Article Title**: Speak Up: VR-based training system for improving oral presentation skills**

Short title: **VR solution to public speaking**

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Abstract (word limit: 100 words): In this paper, we present a self-regulated training platform to help individuals deliver effective presentations. The speaker delivers a presentation in the VR environment emulating the settings of distracted audience, a commonly observed audience behaviour. The learner is exposed to specific strategies, such as engaging with audience, using scaffolds embedded in the system. Opportunities for feedback from experts, self-assessment and self-reflection exercises are some of the integral features of the training module. The situated learning environment and exploration of what works for a particular user, in context of making a presentation, makes the tool valuable.

Extended Summary (word limit: 300 words): Presenting to an audience is a well-established way of articulating your ideas, work, research and projects. People who fear public speaking are too scared to practice in front of real audience, and avoid presentations all together. Most people attempt to hone their skills through demo-practicing without audience, reading listed suggestions for making effective presentations, or in some cases going back to their audio/video-recorded presentations. Some people also go through expensive training programs and workshops to skill the art. However, there are not many self-regulated training platforms for users to practice effective presentation delivery. This is where VR plays a critical role. A wide ranging research effort has been investigating the possibility of using virtual reality exposure therapy to treat phobias of different kinds. In this study, employing Unity platform and Google VR package, we present a VR-based application (Speak Up) to enable anxious individuals in improving their oral presentation skills. To accelerate the learning process, the application provides a realistic audience-settings to recreate the experience of delivering a real presentation, anywhere and any number of times. The speaker delivers a presentation in the VR environment emulating the settings of distracted audience, a commonly observed audience behaviour. The learner is exposed to specific strategies, such as engaging with audience, using scaffolds embedded in the system. Opportunities for feedback from experts, self-assessment and self-reflection exercises are some of the integral features of the training system. The situated learning environment and exploration of what works for a particular user, in context of making a presentation, makes the tool valuable. Anyone, including novice students or experienced teachers and professionals, can benefit from such a platform, which fulfils the crucial need of exposing the speaker to real audience with guided practices to improve on their oral presentation skills.

Speak Up: VR-based training system for improving oral presentation skills

I. Introduction:

Speaking in front of an audience often elicits an anxious response in people. This anxiety is often termed as fear of public speaking or speech anxiety (Anderson, Zimand, Hodges, & Rothbaum, 2005). A literature survey showed that 85% of individuals feel anxious when speaking in front of an audience (Motley, 1998). Individuals who fear public speaking often tend to avoid giving a talk; however, under unavoidable circumstances, the situation is endured with intense feelings of anxiety and distress (Stein MB, Walker JR, & Forde DR, 1996). Speech anxiety makes it challenging to convey ideas effectively during professional communication and interviews, or present accomplished work and projects, which may negatively impact career and personal lives. Delivering presentations to audience has become a well-established way of articulating one's thoughts, work, research and projects in professional life. However, high levels of anxiety do not result in satisfactory performance in communication (Behnke & Sawyer, 1999).

Three important techniques suggested in literature to reduce public speaking anxiety (PSA) include skill development, cognitive modification and systematic desensitization (Allen, 1989). One of the studies also delineates the factors affecting public speaking (Menzel & Carrell, 1994). Factors that positively correlate with quality of public speaking included the time devoted to preparation for the talk, cumulative grade point average of the speaker and number of rehearsals for an audience. The anxiety scores were shown to negatively correlate with the performance of public speaking. Although there are some expensive training programs available to sharpen one's presentation skills, there are not many self-regulated platforms in academic institutions or professional settings, providing an opportunity to practice.

Our work focuses on utilizing the desensitization technique using exposure therapy, which involves exposing the patients to a feared stimulus such as making oral presentation to an audience. Decrease in anxiety is often reported with samples becoming "habituated" to the stimulus (Emmelkamp, Bouman & Schooling, 1995). Due to the technology affordance, this therapy is often undertaken in "virtual" environment to create scenarios and stimulus used to treat specific phobias (Botella, Fernández-Álvarez, Guillén, García-Palacios, & Baños, 2017). Hence, the use of VR in a controlled and safe environment, and inexpensive manner is promising in benefitting learners to overcome their fears of addressing an audience. In this study, we present a virtual reality (VR)-based application (Speak Up), created to train anxious individuals in improving their oral presentation skills. The graphical representation of our training solution is illustrated in Fig. 1 with the process flow of different tasks. The application provides a realistic audience-settings to recreate the experience of delivering an oral presentation, which fulfils the crucial need of exposing the speaker to real audience with guided practices to improve on their presentation skills.

