Educational Technology International
2023, Vol. 24, No 1, 1-27

https://doi.org/10.23095/ETI.2023.24.1.001


# Scenario Usefulness and Avatar Realism in an Augmented Reality-based Classroom Simulation for Preservice Teacher Training*

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This study aimed to examine an augmented reality-based teaching simulation in a mobile application. We examined how AR-enabled interactions affect users' perceived scenario usefulness and avatar realism. The participants were forty-six undergraduate students. We randomly grouped them into two conditions: AR and Non-interactive video groups with equal sample sizes. This study employed an experimental design approach with a one-way multivariate analysis of variance with repeated measures. The independent variable is the presence/absence of AR interaction with a mobile application. The dependent variables were avatar realism and scenario usefulness. The measures explored how the student avatar's emotional intensity in a scenario influences user perception. The results showed that participants in the AR-interaction group perceived avatar realism significantly higher than those in the non-interactive video group. Also, participants perceived the high emotional intensity scenario (aggression toward peers) to be significantly higher usefulness than the low emotional intensity scenario (classroom disruption).

*Keywords : Teaching simulation, Augmented reality, Mobile application, Classroom management*

* This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2021S1A5B8096558).
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## Introduction

Classroom management skills are essential for teachers to become proficient at creating effective teaching and learning environments for diverse learners (Jones & Jones, 2013). Preservice teachers have to not only acquire pedagogical and subject matter knowledge but also learn classroom management strategies and how to plan and implement them. However, in a distance education situation, preservice teachers are forced to move to an online environment for their training, which does not provide the necessary context for clinical classroom management practices because of the lack of authenticity and limited interactions with students.

To solve this issue and provide authentic practice opportunities for preservice teachers, virtual simulations have been developed, as they allow unlimited training opportunities with realistic student avatars (i.e., SimSchool [Badiee & Kaufman, 2014; Kelleci & Aksoy, 2020] or Mursion [Dalinger et al., 2020]). Although they are not perfect replacements for real classroom settings, virtual simulations are considered to be an innovative approach for preservice teacher training (Kaufman & Ireland, 2016), as they can create a virtual classroom in which preservice teachers can interact with virtual student avatars using multimedia haptic interfaces (Bradley & Kendall, 2014; Kaufman & Ireland, 2016).

Interactions and student avatars are essential design considerations to create classroom management simulations as realistic as possible. Well-designed user interactions are necessary for a high level of virtual presence (Motejlek & Alpay, 2019; Ryu et al., 2006; Shin et al., 2019). For example, requiring users to extend and rotate the 3D objective with their hands or select button responses using their fingers are effective ways to facilitate their engagement in learning activities (Shin et al., 2020). In addition, realistic student avatars influence users' perceived immersion while interacting with them. Because student avatars play the main role in a simulated scenario, how realistic a student avatar is will determine the level of active interaction. Particularly, the emotional intensity a student avatar expresses combined with facial

movements, voice tone, and body gestures all help to increase avatar realism (Larradet et al., 2020; Treal et al., 2020).

## Research Problem

In the interactive simulations, the design of a realistic avatar is an essential part of human-avatar interactions, as it can enhance the immersiveness of scenarios and user engagement by generating expressive and emotive representations of realistic situations (Grinberg et al., 2014). They also present an affective personality when interacting with users with appropriate using their voice, gestures, and facial expressions (Kang & Watt, 2013; Larradet et al., 2020; Treal et al., 2020). Similarly, avatars designed with excessive realism can elicit negative impressions among users because of large discrepancies between the appearance of the avatar and the degree of concordance of its gestures (Nowak & Fox, 2018; Wang & Rochat, 2017). Unpleasant feelings perceived from avatars hinder efforts to improve interaction skills in training simulations (Kang & Watt, 2013; Nowak & Fox, 2018). Thus, building realistic avatars is a critical design consideration to improve the interaction between avatars and users. In this study, we define avatars as interactive virtual characters that users can interact with to experience simulated classroom scenarios.

## Research questions

Given the importance of interaction and avatar design for the effectiveness of a simulation, we tested a teaching simulation for pre-service teachers by designing two types of interactions and two levels of realistic scenarios with different levels of emotional intensity expressed by student avatars. Therefore, the purpose of this study was twofold. First, we examined the effects of AR-enabled interactions in a teaching simulation on users' perceived avatar realism and scenario usefulness. Second, we examined the extent to which the student avatar's emotional intensity in a scenario

influences users' perceived avatar realism and scenario usefulness.

For this purpose, the following research questions were derived:

1. What are the effects of AR-enabled interactions in a teaching simulation on users' perceived avatar realism and scenario usefulness?
2. To what extent does the student avatar's emotional intensity level expressed in a scenario influence users' perceived avatar realism and scenario usefulness?

## Literature Review

### Simulation for preservice teachers

Using an interaction scenario repository designed and expanded to emulate various realistic classroom situations (Park & Ryu, 2019), preservice teachers can experience various simulation scenarios repeatedly without worrying about making mistakes or having adverse effects on vulnerable students' learning (Carrington et al., 2011). To effectively address and control student behaviors in the classroom, preservice teachers need to learn how to interact with students (Evertson & Weinstein, 2006) by actively implementing classroom management practices. Many teacher preparation programs require that preservice teachers complete clinical field experience programs at local schools before graduation.

