# VIRTUAL REALITY TRAINING OF PRESENTATION SKILLS: HOW REAL DOES IT FEEL? A MIXED-METHOD STUDY.

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## ABSTRACT

Being able to deliver effective and compelling presentations to various audiences, becomes more and more important for engineers. However, with full curricula and growing numbers of students in engineering domains, the training of good presentation skills often receives (too) little attention. Instructors don't have time to train the students intensively, let alone that there is room for individual, formative feedback. The use of Virtual Reality (VR) might offer a solution. With this technology, students can practice their presentation skills on their own in front of a virtual audience.

The study presented here is part of a line of research into the effects and user experiences of VR presentation skills training for students of engineering. The current study is about capturing the user experience and focused on an attribute that is assumed to be central to VR technology, namely the capacity to induce a strong sense of immersion in the user. The current study sought to explore if VR users respond to a virtual audience as were it a real audience. In order to investigate this, a mixed-method study with 46 students from a technical university was applied, in which the responses from the virtual audience were manipulated, and the effects of those manipulations on the level of user immersion were measured. We also investigated if personality traits moderated these effects. Quantitative (questionnaires) and qualitative (interview) data were collected to capture the effects of the manipulation, and the extent to which personality influenced the responses of users to the VR experience.

## 1 INTRODUCTION

### 1.1 Problem statement

More than ever before, engineers have to deal with complex technical problems in interdisciplinary teams and in competitive market conditions. About 60 percent of the work of engineers is communicating with others [1; 2]. Therefore, it is of utmost importance that engineers are capable of communicating clearly and are able deliver effective and compelling presentations to various audiences, including colleagues,

management, and clients. Companies actively search for engineers who have these skills [3].

Engineering studies recognize the importance of these communication skills. However, with full curricula and growing numbers of students in engineering domains, the training of good presentation skills often receives little attention. Instructors don't have time to train the students intensively, let alone that there is room for individual, formative feedback. The use of Virtual Reality (VR) might offer a solution. With this technology, students can practice their presentation skills on their own in front of a virtual audience.

### 1.2 Training of presentation skills

In the literature about 21st century skills, it is often emphasized how important it is that students can train complex skills in realistic contexts [4; 5]. In the case of presentation skills, this means that students must be able to train their skills in front of an audience. The realism of the practice context in presentation skills training is important for two reasons. First, most people experience some level of stress will speaking in public. In some publications it is estimated that at least 75 percent of the student population fears speaking public [6]. The stress affects their posture, gesturing, use of voice (e.g., speed, pitch), and so on. Students have to get used to such stress and learn how to deal with it. Second, during a real presentation there might be interfering factors, such as mobile phones that are ringing, people in the audience that appear distracted or uninterested. Students must also learn how to deal with such situations, or at least how they can keep their focus on their presentation, without getting distracted.

In the previous section, the use of VR was suggested as a solution that could offer students a venue where they can train their presentation skills in front of a (virtual) audience. The question is however: does such a virtual environment really make students feel like they are in an official lecture-hall giving their presentation in front of an audience? And if so, could this virtual experience, or perhaps we should call it 'perceptual illusion', be so compelling, that students even respond to the non-verbal behavior of the virtual audience?

### 1.3 Virtual Reality and presentation skills training

Mikropoulos and Natsis [7] describe Virtual Reality (VR) as "technologies that support the creation of synthetic, highly interactive three dimensional (3D) spatial environments that represent real or non-real situations." Users have to wear a head-mounted display (HMD), that is a head-mounted set of VR goggles in combination with headphones and (often) hand-held controllers. When wearing the HMD, the users can't see the real world outside themselves anymore. Instead, they see a 360 degree virtual world that is projected inside the HMD. When the users turn around or turn their heads, they see what is next to them or behind them.

In the case of presentation skills training in VR for example, the application gives the users a first-person perspective of a presenter on a stage. The users find themselves on this virtual stage in front of an audience that is looking at the user.