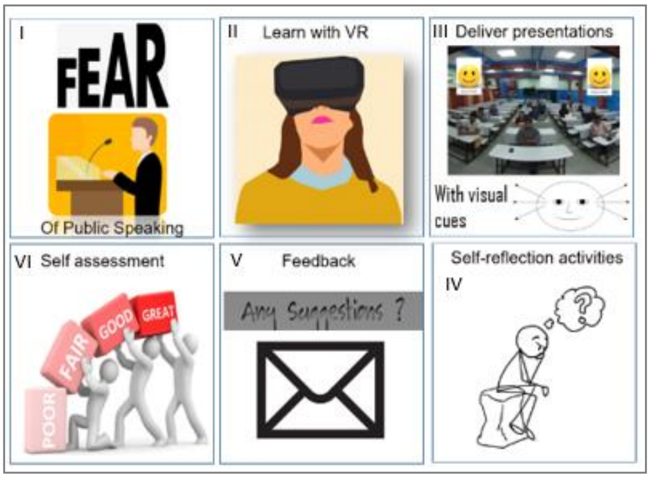

Figure 1: Graphical representation of the VR application process

II. Related Work

Common barriers to developing confidence and reducing anxiety, while presenting in public, include our reluctance to seek help and practice with an audience. This occurs primarily due to logistic challenges of practicing with an audience, and the fear of embarrassment while practicing in public. Technology-enabled therapies may improve upon existing techniques by reducing the cost, thus improving the affordability and accessibility of therapy for individuals (Newman, Szkodny, Llera, & Przeworski, 2011). Virtual Reality (VR) offers a great potential in exposure therapy mimicking a real-life scenario through an artificially created and controlled environment (Pertaub, Slater, & Barker, 2002).

The immersive VR technology is found to be an effective tool to improve exposure therapy for phobias, and even to analyse the processes and mechanisms involved in this therapy (Botella et al., 2017). Earlier literature has utilized VR therapy for fear of heights (Rothbaum et al., 1995), fear of flying (Rothbaum, Hodges, Watson, Kessler & Opdyke, 1996; Rothbaum, Hodges, Smith, & Lee, 2000), and also showed promise in treatment of agoraphobia and claustrophobia (North, North, & Cobble, 1998). The efficacy of VR exposure therapy (VRET) for treatment of speech anxiety has been shown to be greater as compared to guided methods by the experimenters to manage their phobia either by using visualization techniques or self-exposure in trivial virtual reality settings (North et al., 1998).

Most of the existing reports either evaluate efficacy of VRET to treat specific phobias or evaluate the immersivity and audience reaction to functional elements of VR (Vanni et al. 2013; Pertaub et al., 2002). Harris and Kemmerling (2002) presented a report on the effectiveness of VRET with virtual audience in reducing PSA of university students (Harris et al., 2002). The results showed that subjects shared positive experience with VRET, and that it took four VR treatment sessions in reducing PSA for students. Another study conducted on clinical patients for social phobia employed sessions of anxiety management along with VR exposure. The results showed VR exposure to be more effective than waiting list control groups with decrease in self-report measures of public speaking anxiety from pre- to post-treatment (Anderson et al., 2005). However, since VRET was combined with anxiety management sessions, the contribution of VR in anxiety reduction was unclear.

A recent report describes a cloud-based software as a service solution for VRET for public speaking anxiety disorder using virtual audience, with different emotion settings (Salkevicius & Navickas, 2018). Some other control options, which could be simulated in the environment included heartbeat or heavy breathing sound effects or even a computer crash. Physical sensors were employed to determine the subject's state during the therapy by measuring their galvanic skin response. Results did not show conclusive data due to small number of subjects; however, the results established that VRET applications can be designed as a software-based solution.

