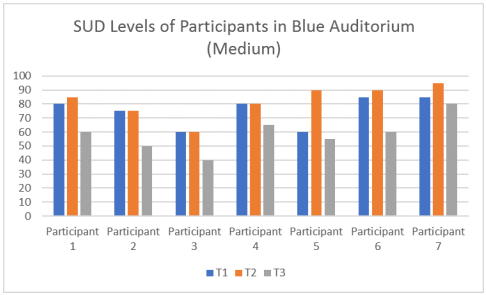


Fig. 10: SUD levels of participants in blue auditorium (medium)

($z = -2.38$, $p < .05$). The anxiety levels of participants at pre-testing ($M = 56.86, SD = 11.99$) were significantly higher than post-testing ($M = 51.43, SD = 9.88$) for LSAS. The anxiety levels of participants at pre-testing ($M = 49.29, SD = 6.95$) were significantly higher than post-testing ($M = 45.14, SD = 7.38$) for IAS. The anxiety levels of participants at pre-testing ($M = 39.71, SD = 10.16$) were significantly higher than post-testing ($M = 36.29, SD = 8.64$) for SAAS. The anxiety levels of participants at pre-testing ($M = 41.29, SD = 7.97$) were significantly higher than post-testing ($M = 36.57, SD = 7.55$) for BFNE.

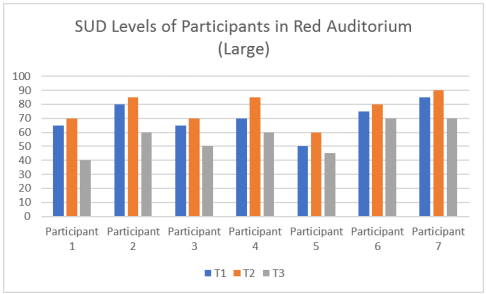


Fig. 11: SUD levels of participants in red auditorium (large)

For control group, the Wilcoxon signed-rank test, which is suitable analysis for small subject numbers and repeated measures [14], was also used to compare for both pre-test and post-test scores of LSAS, IAS, SAAS and BFNE. There were significant differences between pre-testing and post-testing on LSAS scores ($z = -2.37$, $p < .05$), on IAS scores ($z = -2.38$, $p < .05$), on SAAS scores ($z = -2.38$, $p < .05$) and on BFNE scores ($z = -2.41$, $p < .05$). The anxiety levels of participants at pre-testing ($M = 55.86, SD = 5.34$) were significantly higher than post-testing ($M = 52.00, SD = 4.40$) for LSAS. The anxiety levels of participants at pre-testing ($M = 40.57, SD = 6.16$) were significantly higher than post-testing ($M = 37.29, SD = 5.82$) for IAS. The anxiety levels of participants at pre-testing ($M = 42.00, SD = 7.79$) were significantly higher than post-testing ($M = 39.43, SD = 7.93$) for SAAS. The anxiety levels of participants at pre-testing ($M = 42.14, SD = 5.40$) were significantly higher than post-testing ($M = 38.57, SD = 5.26$) for BFNE.

The Mann-Whitney U-test was used to understand whether there is a significant difference between the post-test scores of the participants in each group. According to the results obtained from this test, no significant difference was found between the VRET group and psychoeducation group in terms of LSAS ($p = .80$), IAS ($p = .90$), SAAS ($p = .06$) and BFNE ($p = .48$) scores.

5 Discussion and Conclusion

Social activities (i.e., presenting the developed product or meeting with customers) that needs to be done within the scope of software projects are as important as the technical information required to develop the project since a group work in which many stakeholders are involved is needed to successfully complete software projects.. For this reason, it is expected that people working on software projects will be successful in social activities as well as strong technical knowledge. Although it is an essential issue for software engineers, most of them may suffer from public speaking anxiety by excessively concerns about being embarrassed and judged by other people [29]. In order to decrease this kind of fears and feel better, individuals need to confront their fears [23]. Unfortunately, it is almost impossible to provide real-life presentation environments for individuals to face public speaking anxieties before actual presentations. However, virtual environments similar to real life can be designed o overcome these kinds of fear and anxieties of individuals due to the properties of VR technology.