Behind the user there is often a screen on which the user's PowerPoint slides are projected (most applications allow users to upload their slides in advance into the VR application, so they can practice their presentation with their own slides). In some of the more advanced VR applications, the users can move around through the virtual room and when they move, the eyes of the audience will follow them. Some applications even allow the level of audience engagement to be set, ranging from an audience that appears highly engaged (e.g., nodding in approval, looking alert and interested, keeping their eyes on the presenter, looking friendly) to an audience which appears disengaged (e.g., sitting with their arms folded, looking at the ground, looking at their phone, yawning).

### 1.4 One of the key attributes of VR: Presence or the feeling of 'being there'

One of the attributes that are assumed to be central to VR technology, is VR's capacity to induce a strong sense of presence or psychological immersion in the user. Witmer and Singer [8] view this as a "psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" (1998, p. 227). Many other authors refer to this psychological immersion as 'presence', the psychological perception of being "there," within a virtual environment in which the person is immersed (Witmer & Singer, 1998). Onwards we will use the term 'presence'.

Several factors have been found to influence the level of presence, both from the side of technology as from the side of the users. An example of the role of technology in inducing presence is offered by Freeman and colleagues [9], who found that virtual environments that allow or even stimulate the users to act and move around, are associated with higher levels of presence. But characteristics of the users might also play a role. It may be that for some persons it is easier to experience presence than for others. Weibel et al. [10] for example, found a positive relation between the level of presence on the one hand and the personality traits Neuroticism, Extraversion and Openness to Experience on the other hand.

### 1.5 Research questions

The main question in this study is: Can a VR environment provide students with a realistic context for practicing presentation skills in the context of a technical university? Will the students feel that they are "really there", in that (virtual) lecture-room in front of an audience? In order to answer these questions, we have the following sub-questions:

1) To what extent does a VR training of presentation skills induce a sense of presence in students?
2) Does the level of engagement of the virtual audience, as expressed by their nonverbal behavior, affect the students and their sense of presence?

*3)* To what extent do personality traits (Extraversion, Neuroticism, and Openness to experience) moderate the students' sense of presence and their response to the audience's level of engagement?

## 2 METHODOLOGY

### 2.1 Design

In this study we use a mixed-methods approach. In the quantitative part, within-subject and between-subject designs are used. The qualitative part consists of semi-structured interviews with the respondents.

### 2.2 Respondents

In this study, 46 students from a technical university participated. Thirty-four female participants and 12 male participants participated. The mean age of the participants was 23.41 years (SD = 3.99, ranging from 18 to 34 years old).

### 2.3 Instruments

**Hardware and software**

The VR hardware that was used in the study was an HTC Vive set. The software was produced by Brainstud. In this application, users can practice their presentation on a virtual stage. PowerPoint slides can be uploaded in advance of the practice session. During the practice session, the slides are displayed in the virtual environment. The engagement level of the audience can be controlled by the instructor. This level can range from 0% (highly disengaged) to 100% (fully engaged). When the engagement is at the lowest level, the virtual public looks down, talks among each other and appear uninterested. When the virtual public is fully engaged they nod every now and then, and they show interest in the talk by looking at the participant. The instructor can vary the level of engagement during the presentation. He or she also can let phones ring in the audience, or let the audience give a round of applause.

**Questionnaires**

*Sense of presence*

The Igroup Presence Questionnaire (IPQ) (Schubert et al., [11] was used to assess the extent of sense of presence. The IPQ is a combined questionnaire constructed from previous published validated questionnaires [12]. The subset used in this research contained 14 items about the extent of sense of presence a participant experienced when standing inside the virtual environment. Participants rated each item on a seven-point Likert scale. The IPQ measures several constructs of presence: Spatial Presence (SP) (e.g., "I had a sense of acting in the virtual space, rather than operating something from outside"), Involvement (INV) (e.g., "I was not aware of my real environment"), Experienced Realism (REAL) (e.g., "How real did the virtual world seem to you?"), and one general item measuring presence, called General Presence (GP) (e.g., "In the computer-generated world I had a sense of 'being there").