Some of the reports also investigated the relation between speaker's anxiety response and type of feedback received from the virtual audience (Harris et al., 2002; Slater, Pertaub, & Steed, 1999), where the computer generated avatars in the VR environment emulated positive, negative and mixed audience responses. The results from these studies showed that the speakers' response was affected by the behaviour of the virtual audience. It was concluded that different VR audience scenarios could be of great benefit in treating social performance situations. It is also shown that presence of live audience or pre-recorded audience is essential to create a condition of social-evaluative threat (Westenberg et al., 2009).

Building on these results from literature, the goal of our work was to develop a comprehensive training solution platform entailing VRET and guided practice activities. We focused on creating a VR environment emulating the settings of distracted audience, one of the commonly observed audience behaviour, with real people unlike most of the studies, which employ computer generated avatars.

III. System Development

A. Technological design

A conscious effort in our application was to make our training module compatible with most VR headsets like HTC Vive, Google Cardboard, Mi VR Play, Samsung Gear VR and Oculus Rift. These devices come with additional features and dedicated installation tutorials, making it easy to use and access, and aiding clinicians and educators in choosing the right product. In this study, we tested our application on Mi VR Play, which enables docking a smart-phone. Mi VR Play can work without additional sensors, while smart phone devices are now sufficiently powerful to support VR environment for videos at Ultra-High Definition (UHD; 3,840 × 2,160 pixels) resolution. For this purpose, we used Android Studio in conjunction with Unity to build an android application supplementing the desktop application, primarily for training module. We tested our virtual environment using Mi VR Play and Redmi Note 5 Pro, which has screen resolution of 1080 × 2160 pixels and screen size of 5.99 inches. Moreover, the smartphone penetration in India has amplified significantly in the past decade (Davey & Davey, 2014), which will make it easy for our application to be accessible to anyone with a smartphone.

The goal of the training application was to provide a self-regulated platform, which aids in practicing with an audience and providing guided activities for the learners. The training platform was designed in Unity, and the interactables were coded using C-Sharp language to imbibe appropriate functionality into elements encoded within the scenes (Fig. 2). The base application programming interface (API) of Unity VR ensures compatibility with multiple devices, and enables intuitive interaction with 360 videos, after building an application for a particular platform. As shown in Fig. 2, our application was compatible with both Android and Windows.

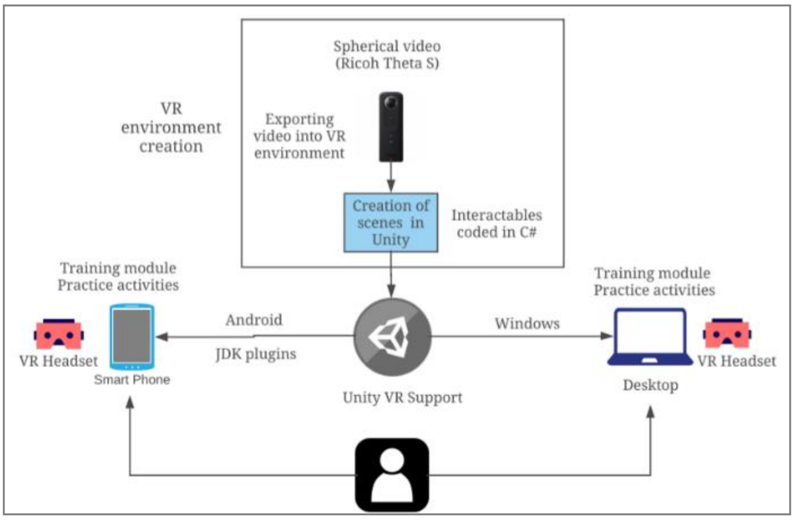

Figure 2: VR application creation process and framework

The mobile application, which comprise the VR training module, is supported by various versions of Android operating system (version 4.4 to 8.0). The desktop version of the system is a stand-alone Unity application that works on Mac, Windows and Linux. The user can choose a mobile or desktop application for trainings; however, we recommend the desktop environment for the practice activities for the ease of performing guided activities, and going through other components.

