Interactive three-dimensional 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 rely not only on the technical tasks but also require 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 the virtual exposure intervention is an effective strategy to reduce public speaking anxiety. In this study, an interactive three-dimensional virtual environment similar to real classrooms and auditoriums was developed to examine whether this might decrease the anxiety levels of novice software engineers. To compare the traditional and virtual exposure intervention, the sample set was divided equally into two groups including one experimental group and one control group. For 4 weeks, the virtual exposure intervention was conducted in the experimental group, whereas the cognitive behaviour therapy-based psychoeducation was used in the control group. The findings from authors’ study illustrate that the virtual exposure intervention may represent an alternative solution to the traditional interventions for software engineers seeking to overcome public presentation anxiety.

1 Introduction

Software engineering (SE) is one of the most popular professions in the world [1]. This popularity creates a competitive environment among individuals who want to work in good positions in the SE field [2]. Individuals who want to be well placed in this competitive environment must develop themselves to fulfill both the technical and social requirements of SE. The training received at the university or external sources may provide technical development of individuals; however, there is a limited number of sources that help people in terms of professional development and the social tasks of SE such as public speaking, project presentations and daily stand-up meetings. Due to this reason, software engineers generally feel nervous and anxious when making presentations or meeting with people [3]. People who are anxious during presentations or meetings cannot express themselves well even if they are very successful [4]. 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 [5]. In this way, the SE students can increase their public speaking abilities, which is one of the most important social skills sought in software engineers, before starting their careers [6].

Practicing with a topic is one of the most effective ways to reduce the anxieties and concerns of the individuals on the related topics [7]. 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 actual presentation, the level of anxiety felt during the presentation diminishes [8]. However, real-life constraints, such as long distances, working hours 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 the presentation [9]. 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 the real life [10]. Due to the properties of this technology, people from many different professions such as engineering [11], medicine [12], science [13] and civil defence [14] 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. [15] in which six novice software engineers with public speaking anxiety symptoms were exposed to a standard classroom (i.e. small size) scene. In that study, it was aimed to expose the participants to distinct situations such as texting, message sound, ring phone, raise the voice request, audiences’ questions, yawning, laughing, talking and leaving from auditorium during the presentation, which are commonly seen in daily meetings and presentations. The results of the study supported possible effects of VR exposure and revealed a level of decrease in anxiety rates of participants. The current study was designed to extend upon this study. Thus, one of the aims of the current study was to design a training platform in which novice software engineers can make presentations in an environment similar to the real environment to reduce their public speaking anxiety levels. In this platform, virtual auditoriums of different sizes (i.e. small, medium, large) were designed to allow participants to 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 the 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 formed to compare the effects of cognitive-behaviour therapy (CBT)-based psychoeducation and virtual therapy exposure intervention. Besides, to test the reliability of the research, the study design was implemented to investigate the effects of VR exposure on the level of public speaking anxiety in a Turkish population.

The overall structure of this paper is as follows: Section 2 illustrates the literature review of the study. In Section 3, the research process and the design of the virtual environment are explained. Section 4 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

In recent years, conceptualising anxiety disorders have been frequently studied by the scientific community and clinicians. Anxiety is a common response that represents a sense of tension, nervousness and worry related to the arousal of the nervous system [16]. 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 evidences have demonstrated that early learning histories serve as vulnerability factors which lead to an 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 a predisposition which make those people more susceptible to stressful experiences when it occurs with such early learning histories [17]. 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, the negative consequences can appear in various domains of life such as social, occupational, or academic life [18].

In a range of anxiety disorders, a considerable number of people suffer from social anxiety disorder which is delineated by cognitive biases and distortions in the social-information processing and thoughts, attitudes and beliefs, resulting in social phobic effect and behaviours [19]. Public speaking anxiety, that is a highly prevalent psychological problem, invariably causes a feeling of intense dread in real or anticipated an oral performance situation [20]. Public speaking anxiety is commonly accepted as a distinct subtype of social anxiety disorder, but it is suggested that there are some differences as well as similarities between the generalised social phobias and public speaking phobias. For instance, recent findings showed that individuals with public speaking anxiety experienced more difficulty with cardiovascular arousal during the behavioural challenge [21]. Individuals with public speaking anxiety have a fear that other people would criticise or humiliate them even if they acknowledge that their fear is irrational [22]. 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 [23]. Indeed, individuals with public speaking anxiety experience lots of physiological, cognitive and behavioural changes when anticipating or performing the event. For example, the most common physiological changes are heart rate, blood pressure, sweating, gastrointestinal discomfort, diarrhea and muscle tension once the autonomic nervous system is activated [24]. Moreover, it has been suggested that those people have some types of inferences (e.g. ‘They will criticise me’), or appraisals (e.g. ‘They must not laugh at me and it is awful if they do’), resulting in performance-related anxiety [25]. Thus, they typically try to avoid the anxiety-eliciting social situations whenever possible [22].

