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Evaluation of a Motion Capture and Virtual Reality Classroom for Secondary School Teacher Training

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Abstract: Nowadays having qualified and experienced teachers in school classrooms is considered to be of the highest priority in any society. However, most teachers report that they haven't received sufficient practical training to manage disruptive situations in the classroom. Fortunately, virtual reality can provide a solution to this issue. This paper will introduce ClassroomVR-MotionCapture (CVR-MC) and its evaluation by experts. CVR-MC is an IT tool that can simulate a virtual classroom, thus allowing different users to face real-life problems that usually take place in real classrooms. The system captures the users' tone of voice and the substance of their speech, as well as their gaze and corporal movements. Virtual students will react according to these parameters. To evaluate the usability and functionality of the tool, we conducted a study involving 14 education professionals. The research question that guided the study was the following: is it possible to use the CVR-MC system in teacher training to improve teachers' communication skills for classroom climate management? The main conclusion of our study is that many participants described the CVRMC system as a friendly, safe and feasible environment for teacher training, especially for improving their classroom climate management competence. However, the study also found that the emotions detected through the users' body expression did not match the emotions they reported feeling during the test.

Keywords: Non-verbal language, emotion recognition, virtual reality, teacher training, classroom climate, Secondary Education

1. Introduction

From an ecological perspective of teaching, classroom management creates, through the actions of teachers, an environment that facilitates achieving the learning goals and improving students' socio-emotional well-being (Emmer & Stough, 2001). However, unexpected events may occur in the classroom that could disrupt instructional activities. The success of classroom management is dictated by the teacher's competence in understanding and interpreting conflictive events in immediate circumstances.

Due to the importance of this issue, there is an urgent need to overcome teacher training deficiencies by improving teachers' competence in classroom climate management. The Organization for Economic Co-operation and Development (OECD) and Teaching and Learning International Survey (TALIS) (Schleicher, 2020) state that Spain is well below the average for teachers who report having received training regarding management of students and classroom climate. Less than half of Spanish teachers (40%) report feeling prepared to control a class. This study also reveals that Spanish teachers spend the longest time trying to maintain order in class.

The lack of training in classroom management could potentially be resolved through the introduction of an initial training program to enhance preservice teachers' communicative competence and increase their ability to respond to conflicts that frequently arise in secondary education classrooms.

Taking into account the deficiencies identified in current teacher training programs, particularly in relation to the competence for classroom climate management, our objective is to explore the

usefulness of a virtual classroom system that has been created with the intention of developing this competence in initial teacher training.

1.1 Tools for Teacher Training

Our work is not the first approach to developing tools for improving teaching skills using virtual reality environments and technologies. Firstly, a US team developed the TeachLiveETM system (Barmaki & Hughes, 2015), a tool for analyzing non-verbal language. The authors conducted an experiment where only half of the participants received feedback on their non-verbal language and how to improve it during their lessons. They concluded that users who were given feedback experienced a significant improvement compared to those who did not receive it. Although this tool seems to have had good results, it did not consider the different elements of non-verbal language, such as gaze direction or voice tonality.

In Japan, Huang et al. (2016) developed a system for training non-experienced teachers in a virtual environment that simulated a high school class and used a Kinect device to register users' head and hand movements, as well as their voice. Overall, the participants had a good impression of the system, reporting that this virtual training system is needed. However, they pointed out that more animations were required, as well as an environment allowing the teacher to get closer to the students.

For its part, a study by the German Knowledge Media Research Center (Leibniz-Institut für Wissensmedien) (Sümer et al., 2021), validated a system that permits the evaluation of students' attention span through visible indicators of their level of participation in learning. Although the system proved to be efficient, it could be more effective using automated analysis.

All these systems provide very useful information about how non-verbal communication affects interactions with students. The information collected by these studies support the view that the systems are appropriate for improving competencies of non-experienced teachers. Moreover, the systems also allow teachers in training to have as many goes as needed to feel in command of the situation, which is the ultimate goal of the training exercise. However, we have not found any tool that can combine the detection and evaluation of non-verbal behavior (emotions and attitudes) with strategies to manage classroom conflicts.

Given the close relationship between both areas, our research attempts to provide a VR environment that would allow future teachers to develop their competence in managing classroom climate. We have called it CVR-MC, an extended work of which is called ClassRoomVR (Bocos Corredor et al., 2020). With this tool, we test users' competence by exposing them to three conflictive situations that are commonly faced in high school classrooms. this template, because they might have been overwritten by your local settings.

1.2 Non-Verbal Analysis Using Motion Capture

Due to the complexity of the field, the study of non-verbal language and how to capture it has been a long process. The behavioral aspect of emotion is reflected in facial expressions, vocal features, gestures and body postures. Thus, in a real situation, it is possible to analyze people's non-verbal language based on their natural movements (Torres, 2019). By observing body language, we can estimate the emotions people may be feeling (Ruano Arriagada, 2004).