The aim of the present study was to investigate the efficacy of virtual reality exposure for novice software engineers suffering from public speaking anxiety. The findings revealed that both virtual reality exposure and psychoeducation group were effective to reduce the anxiety in public speaking and social situations. Results of four sessions of VRET seem to have helped students lessen anxiety and avoidance of public speaking, as assessed by self-report measurements. For all three classroom conditions, the average anxiety levels of students were higher at before the speech began than at immediately after the exposure. It confirms that the virtual public speaking environment did successfully elicit high anxiety in students so that they can learn to manage their anxiety in an effective way. However, the average anxiety levels in red auditorium condition were lower than those in classroom and blue auditorium conditions. This finding may show that the exposure could help participants to feel prepared through the VRET sessions. Another possibility to consider is that smaller the size of the audience is likely to create more interactional environment. Furthermore, feedback from the listeners is likely to be more noticeable in these situations [43]. The Wilcoxon signed-rank test findings revealed that participants in both VRET and psychoeducation group showed significant pre-testing and post-testing differences on LSAS, IAS, SAAS and BFNE. Besides, no significant difference was found between the post-testing scores of VRET group and psychoeducation group. Results of the present study proposed for using VRET to help individuals deal with public speaking anxiety. Thus, this paper claimed that VRET have the potential for decreasing public speaking anxiety by modifying our inner experiences.

It is necessary to interpret the results of this study with caution because of some methodological limitations. First, our small sample size may limit the generalizability of the findings. In addition, parametric tests could not be performed due to small size. Further research would replicate our findings with comparison of effect size. Moreover, the use of self-report measures may include biased information since it is assumed that they can truly assess their anxiety levels. Therefore, future studies may include physiological assessments such as heart rates, skin temperatures during the speech. Another limitation is that our results include only short-term efficacy data; thus, follow-up assessments are needed to further studies. Besides, the participants of the present work were novice software students who may be familiar with the virtual applications. Hence, they may adapt quickly to the procedure. If would have been of interest to conduct this type of exposure to various samples in terms of age and background. It is important to note that all three virtual environments were identical with the real ones where students have been familiar to them. This condition may increase becoming immersed in virtual situations.

In sum, the present work highlights that VRET can contribute to improve psychological problems and help individuals who do not accept traditional treatments. Since technological improvements are incredible in the last century, new treatment methods may be accepted as more motivating to overcome their psychological problems for younger people. This study provides the first data comparing the use of virtual reality exposure vs. psychoeducation in a Turkish university sample. The current findings revealed that both conditions were equally accepted.

6 References

1 Aydan, U., Yilmaz, M., Clarke, P. M. & O'Connor, R. V. (2016) Teaching ISO/IEC 12207 software lifecycle processes: A serious game approach. *Computer Standards & Interfaces*.

2 Beidel, D. C., Turner, S. M., Jacob, R. G. & Cooley, M. R. (1989) Assessment of social phobia: Reliability of an impromptu speech task. *Journal of anxiety disorders*, **3**(3), 149–158.

3 Bernárdez, B., Durán, A., Parejo, J. A. et al. (2014) A controlled experiment to evaluate the effects of mindfulness in software engineering. in *Proceedings of the 8th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement*, p. 17. ACM.

4 Bernátová, I., Balis, P., Goga, R., Behuliak, M., Zicha, J. & Sekaj, I. (2016) Lack of reactive oxygen species deteriorates blood pressure regulation in acute stress. *Physiological Research*, **65**, S381.

5 Bliss, J. P., Tidwell, P. D. & Guest, M. A. (1997) The effectiveness of virtual reality for administering spatial navigation training to firefighters. *Presence: Teleoperators and Virtual Environments*, **6**(1), 73–86.

6 Bouchard, S., Côté, S., St-Jacques, J., Robillard, G. & Renaud, P. (2006) Effectiveness of virtual reality exposure in the treatment of arachnophobia using 3D games. *Technology and health care*, **14**(1), 19–27.

7 Capretz, L. F. (2003) Personality types in software engineering. *International Journal of Human-Computer Studies*, **58**(2), 207–214.

8 Çetin, B., Doğan, T. & Sapmaz, F. (2010) Olumsuz değerlendirilme korkusu ölçeği kısa formu'nun Türkçe uyarlaması: geçerlik ve güvenirlik çalışması. *Eğitim ve Bilim*, **35**(156).