B. Pedagogical Design

It is shown that the features in a learning environment influence the learning process and learning outcomes (Salzman, Dede, Loftin, & Chen, 1999), while the unique affordances of the VR environment play an important role in education (Mikropoulos & Strouboulis, 2004). A growing body of research suggests that constructivist principles are fundamental to our understanding of learning in virtual reality learning (Cheng & Wang, 2011; Huang et. al., 2010). The pedagogical design of our application is well supported by the numerous principles of constructivism, which includes 1) providing multiple representations of reality – avoid oversimplification of instruction by representing the natural complexity of the world; 2) providing real world, case-based learning environments; 3) enabling context-dependent knowledge construction; 4) presenting authentic tasks rather than pre-determined instructional sequences; and foster reflective practice (Jonassen, 1994). To address the natural complexity of the world, in our VR environment, we focused on creating an environment closest to the real world scenario for oral presentations, showcasing live audience whose behavioural characteristics were supported by literature. Our VR training environment promotes a context-dependent (oral presentation in a lecture room) and case-based (distracted audience) learning experience through a self-regulated training platform. The learners perform authentic tasks such as making oral presentations and activities related to their tasks. Learner reflection has been targeted through open-ended reflection activities to be performed immediately after the training session. The activities motivate the speaker to reflect on their own knowledge structure, and how they can build on it. According to constructivists, learning occurs from our reflections on feedback received from environmental interactions (Swan, 2005). We implemented a functionality in our system for audio-recording of the speaker presentation, which can be saved and shared with experts for feedback.

Our training solution emphasizes on knowledge building in learners through activities and the environment they are “situated” in. A comprehensive overview of the steps involved in the training intervention has been illustrated in Fig. 3. The process initiates with filling out a form on self-report of confidence as a speaker (Fig. 3A and 3B), followed by training in the virtual environment (Fig. 3C). Visual cues are provided as scaffolds in the virtual environment where the speaker delivers an oral presentation. The audio of the presentation can be recorded and saved, which can further be sent to experts for feedback (Fig. 3D). An open writing space, termed as noteboard, has been provided to the learner to record their reflections from the training experience (Fig. 3E). Scaffolds as textual hints are also incorporated in the system to aid learning (Fig. 3E). Further, open-ended reflection activities need to be performed by the learners to translate their experience into effective learning (Fig. 3F). Each of these activities have been described in detail in the next section.

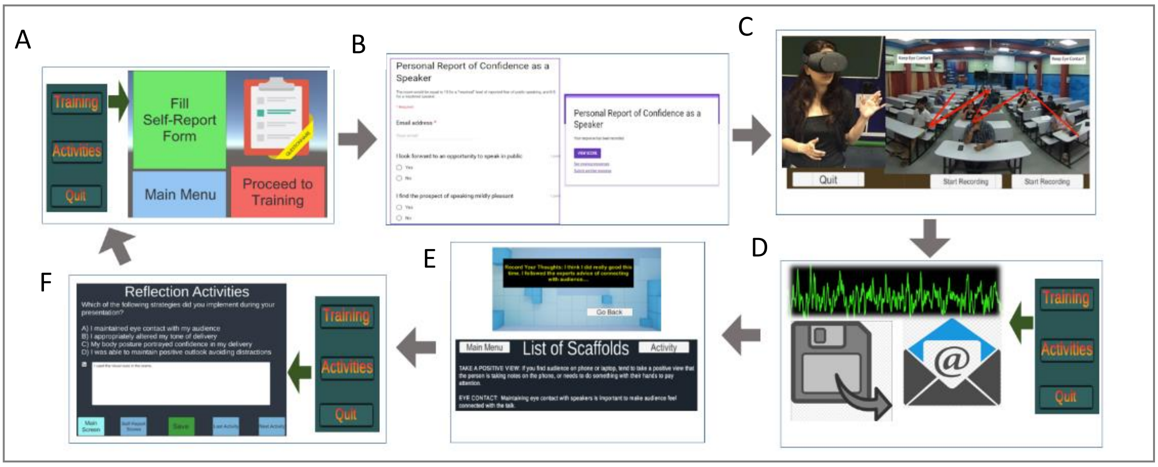

Figure 3: Flow of activities inside the VR application (Speak Up) for a training intervention

IV. Training Solution Components

There are two key components of our application, including VR training module and practice activities. The training dashboard enables the users to navigate through the training session, performing activities and performance analysis. The three main functional blocks of the system have been described below (Fig. 4).