Past research has examined the effectiveness of some treatment models on public speaking anxiety. The literature commonly proposes three major methods: (a) exposure-based treatments such as systematic desensitisation, (b) negative thought interventions such as cognitive restructuring or rational emotive therapy and (c) skills training have been successfully used to reduce the public speaking anxiety [26]. 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 realise that the expected catastrophic situation would not occur. Thus, they have a chance to reevaluate their irrational beliefs and manage appropriately their emotions [27].

Nowadays, the application of VR 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 VR in the treatment of many psychological disorders such as post-traumatic stress disorder or eating disorders. The compelling evidence demonstrated that VR exposure intervention (VREI) is an effective method especially in the treatment of phobias including acrophobia (heights) and agoraphobia (open spaces) [28]. It is also important to acknowledge that VREI is an effective therapeutic tool for public speaking anxiety [29]. For instance, in Pertaut et al.’s [22] study, participants were asked to present 5 min to virtual audiences consisting of three different types i.e. an emotionally neutral audience, a positive audience and a negative audience. The findings showed that the 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 the real-world situations after five weekly 10–15 min sessions of a VR intervention which included a virtual wooden podium and a speaker’s stand; however, the participants in the comparison group did not report significant changes [30].

VREI allows participants to interact in real time with sounds and three-dimensional visuals created in a 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 [31]. This type of intervention is based on a premise of the ‘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 [29]. 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 [32]. VREI has an essential value since it enables individuals to experience an identical anxiety-producing situation in a safety environment, unlike conventional treatment methods [23]. 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 [33]. VR environment is also important to understand both the 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 [34]. In general, it can be concluded that VREI may be the key as an alternative intervention to overcome public speaking anxiety. As such, both VREI and traditional therapy method have been selected to examine their effects on the 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 symptoms from Çankaya University. The ages of participants ranged from 20 to 24 years old with the mean being 21.36 (SD = 1.08) years. 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.

3.2 Measures

The following measures were applied by using the paper-pencil method.

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 (LSAS): LSAS [35] was used to assess the level of social anxiety in various social situations including public performance or speaking. Participants are expected to rate each item separately for the ‘fear subscale’ (anchors of 0: none and 3: severe) and for the ‘avoidance’ subscale (anchors of 0: never and 3: usually). The internal consistency of the scale ranges from 0.81 to 0.92. The Turkish reliability and validity study of the scale was studied by Soykan et al. [36].

Subjective Units of Distress (SUD) Scale: SUD Scale was used to measure participants’ baseline level of anxiety. Participants rate their anxiety level using a scale of 0–100, where 0 represents totally relaxed and 100 represents the highest anxiety or discomfort that a participant has ever felt [37].

Interaction Anxiousness Scale (IAS): IAS [38] 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 the scale was studied by Coşkun [39].

Social Appearance Anxiety Scale (SAAS): SAAS [40] is an instrument developed to examine anxiety about social appearance. Respondents rated 16 Likert-type items 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 0.94, 0.95 and 0.94, respectively. In addition, the reliability and validity analyses showed that the scale had a satisfactory level of reliability and validity in Turkish university students [41].

Brief Fear of Negative Evaluation (BFNE) Scale: BFNE Scale [42] was developed to assess fears about others’ negative evaluation. Each of 12 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 0.84 [43].

Speech task: All participants completed a speech task so that the cognitive and behavioural 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. Indeed, the clinical cut-off point of LSAS is 25 for both subscales. Since our sample consisting of participants with public speaking anxiety problems, individuals who fulfilled criteria of being above cut-off 20 points on both ‘fear or anxiety’ and ‘avoidance behaviour’ subscales were recruited. Moreover, a scale measured to determine the participants’ level of anxiety about social interaction was also applied as a second inclusion criterion. Those students who volunteered to participate in the present study were separated into two different groups by a chance procedure (i.e. random assignment), one is the VREI group (N = 7) and the other one is the CBT-based psychoeducation control group (N = 7), in order to prevent any systematic differences between the groups. 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.

Prior to beginning the VREI, 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 VREI. The participants in the VREI group individually received three separate VR sessions with 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 behaviour 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 standardised speech assessment protocol [44] was carried out. The participants were asked to talk on one or more of the three 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 for about 3 min, 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 the phone. For all three sessions, the same manipulations were used. In addition, the psychologist randomly applied each participant to all events in order to prevent order effect of the scenario. Meanwhile, the therapist elaborated the participant’s anxiety and therapeutically encouraged the participant to face anxiety-eliciting situations. At the end of each session, participants had the opportunity to discuss their cognitions about the experience with the therapist. In other words, the thoughts and beliefs of them were discussed face to face with the therapist after each VR intervention and then, SUD scores were obtained from each participant.