If we add to the above the content of the message or even the user's biometric measurements, machine learning can help detect the emotions felt by the user in real time. For example, García-Magariño et al. (2019) put forward the Emopose tool, which is capable of analyzing an image projected on a 3D avatar and identifying basic emotions. This tool is based on the closest neighbor algorithm, choosing from its database the position closest to the one analyzed.

These studies use a Kinect device for detecting emotions through the user's body expression. They all agree that it is difficult to determine the user's predominant emotion just based on the person's posture. In sum, the use of virtual simulations is increasingly seen as an opportunity to provide pre-service teachers with unique opportunities to experience examples of classroom life in a controlled and structured manner. As stated McGarr (2021), it has been claimed that a complete psychological study is needed.

1.3 Research Question and Objective

This study seeks to answer the following research question (RQ): is it possible to use the CVR-MC system in teacher training to improve teachers' communication skills for classroom climate management? The main objective of this paper is to show our tool validation.

2. CVR-MC Architecture

The work by Bocos Corredor et al. (2020) established the basis of CVR-MC, which is aimed at practicing and improving teaching skills. Consequently, the authors created an environment that allows teachers to experience the climate and emotional factors present in the classroom. Based on this application, several extensions with new functionalities were developed, as shown below:

- Generation of conflictive situations and their corresponding management options: this allows situations to escalate and allows them to be easily generated.
- Tone of voice analysis: changes are detected during key moments of the simulation.
- Analysis of proxemia between interlocutors: distance between interlocutors (student and teacher) is analyzed and will determine the simulation response.
- Keyword detection in conflict management: keywords are classified to determine the response to the simulation and relate them to the user´s emotions.
- Possibility of choosing the execution platform: CVR-MC allows you to choose your preferred execution platform: a virtual reality environment or a desktop environment (PC).
- Analysis of the user´s body expression to establish the predominant emotion: the Perception Neuron and EmoPose system (García-Magariño et al., 2019) captured and analyzed the teacher´s body expression in order to associate it with an emotion.
- Storage of the most relevant parameters of the simulation: during simulation, key parameters are saved for analysis.
- Final feedback to the user after the simulation: final feedback is given to the user about his/her behavior and intention perceived during the simulation.

3. Evaluation of CVR-MC: Participants and Experimental Design

Fourteen participants, all experienced in the education field, were recruited to take part in the first CVRM test. Among them were high school principals, teachers and school counselors, lecturers of the Master's Degree in Training for Primary or Secondary Teachers and students of the Master's Degree in Teaching. The test took 25 minutes to complete and consisted of four stages:

1) *Test explanation*. Users were welcomed by a member of the technical team and were asked to sign the consent document to allow us to record audio and video for educational purposes.
2) *Test*. At this step, users were equipped with all the virtual reality immersion gear. When the user started to practice, a brief description of the environment was shown and the user was expected to simulate a response as if they were in a real classroom. After a short period of time, a disruptive situation would occur and the possible options that the user could choose to perform were shown. The player then had to simulate one of these actions in a natural way. The game recognized one of the paths taken and showed final feedback. Feedback consisted of three screens: 1) It indicated whether the action chosen was the most appropriate one, 2) It showed the main emotion captured by the system during the scene (fear, anger, joy, disgust, surprise or sadness), or 3) It reflected the variation in the tone of the player's voice during the interaction with the virtual students.
   Once the three scenes were completed, the devices were removed and the test recording stopped (see screenshot in Figure 1).

Figure 1. Perception Neuron Suit Calibration using Axis Neuron & Short Video Demonstration. https://youtu.be/r98GoEqEed0.

3) *Post-test Questionnaire*. We administered a questionnaire based on the Technology Acceptance Model (TAM, Davis, 1989). We adapted the questionnaire proposed by Huang et al. (2016), who conducted a similar study in Japan. Eighteen items grouped into three dimensions defined by the TAM were included.
   a) Perceived usefulness: how the user (teacher/teacher in training) perceives that the use of the learning environment (LE) can improve their competence to manage classroom conflicts (8 items). For example: "I felt that my behavior (movements, attitudes, words...) impacted students in the virtual environment."
   b) Perceived ease of use: if the user (teacher/teacher in training) perceives that the use of the LE will not involve any effort for them.
   c) Attitude towards app use: this refers to the emotions (positive or negative) experienced by the user (teacher/teacher in training) in their experience in the LE.
   d) Behavioral intention: how likely is that the user will use the LE as an environment to teach and learn about classroom climate management.

   To illustrate user answers, we used a seven-level Likert scale with the following correspondence: from total disagreement (1) to total agreement (7). For more information about the questionnaire, please contact the authors.