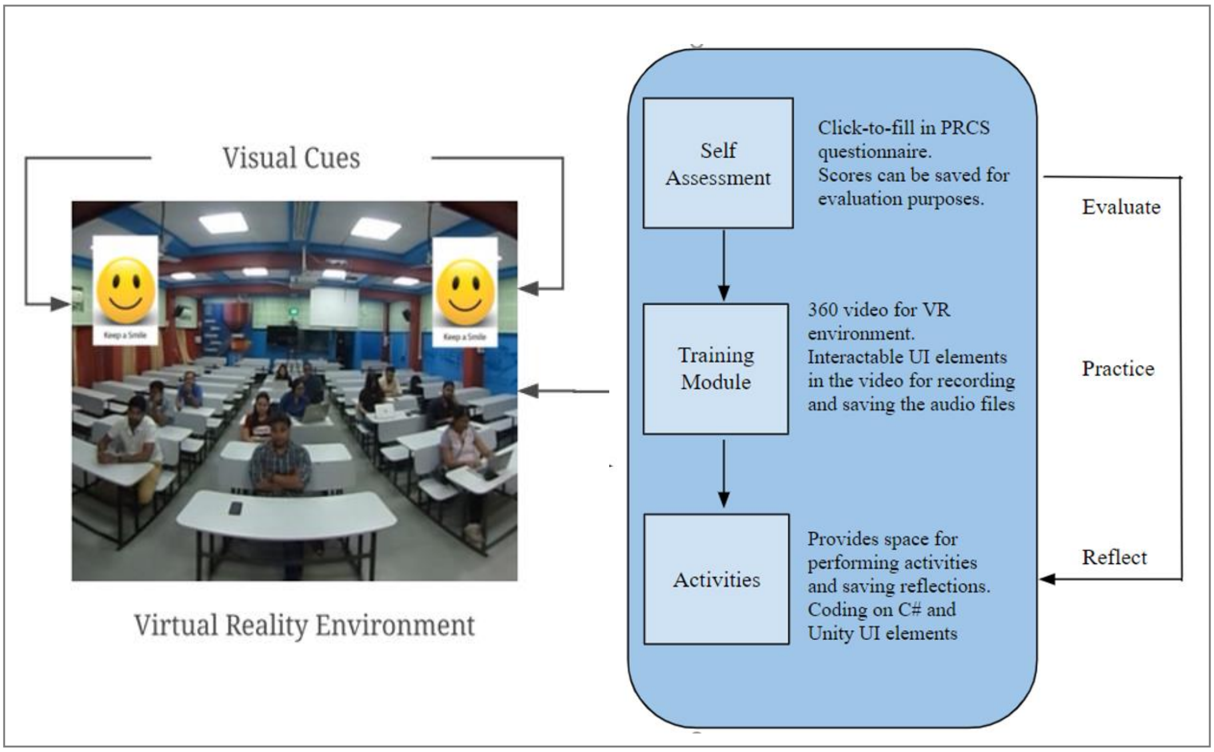

Figure 4. Functional blocks of the system including self-assessment, training module and activities.

A. *Virtual Reality Environment*

One of the important reasons for the observed potential of VR in exposure therapy for different phobias is the immersivity of the environment (Psotka, 1995; Chollet, Wörtwein, Morency, Shapiro, & Scherer, 2015). This virtual environment can be layered with graphics to provide a realistic feel. Virtual environments have been specifically evaluated for treating speech anxiety, showing acceptable level of immersivity including extent of realism, interactions, involvement, and naturalness of the VR experience (Parrish, Oxhandler, Duron, Swank, & Bordnick, 2016).

Wearing head-mounted display (VR headset) for a longer period of time may give rise to VR-induced symptoms and effect (VRISE). Individuals wearing VR headsets have reported symptoms similar to motion-sickness such as headache, dizziness and nausea (Cobb, Nichols, Ramsey & Wilson, 1999). Some of the solutions offered by literature for VRISE include giving control of the simulated environment to the user, increasing frames per second, and avoiding usage of dark lighting in the virtual environment (Sharples, Cobb, Moody, & Wilson, 2008). The time spent in the virtual reality environment is an important predictor of VRISE. A study investigating the side effects of VR reported that 61% of participants experienced symptoms at some point during 20 min immersion or 10 min post-immersion period (Regan & Price, 1994). Consequently, our application was designed considering the above challenges. The prospective speaker engaging with virtual environment controls the environment through head-movements; the virtual environment is a brightly lit classroom and the time of the training module is restricted to only 10 min.