9 Cornwell, B. R., Johnson, L., Berardi, L. & Grillon, C. (2006) Anticipation of public speaking in virtual reality reveals a relationship between trait social anxiety and startle reactivity. *Biological Psychiatry*, **59**(7), 664–666.

10 Coşkun, H. (2009) Etkileşim Kaygısı Ölçeği: Geçerlik ve Güvenirlik Çalışması. *Türk Psikoloji Yazıları*, **12**(23), 41–49.

11 Croft, R. J., Gonsalvez, C. J., Gander, J., Lechem, L. & Barry, R. J. (2004) Differential relations between heart rate and skin conductance, and public speaking anxiety. *Journal of behavior therapy and experimental psychiatry*, **35**(3), 259–271.

12 Darmuki, A., Andayani, A., Nurkamto, J. & Saddhono, K. (2017) Evaluating Information-processing-based Learning Cooperative Model on Speaking Skill Course. *Journal of Language Teaching and Research*, **8**(1), 44–51.

13 Doğan, T. (2010) Sosyal Görünüş Kaygısı Ölçeği'nin (SGKÖ) Türkçe uyarlaması: geçerlik ve güvenirlik çalışması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, **39**(39).

14 Field, A. (2005) Regression. *Discovering statistics using SPSS*, **2**, 143–217.

15 Goldin, P. R., Lee, I., Ziv, M., Jazaieri, H., Heimberg, R. G. & Gross, J. J. (2014) Trajectories of change in emotion regulation and social anxiety during cognitive-behavioral therapy for social anxiety disorder. *Behaviour research and therapy*, **56**, 7–15.

16 Gregg, L. & Tarrier, N. (2007) Virtual reality in mental health. *Social psychiatry and psychiatric epidemiology*, **42**(5), 343–354.

17 Harb, G. C., Eng, W., Zaider, T. & Heimberg, R. G. (2003) Behavioral assessment of public-speaking anxiety using a modified version of the Social Performance Rating Scale. *Behaviour research and therapy*, **41**(11), 1373–1380.

18 Hart, T. A., Flora, D. B., Palyo, S. A., Fresco, D. M., Holle, C. & Heimberg, R. G. (2008) Development and examination of the social appearance anxiety scale. *Assessment*, **15**(1), 48–59.

19 Hazzan, O. & Har-Shai, G. (2014) Teaching and learning computer science soft skills using soft skills: the students' perspective. in *Proceedings of the 45th ACM technical symposium on Computer science education*, pp. 567–572. ACM.

20 Heimberg, R. G., Hope, D. A., Dodge, C. S. & Becker, R. E. (1990) DSM-III-R subtypes of social phobia: Comparison of generalized social phobics and public speaking phobics.. *Journal of Nervous and Mental Disease*.

21 Hindo, C. S. & González-Prendes, A. A. (2011) One-session exposure treatment for social anxiety with specific fear of public speaking. *Research on Social Work Practice*, **21**(5), 528–538.

22 Huff, W. K. (2008) *Public speaking: a concise overview for the twenty-first century*. Peter Lang.

23 Klinger, E., Bouchard, S., Légeron, P., Roy, S., Lauer, F., Chemin, I. & Nugues, P. (2005) Virtual reality therapy versus cognitive behavior therapy for social phobia: A preliminary controlled study. *Cyberpsychology & behavior*, **8**(1), 76–88.

24 Leary, M. R. (1983) A brief version of the Fear of Negative Evaluation Scale. *Personality and Social Psychology Bulletin*, **9**(3), 371–375.

25 Leary, M. R. & Kowalski, R. M. (1993) The interaction anxiousness scale: Construct and criterion-related validity. *Journal of personality assessment*, **61**(1), 136–146.

26 Lee, J. M., Ku, J. H., Jang, D. P., Kim, D. H., Choi, Y. H., Kim, I. Y. & Kim, S. I. (2002) Virtual reality system for treatment of the fear of public speaking using image-based rendering and moving pictures. *Cyberpsychology & behavior*, **5**(3), 191–195.

27 Liebowitz, M. R. (1987) *Social phobia*. Karger Publishers.

28 Limniou, M., Roberts, D. & Papadopoulos, N. (2008) Full immersive virtual environment CAVETM in chemistry education. *Computers & Education*, **51**(2), 584–593.