A reliability check was carried out to measure the internal consistency coefficient of the IPQ. The seven-item scale showed adequate internal reliability with a Cronbach's alpha of .78 for the results of the IPQ disengaged public and .79 for the results of the IPQ engaged public. Principal axis factoring with oblique rotation confirmed the presence of the four IPQ factors in our data: Spatial Presence (SP), Involvement (INV), Experienced Realism (REAL), and General Presence (GP).

*Personality traits*

The NEO Personality Inventory (NEO-FFI) was used to assess the participants' personality in terms of the three dimensions extraversion (e.g., ''I am spontaneous''), openness to experience (e.g., ''I have a very active imagination''), and, neuroticism (e.g., ''Frightening thoughts sometimes come into my head''). This set of subscale consisted of 26 items and turned out to be reliable (with Cronbach's alphas of .86, .80, and .65 respectively). The participants rated each item on a 5-point Likert scale.

**Semi-structured interview**

After completing the two questionnaires a semi-structured interview gave insight into the overall VR experience. For example, "How aware were you of us being in the room?" and "Did you notice any difference in the type of public?".

### 2.4 Procedure

At first, permission was asked for conducting this experiment to the ethics committee of the University of Twente. The participants were asked for consent, before participating. All participants were informed in advance about the purpose of the study. They were asked to prepare a short presentation (max. 5 minutes) about their topic of choice, before attending the experiment. They also received a link to an online questionnaire to assess their personality. Participants were asked to fill out this questionnaire before the participated in the experiment. During the experiment, participants presented one time for a disengaged virtual public and one time for an engaged virtual public using the VR speech application, with a small break in between. Counterbalancing was applied, so in one condition, participants started with presenting for an engaged audience, followed by presenting for a disengaged audience. In the other condition, particants started with a disengaged audience followed by presenting for an engaged audience.

On the day of the experiment, each participant was exposed to the virtual environment to get familiarized with the technology before starting his or her presentation. The participants did not receive any feedback during or after their talks. Furthermore, the researcher was unaware of the participant s' NEO-FFI scores.

After each presentation, participants were asked to fill out a questionnaire about their experienced sense of presence, based on the Igroup Presence Questionnaire (IPQ) [11]. The presentations were audio and video recorded. The level of engagement of the virtual public was at the discretion of the researcher. For the public who was fully engaged, the engagement was set at 100%, hereinafter referred to as the engaged public. For the public who was disengaged, the engagement was

set at 0%, hereinafter referred to as the disengaged public. To equalize the experience across participants in the experiment, a mobile phone rang in the virtual environment at 2 min 30 when presenting for the disengaged public. The public applauded only when the participants finished their presentation for the engaged public to emphasize the positive ambiance. For ethical reasons, participants who presented for the disengaged public the second time were debriefed and told that the negative reaction from the audience was not due to their talk. At the end of the second and final presentation, a semi-structured interview was taken by the researcher to gain more insight into the overall VR experience of the participant. The overall experiment lasted 60 minutes for each participant.

## 3 RESULTS

### 3.1 Presence

First, a comparison was made between the experienced levels of presence when presenting for an disengaged audience versus presenting for an engaged audience. The average IPQ scores are displayed in Table 1.