Most of the studies that employ virtual reality to treat public speaking anxiety use computer-generated avatars as audiences. These virtual audiences are observed to provide verbal and non-verbal feedback depending on the scenarios (Pertaub et al., 2002; Chollet et al., 2015).

Studies have also investigated on the effect of audience behaviour on the speaker in a virtual environment, and found that speakers engaging with positive audiences reported lower anxiety scores than speakers who engaged in negative audience scenario (Pertaub et al., 2002).

In our training application, the user engages with live audience who act in a distracted manner. The body cues for distracted audience include yawning, looking at smartphones, talking to others, avoiding eye contact, signs of disinterest, gaze aversion and sleepy. A fish-eyed lens camera (RICOH THETA S) was employed to video-record audiences at 30 fps and full HD (1920 × 1080 pixels) resolution. The spherical video of the distracted audience was further converted into 360 video, to ensure compatibility with the VR headset. The 360 VR video was layered with some non-verbal visual cues, which serve as reminders for speakers to some critical behavioural gestures while speaking to an audience. The Adobe After-Effects was employed to encode these visual cues inside the 360 videos. The cues (keeping a smile, making an eye contact with audience and maintaining a correct posture), incorporated in the videos, are key to good public speaking (The best public speaking tips from 90 years of Toastmasters). Studies already exist which focus on helping individuals towards improving eye contact while communicating in a formal and informal environment (Chollet et al., 2015). Literature also suggests providing sparse feedback from the learning environment (Chollet et al., 2015; Tanveer, Lin, & Hoque, 2015), since frequent feedback was reported to distract speakers from their presentation. Consequently, our training module has two cues for "eye contact" interspaced at 4 min interval; two visual cues to "smile" and one visual cue for "posture". These cues serve to remind the speakers to perform these actions. Through repeated reminders, the individuals are likely to become habitual to the practice, whenever delivering a talk to an audience.

Users are also provided with an option of recording the audio of their oral presentation, which can be saved, and played back for self-evaluation to glean further insights. Another functionality offered by the application is the ability to share the recording with an expert for feedback.

B. Activities Module

One way to translate an experience into effective learning is through reflection (Seibert & Daudelin, 1999). Reflection can happen when a certain event, experienced by an individual, triggers uncertainty, instability or challenge, or by using individual's willingness to engage in a reflection activity (Rogers, 2001). The atypical nature of speaking in front of an audience, evokes uncertainty and instability, which should trigger some reflection space. By providing an opportunity for reflection through reflection activities (RAs), immediately after the training, we take advantage of the aforementioned belief, and intend to integrate their experiences into effective learning.

In the activity module of the application, the RAs are modelled based on a previous work, which emphasize on triggering reflection in the light of the situation (Rogers, 2001). We provide six RAs to ask specific questions about their experience through the VR training, reflecting on strategies implemented in the environment or new techniques that they wish to learn and implement. To provide an example of the design, one of the questions asked for reflection is as follows.

Which of the following strategies did you implement during your presentation?

A) I maintained eye contact with my audience
B) I appropriately altered my tone of delivery
C) My body posture portrayed confidence in my delivery
D) I was able to maintain positive outlook avoiding distractions

Fig. 5 provides a screenshot of another RA from the activities module. As shown in the figure, the "save" button functionality enables the user to save their responses, which can be used to compare their reflections over a period of time.

Figure 5: An example screenshot of a reflection activity in Activities module

In addition, the activities module also incorporates a list of recommended strategies (scaffolds) compiled from several public speaking guides and courses (Anderson, 2016; O'Hair, Rubenstein, & Stewart, 2007). These scaffolds provide actionable hints that one can act upon during their presentations. Few examples of the scaffolds provided on the module include 1) Keep a positive view about your audience, 2) Keep the presentation engaging like a story, and 3) Break the monotony in presentation delivery.