In the control group, the participants received CBT-based psychoeducation about the anxiety in 3-week group sessions of 45 min duration. Three didactic sessions with distinct objectives and discussion points designed to elicit group member participation; however, group members were not allowed for the type of deep interpersonal sharing. CBT-based psychoeducation included an explanation of the relationship between thoughts, behaviours, 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 Fig. 1.

According to the use case diagram (see Fig. 1) 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 accessed, they can only be
The reason for designing three different venues is that after the first study [15], it has been understood that the size of the presentation environment and the number of audiences in the environment may cause different anxiety levels for the participants. For this reason, the capacity of the standard classroom was designed to be 32 (see Fig. 3), the capacity of the blue auditorium to be 70 (see Fig. 4) and finally the capacity of the red auditorium to be 117 people (see Fig. 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 be present.

After choosing the venue, the psychologist should enter the number of audiences that should be in the environment. On this screen, four different text boxes were placed to allow the psychologist enter the number of formal male, formal female, informal male and informal female separately since the participants indicated in the first study [15] that they are concerned due to audiences’ clothing style and gender during the real presentation. Hence, the psychologist has the 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, eight different audience models were used in the venue.

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 selected among various subjects which were determined by the psychologists. 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 sees 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 Figs. 3–5. The participants look at 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 behaviours in the system in order to make the selected audience to act one of the behaviours that would increase the participants’ concerns as shown in Fig. 6.

These nine behavioural 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 the presentation were determined after the first study [15] with participants. When the participant makes a presentation, the psychologist chooses one of the audiences 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.

4 Results

The SUD scores of each participant in VREI group were measured at three time points (i.e. $T_1$ = immediately after introduction to the audience but before the speech began, $T_2$ = a retrospective rating of peak anxiety during the speech and $T_3$ = immediately after the exposure) as shown in Figs. 7–9.

For the 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 VREI group, the Wilcoxon signed-rank test, which is a suitable analysis for small subject numbers and repeated measures [45], was used to compare for both pre-test and post-test scores of the LSAS, IAS, SAAS and BFNE. There were significant differences between the pre-testing and post-testing on LSAS scores ($z = -2.37, p < 0.05$), on IAS scores ($z = -2.41, p < 0.05$), on SAAS scores ($z = -2.38, p < 0.05$) and on BFNE scores ($z = -2.38, p < 0.05$). The anxiety levels of participants at

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Fig. 1 Use case diagram of the psychologist

Fig. 2 Use case diagram of the participant

function that can be performed by the participant as shown in Fig. 2.

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

• standard classroom,
• blue auditorium,
• red auditorium.

For the 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.

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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.

For the control group, the Wilcoxon signed-rank test, which is a suitable analysis for small subject numbers and repeated measures [45], was also used to compare for both the 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 ($z = -2.37$, $p < 0.05$), on IAS scores ($z = -2.38$, $p < 0.05$), on SAAS scores ($z = -2.38$, $p < 0.05$) and on BFNE scores ($z = -2.41$, $p < 0.05$). 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.
VREI 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, average anxiety levels in red auditorium condition were lower than those in the classroom and blue auditorium conditions. This finding may show that the exposure could help participants to feel prepared through the VREI sessions. Another possibility to consider is that smaller the size of the audience is likely to create the more interactional environment. Furthermore, feedback from the listeners is likely to be more noticeable in these situations [29]. The Wilcoxon signed-rank test findings revealed that participants in both VREI and CBT-based 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 VREI group and CBT-based psychoeducation group. Results of the present study are proposed for using VREI to help individuals deal with public speaking anxiety symptoms. Thus, this paper claimed that the VREI 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 generalisability of the findings. In addition, parametric tests could not be performed due to small size. Further research would replicate our findings with a 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, the future studies may include physiological assessment 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. Moreover, 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. It 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 the 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. Besides, the nature of CBT-based psychoeducation group may lead to exposure-like experience for participants since they shared their private thoughts and emotions related to public speaking anxiety.

In sum, the present work highlights that VREI can contribute to improve the 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 VR exposure versus CBT-based psychoeducation in a Turkish university sample. Although the duration of VREI and CBT-based psychoeducation group was differentiated (i.e. the duration of CBT-based psychoeducation group was longer), both interventions were effective to decrease their anxiety levels. The current findings revealed that both conditions were equally accepted.

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