4) *Final interview*. The last stage consisted of a semi-structured interview (see next section) guided by a member of the research team. The interview lasted approximately 15 minutes and it explored the participants' evaluation of the experience, specifically focusing on the feedback provided about their emotions during the execution of the system test. In addition, participants were asked to write down suggestions for possible improvements to the tool.

4. Results

According to the model used to create the test (Davis, 1989), there are two main variables that affect users' acceptance and adoption of new technologies: perceived ease of use (1) and perceived usefulness (2). The answers to the questions in the post-test questionnaire (based on TAM), which users filed after the CVR-MC test, are shown in Table 1.

Table 1: *Summary of the Results Obtained in the Post-Test Questionnaire to Assess Users' Adaptation to CVR-MC (seven-level Likert-type scale)*

Criteria	Number of items	Cronbach's Alpha	Average	SD
Perceived usefulness (PU)	8	0.815	4.7	1.3
Perceived ease of use (UF)	4	0.840	5.1	1.3
Attitude towards the use of the learning environment (UA)	2	0.802	6.1	0.7

Behavioral intention (UI)	3	0.617	6.3	0.8

Questions around PU criteria showed information about the usefulness of CVR-MC, according to users. For this analysis, we added the responses obtained. In order to answer this question, a Cronbach's alpha was carried out, obtaining as a result an alpha of 0.915 and an average of 4.7 in responses. These responses show that users considered that the tool could improve their competence in managing conflicts in the classroom. This matches the positive reception shown by the users in the final interview and their perception of having had a safe environment for the practice of these skills.

Questions related to UF were analyzed with Cronbach's alpha, which produced an average of 5.1, showing that a large part of the users didn't have to make a big effort to use the tool; however, some reported feeling some discomfort. In the interviews, we were able to find out the limitations detected by the participants.

We then analyzed the questions looking at UA criteria (that is, those eliciting information about the attitude towards use), using a Cronbach's alpha that resulted in 0.802 and an average result of 6.1. These results showed that the user experience with the tool was relatively good. This data shows that although virtual reality environments are something new in this sector, they are also exciting and striking.

Finally, questions around UI criteria referred to the users' intention of using the tool. By means of Cronbach's alpha, we analyzed the results and obtained an alpha of 0.617 and an average of 6.3. With this result, and backed up by the interviews, we can conclude that, with certain improvements, the tool could play a part as a complementary use in teacher training:

"It seems a more significant formative experience than others I know because you can directly study a situation by doing a case study and thinking about what you would do. I find it much more interesting when you wear it, when you experience it, of course" (Participant 01).

5. Discussion

RQ: Is it possible to use the CVR-MC system in teacher training in order to improve teachers' communication skills for classroom climate management?

Yes, after analyzing the results we can affirm that our tool has potential to be used as a learning system that can contribute to teacher training. Users agreed that CVR-MC is a highly recommended support tool (4.7 on average) for teachers in training. CVR-MC will allow them to safely practice the necessary techniques to face a conflictive situation. In consequence, it will allow a greater development in their conflict resolution skills.

According to participants experts' comments, the feedback provided by CVR-MC is highly beneficial for trainee teachers (6.3 on average). Similarly, a joint discussion during teacher training can be very constructive and interesting for future teachers. However, we observed how some participants reported learning problems with the tool due to manageability, from which we can deduce that training prior to practical use would be helpful.

6. Conclusions and Future Work

This document presents the ClassroomVR-MotionCapture virtual reality tool that aims to improve the communication skills of secondary school teachers in order to improve conflict management within the classroom. In addition, the tool has been evaluated by experts in secondary education.

The main result we have obtained is that our tool, as confirmed by users, could be very useful in teacher training, as it would allow teachers to improve their skills in solving complex situations in the classroom. Participants highlighted the importance of the system's immersivity and its realism. Moreover, all participants recognized that the tool is a perfect complement to be introduced in the training of new teachers.

Our system sought to extract users' emotions through their corporal expression with a motion capture system. However, the main conclusion is that it is necessary to study how to track body expression in virtual environments. We concluded that, as the participants had to wear all the necessary

devices to enter virtual reality (glasses, controllers and suit), their body expression changed. Consequently, their gestures were much more discreet than those done in real environments. In this sense, our system based on Emopose (García-Magariño et al., 2019), an application capable of inferring emotions through corporal expression, was not prepared for detecting the emotions felt by participants.

As future work, the first step will be to carry on with the study of body movement within virtual reality so that in the future we will be able to detect real emotions in virtual environments.

In addition, we will improve user experience by following some of the participants' suggestions. For instance, to improve the immersion experience we will replace the initial and final explanatory posters of the situation with a recorded audio.

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