C. Self-Assessment and Feedback

Self-assessment activities for our application include a self-critique of recorded presentation and a self-evaluation of confidence, termed as Personal report of confidence as a speaker (PRCS), before and after the training intervention. The shortened version of PRCS, adopted from literature (ref), is based on 15 statements, each with a yes/no response to be answered by the speaker. The score of '15' would indicate a maximal level of reported fear of public speaking, which would improve as the score decreases. The form needs to be filled in before every training session. Thus, PRCS will provide a measure of subject's degree of improvement in public speaking during the course of trainings. We provide a score-board that keeps track of learners' PRCS questionnaire score, with date, to motivated them to continue and achieve better scores. The first four statements of our PRCS are listed below.

- I look forward to an opportunity to speak in public
- I find the prospect of speaking mildly pleasant
- I am terrified at the thought of speaking before a group of people
- I have a feeling of alertness in facing an audience

Two questions in the reflection activities also pertain to self-assessment. In one of these RAs, users are asked to listen to their recorded presentation, and count the number of pause fillers (hesitation vocalisation, e.g. err and umm sounds), which are an indicative of public speaking performance (Chollet et al. 2015). Feedback for improvement strategies closes the gap between the existing product and the goal product, and is considered to be at the center of formative assessment (Sadler, 1989). The application also provides the opportunity to the speaker to record and share their audio presentation with domain or technical experts to receive feedback for improvement in different dimensions including language, pace, pitch, technical content etc.

V. Future Work

Future work on this project involves conduct of experiments to evaluate the effectiveness of the training application with an appropriate sample size. Some of the research questions to be investigated, with our experimental studies, will include the following.

1. Does VR training aid in improving presentation skills of learners?
2. How many training interventions are required for learners to observe a measurable improvement?
3. What challenges do learners face while interacting with the application?

For the VR training module, we plan to investigate the speakers' perception of realism in our VR environment. We plan to use immersion questionnaire (IQ) and presence questionnaire (PQ), as employed in several previous studies (Psotka, 1995; Parish et al., 2015) to examine the level of immersivity and realism of our virtual environment. We would also examine for any VR-induced symptoms during the VR training session. To measure the degree of improvement in public speaking during the course of trainings, we aim to collect pre- and post-training data for levels of anxiety using PRCS and Subjective Units of Distress Scale (SUDS), which are commonly utilized in literature (Pertaub et al., 2002; Slater et al., 2006). We plan to investigate on the effect of our VR training application towards improvement of presentation skills of a learner. We expect the speakers to experience higher levels of anxiety during the initial rounds of presentation, and gradually improve in their confidence and presentation skills after a few rounds of training interventions. Additionally, we would also want to learn about the number of interventions required for the learners to observe measurable improvement. We would also incorporate additional audience scenarios into the platform such as "friendly" and "hostile" audience. The friendly audience will show high signs of attention, and exhibit positive body cues (encouraging nods, smiles), whereas hostile audience will exhibit unreceptive behaviour with negative body cues such as unpleasant facial expressions, showing disagreement to speaker etc. We also intend to incorporate speech analytics functionality into the system
in order for the learners to receive some constructive and automated feedback from the system regarding their pitch, pauses, etc. Adaptive feedback by audience to learners in the VR environment, based on their presentation delivery skills, is one of the long-term goals of the project.

VI. Conclusion:

The developed system shows that VRET for public speaking anxiety can be designed as a self-regulated training platform, where learning happens through experience, self-reflection and feedback from experts. The scope of the work can be generalized to anxious speakers including research scholars delivering research presentations, teachers delivering a class lecture, school or college students, professionals making proposal presentations, and anyone wanting to improve on their oral presentation skills. In addition to the technology-enabled VR training environment provided in the system, there is a strong pedagogical emphasis in the training process through guided practice activities. The pedagogical features, incorporated in the platform, such as reflection activities, scaffolds, expert feedback feature, make our application an exclusive and comprehensive training solution. Using a VR headset, the application enables learners to go through this self-regulated training process anytime and anywhere, as required. The application design shows great promise in a range of social performance situations; however, we plan to support our design with research evidence in our future work.

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