*Table 1. IPQ scores when presenting for disengaged and engaged audiences*

| | Disengaged audience | | | Engaged audience | |
|---|---|---|---|---|---|
| | Mean | SD | | Mean | SD |
| Spatial Presence (SP) | 4.51 | 0.75 | | 4.67 | 0.65 |
| Involvement (INV) | 4.77 | 1.11 | | 4.82 | 1.03 |
| Experienced Realism (REAL) | 3.93 | 0.99 | | 4.16 | 0.98 |
| General Presence (GP) | 5.17 | 1.12 | | 5.33 | 1.10 |
| Average IPQ score | 4.60 | 0.79 | | 4.74 | 0.68 |

A paired-samples t-test was carried out to compare the mean IPQ scores when presenting for a disengaged or engaged engaged audience. Results indicated that Experienced Realism was significantly higher when presenting in front of an engaged audience as compared ot presenting for a disengaged audience ($t(45) = -2.66$, $p < .05$). No significant differences were found within the subscales Spatial Presence, Involvement, General Presence, or the average IPQ score.

To facilitate the interpretation of the sense of presence (IPQ) scores, we provide some benchmark IPQ scores reported in other studies. It should be noted that in all cases, 7-point Likert scales are used, however in those other studies, they are scored from 0-6. In our study, we score them from 1-7. In order to be able to compare the scores, we have added 1 point to the scores of the other studies, so they are now in the 1-7 range as well. The benchmark data come from three sources. The IGroup [11; 13], the inventors of the IPQ. They have reported IPQ scores of participants playing two highly immersive games, Tomb Raider and Half Life. Second source is a study by Buttussi and Chittaro [14] in which they offered a safety training in a virtual environment in which users experienced a full emergency evacuation of a commercial twin-aisle, narrow-body aircraft. The third source is a

study reported by Peperkorn, Diemer, and Mühlberger [15]in which they studied a VR exposure therapy application aiming at the treatment of spider phobia. The benchmark scores are displayed in Table 2.

*Table 2. IPQ benchmark scores*

| | Tomb Raider [13] | Half Life [13] | Safety training [14] | Spider anxiety [15] |
|---|---|---|---|---|
| | Mean | Mean | Mean | Mean |
| Spatial Presence (SP) | 4.06 | 4.99 | 4.90 | 3.95 |
| Involvement (INV) | 3.40 | 4.27 | 5.15 | 3.20 |
| Experienced Realism (REAL) | 2.92 | 3.34 | 3.81 | 4.57 |
| General Presence (GP) | 4.00 | 4.93 | 4.75 | 4.45 |

When we compare the benchmark scores in Table 2 with the scores obtained in our study (see Table 1), we see in our study, the levels of reported spatial presence are mid-range, the levels of involvement are relatively high, experienced realism is also relatively high, and our level of general presence is the highest of all studies.

### 3.2 Personality traits

**Neuroticism**

The role of the personality trait Neuroticism was investigated in two ways. First, it was assessed if the participant's sense of presence (that is, their IPQ scores) with an engaged audience, with a disengaged audience, and the difference between those scores, was affected by the participant's level of Neuroticism. A repeated measures ANCOVA was carried out with IPQ scores (with engaged versus disengaged audiences) as within-subject factor and Neuroticism score as covariate. The analysis showed that the effect of audience engagement on the sense of presence was not significant, and neither was the role of the covariate Neuroticism.

Second, we split up the group of participants in a low Neuroticism group and a high Neuroticism group, using a split-median approach. Then, we tested for possible interactions with the effect of audience engagement on sense of presence. The repeated measures ANOVA showed that the interaction was not significant.

**Extraversion**

For the personality triat Extraversion, the same analyses as for Neuroticism were run. The repeated measures ANCOVA, showed no significant role of Extraversion. In the media-split procedure, where a group of participants scoring relatively low on Extraversion with a group scoring relatively high on Extraversion, did not show a significant difference.

**Openness to experience**

The same analyses were repeated for personality trait Openness to experience. The level of Openness to experience did not play a significant role as covariate in the effect

of audience engagement on sense of presence. Also, a comparison between a group scoring relatively low on Openness to experienct to a group scoring relatively high, did not show a significant difference between those groups with regard to how their sense of presence was affected by audience engagement.