29 Ling, Y., Brinkman, W.-P., Nefs, H. T., Qu, C. & Heynderickx, I. (2012) Effects of stereoscopic viewing on presence, anxiety, and cybersickness in a virtual reality environment for public speaking. *Presence: Teleoperators and Virtual Environments*, **21**(3), 254–267.

30 Lu, Y., Xiang, C., Wang, B. & Wang, X. (2011) What affects information systems development team performance? An exploratory study from the perspective of combined socio-technical theory and coordination theory. *Computers in Human Behavior*, **27**(2), 811–822.

31 Maner, J. K. & Kenrick, D. T. (2010) When adaptations go awry: functional and dysfunctional aspects of social anxiety. *Social issues and policy review*, **4**(1), 111–142.

32 Mineka, S. & Zinbarg, R. (2006) A contemporary learning theory perspective on the etiology of anxiety disorders: it's not what you thought it was.. *American psychologist*, **61**(1), 10.

33 Nazligul, M. D., Yilmaz, M., Gulec, U., Gozcu, M. A., O'Connor, R. V. & Clarke, P. M. (2017) Overcoming Public Speaking Anxiety of Software Engineers Using Virtual Reality Exposure Therapy. in *European Conference on Software Process Improvement*, pp. 191–202. Springer.

34 North, M. M., Hill, J., Aikhuele, A. S. & North, S. M. (2008) Virtual reality training in aid of communication apprehension in classroom environments. *International Journal of Emerging Technologies in Learning (iJET)*, **3**(2), 34–37.

35 North, M. M., North, S. M. & Coble, J. R. (2015) Virtual reality therapy: an effective treatment for the fear of public speaking. *International Journal of Virtual Reality (IJVR)*, **3**(3), 1–6.

36 Oudejans, R. R. & Pijpers, J. R. (2009) Training with anxiety has a positive effect on expert perceptual–motor performance under pressure. *Quarterly Journal of Experimental Psychology*, **62**(8), 1631–1647.

37 Pertaub, D.-P., Slater, M. & Barker, C. (2002) An experiment on public speaking anxiety in response to three different types of virtual audience. *Presence: Teleoperators & Virtual Environments*, **11**(1), 68–78.

38 Pribyl, C. B., Keaten, J. & Sakamoto, M. (2001) The effectiveness of a skills-based program in reducing public speaking anxiety. *Japanese Psychological Research*, **43**(3), 148–155.

39 Rapee, R. M. & Spence, S. H. (2004) The etiology of social phobia: Empirical evidence and an initial model. *Clinical psychology review*, **24**(7), 737–767.

40 Reeves, B. & Nass, C. (1997) *The Media equation: how people treat computers, television, and new media*. Cambridge University Press.

41 Sampaio, A. Z. & Martins, O. P. (2014) The application of virtual reality technology in the construction of bridge: The cantilever and incremental launching methods. *Automation in construction*, **37**, 58–67.

42 Seymour, N. E., Gallagher, A. G., Roman, S. A., O'brien, M. K., Bansal, V. K., Andersen, D. K. & Satava, R. M. (2002) Virtual reality training improves operating room performance: results of a randomized, double-blinded study. *Annals of surgery*, **236**(4), 458–464.

43 Slater, M., Pertaub, D.-P., Barker, C. & Clark, D. M. (2006) An experimental study on fear of public speaking using a virtual environment. *CyberPsychology & Behavior*, **9**(5), 627–633.

44 Soykan, Ç., Özgüven, H. D. & Gençöz, T. (2003) Liebowitz social anxiety scale: the Turkish version. *Psychological Reports*, **93**(3_suppl), 1059–1069.

45 Víšlă, A., Cristea, I. A., Tătar, A. S. & David, D. (2013) Core beliefs, automatic thoughts and response expectancies in predicting public speaking anxiety. *Personality and Individual Differences*, **55**(7), 856–859.

46 Vitasari, P., Wahab, M. N. A., Othman, A., Herawan, T. & Sinnadurai, S. K. (2010) The relationship between study anxiety and academic performance among engineering students. *Procedia-Social and Behavioral Sciences*, **8**, 490–497.

47 Wolpe, J. (1958) Psychotherapy by Reciprocal Inhibition. .