### 3.3 Results interview

After completing the second talk a semi-structured interview was held to gain more insight into the overall experience. Despite the fact that the participants were facing a virtual audience, they stated that they felt it was more real than expected (e.g. “Although it didn’t seem real, I was fully captivated in the virtual world”). The majority (38) of the participants indicated that they were unaware that the researcher was in the (same) room (e.g. “I completely forgot my environment”). Eight participants stated that they were only the first time aware that the researcher was in the (same) room. Forty-five participants were able to successfully distinct the disengaged public from the engaged public, one participant only failed to recognize a difference in the type of public. A summary of the reactions can be found below.

**Comments regarding presenting for a disengaged audience**

The reactions on the speeches for the disengaged public were inconsistent. Twelve participants indicated that the disengaged public distracted them. Many reported feelings of confusion and a tendency to forget what they wanted to say. Moreover, one participant stated: “I felt insecure because they seemed bored.” Different from some participants who argued that the disengaged audience did not influence them, what made it easier to give the presentation, for instance: “I felt less nervous because they didn’t seem to care. You can make mistakes as they would not notice it”, and “The public didn’t look, that makes it easier. You are less distracted.”
A further finding was that 12 participants felt like talking to a wall. One participant recalled: “After a while, I tended to say that if they don’t want to listen, they rather go.” And another one stated that he was just going to finish the 5 minutes without paying attention to the public. Participants described the disengaged public as ‘demotivating’, and ‘uncomfortable’.

**Comments regarding presenting for an engaged audience**

Participants’ reactions regarding the presentation for the engaged public were in contrast to the disengaged public more consentient. Twenty-one of the participants indicated that speaking in front of the engaged public was more motivating than speaking in front of the disengaged public. One participant commented: “For the second one (engaged) I felt the time moved on faster”, and “For the second one (engaged) I didn’t have to concentrate that much, because I had the engagement of the audience, so it was easier.” “In the second presentation (engaged) I used more body language and I was more into it.” Another indicated: “And also people looking at me, I felt better”. Though, there were some idiosyncratic reactions amongst the participants. Nine participants argued that the engaged public was making weird

gestures with their hands. One stated that he had a hard time interpreting the engaged public and one participant recalled: “I found the second (engaged) public annoying. You are watching them and they are making gestures which don’t make sense.”

## 4 CONCLUSION AND DISCUSSION

The results of our study show that a VR environment for the training of presentation skills is capable of inducing relatively high levels of presence, the feeling of being there. In that sense it can compete with highly immersive computer games such as Tomb Raider and Half Life. Actually, the average reported levels of general presence, the sense of being there, were in our study even higher than in the benchmark studies.

In our study, we also looked at the effect of the level of engagement of the audience on the experienced sense of presence of the user. The engagement level of the audience was expressed by their non-verbal behavior, and two conditions were compared, one with a highly engaged audience, and one with a highly disengaged audience.Our quantitative data do not show much of an effect. Only for the level of experienced realism, engagement level makes a significant difference. In case of an engaged audience, the students on average rate the experienced realism higher. For all other cases, no differences were observed. Interestingly though, is that our qualitative data, that is the data from the interviews, indicated that the engagement level had quite a profound effect on the user experience. Apparently, our quantitative measures were not fully capable of capturing the effects of audience engagement. In a future study, this point needs reconsideration.

We also conclude that personality traits did not seem to play any role of significance in our data. This might suggest that students’ responses are not or only to a minor extent dependent on their personality traits. From an educational point of view, that might be good news. No differential effects are to be expected from personality. Still, since personality has been found to play a role in other studies, this needs to be investigated further.

Limitations of the current study are, for example, that in the study we did not measure the training effects of the VR training, the training effects compared to “traditional” trainings. And also, we did not compare the level of presence and realism to non-VR conditions, varying from practicing in one’s own room to practicing in front of a real audience. However, at this moment we are running studies to address these points.

For now, we conclude that a VR environment for the training of presentation skills can be promising for technical studies as a means for practicing and training of students in more or less realistic circumstances.

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