Simulation for Teaching Enhancement of Authentic Classroom beHavior EmulatoR (SimTEACHER) is a mixed reality-based teaching simulation (Park & Ryu, 2019) in which preservice teachers can receive unlimited training while directly interacting with virtual student avatars. SimTEACHER requires a curved screen to create an immersive perception experience; moreover, the newest version of SimTEACHER can be used with a head-mounted display (HMD) to enhance 3D spatial perception (Ryu & Kim, 2020). Although it can create a highly interactive

virtual experience, SimTEACHER requires the use of standalone equipment onsite. This simulation may not be an effective alternative when remote access is necessary because of urgent situations.

SimTEACHER-M is a mobile version of SimTEACHER that was developed to support the remote training needs of preservice teachers, especially when their training options are strictly limited. It allows easy access and individualized training experiences on a mobile platform. Classroom management scenarios are presented in the form of interactive simulations. Preservice teachers are able to interact with realistic student avatars and implement various classroom management strategies. Furthermore, the user's log data are saved on a cloud web server and can be analyzed to evaluate the user's behavior with the mobile application.

## Avatars and scenarios in teaching simulations

Avatar realism consists of visual realism and behavioral realism (Kang & Watt, 2013; Nowak & Fox, 2018). Visual realism refers to the degree to which an avatar depicts the visual features of communicators in a specific context. In other words, an avatar needs to represent the actual object that it denotes, and the avatar's appearance must be human-like and represent the characteristics of the intended character. Behavioral realism refers to the degree to which an avatar exhibits realistic human interactions, such as kinetic conformity and social appropriateness, by performing dynamic movements and following social norms and manners. Realistic avatars can improve social presence, which further engages users and enables them to become immersed in a simulation. In short, interactive avatars need to be designed with both visual and behavioral realism, which will further impact a user's interaction, communication, and sense of immersion.

According to Johnson et al. (2018), several design elements must be considered to achieve realistic interactions between avatars and humans, including voice communication, emotion expressions, gestures, and natural interactions. Emotional

reactions are natural responses that occur when communicating in the real world; hence, an avatar's emotional expressions need to be sufficiently realistic for a user to respond and interact naturally. Nonverbal body gestures and facial expressions reinforce realistic emotional expressions by building a rapport between the avatar and user (Gonzalez-Franco et al., 2020; Kruzic et al., 2020).

Scenarios in simulations present specific events that reflect real-world situations (Papadopoulos, 2019). Authentic simulation scenarios are key to designing a successful simulation. For example, when developing *SIMPROV*, a classroom management training simulation, Nordvall et al. (2014) suggested that the scenarios should deliver plausible dilemmas with sufficient complexity so that they are interesting to ensure authentic simulations depicting problem situations.

A scenario-based approach is particularly important for training because it can provide a series of authentic problem situations that are intended to improve users' training outcomes without having any harmful effects. Rosson and Carroll (2002) proposed a scenario-based design method that follows three steps: problem scenarios, activity scenarios, and information/interaction design scenarios. In the first step, problem scenarios, the details of the problematic situation the user encounters are described. In the second step, activity scenarios, specific ideas, and episodes about the actions and behaviors of avatars in the problem situation are designed as well the user's expected reaction and responses. In the last step, information and interaction design scenarios, the sequence of actions/dialogues are created to demonstrate the interactions between the user and avatars.

While the scenarios provide context and background information for users, realistic avatars within the scenarios increase the authenticity and immersive sense of the situation. Therefore, avatars with few details and emotional expressions could influence the user's perception of the given scenarios as well as the effectiveness of the simulation. Previous studies have categorized the intensity of challenges in classroom management scenarios into different levels of student behaviors. In Basutista and Boone (2015)'s study, student behavioral levels were categorized into

five levels with corresponding explanations, ranging from the "0" level (no classroom misbehavior) to the "5" level (distraction, inattention, resistance, and bullying at high frequency). Similarly, Gregory et al. (2013) described the characteristics of disobedient students as walking around the classroom or talking to peers without paying attention to the teacher. Behavior classification levels provide a good reference to design diverse levels of classroom management scenarios based on simulated behaviors, although McGarr (2020) indicated that the behavior levels need to be considered carefully in the context of cultural, social, and individual differences.

## User Interactions in AR

Immersion and virtual presence are key design considerations when developing a training simulation (Rim & Shin, 2021; Turchet, 2015) because a strong sense of immersion makes it easy for users to transfer their training skills to real situations (Selzer et al., 2019). For this reason, in virtual learning, virtual presence and immersion have been used to define well-structured simulations. Well-designed interactions are essential elements for a high virtual presence (Motejlek & Alpay, 2019; Shin et al., 2019). The user's physical interactions, such as extending and rotating the 3D objective with their hands and selecting the button responses, can facilitate the user's engagement in training (Shin et al., 2020). These manipulations then help the trainees to enter into an immersive learning environment and increase the users' virtual presence (Ryu et al., 2006; Smink et al., 2020). Requiring verbal interactions with emotional avatars also affects the user's virtual presence and immersion. An emotional interaction in a simulation provides the users with contextual cues and can increase social presence (Schultze & Brooks, 2019). An emotional verbal interaction requires the users to engage their emotions similar to in-person conversations.

According to Shin et al. (2020), user interactions in augmented reality (AR) are classified into two types: physical interactions and verbal interactions. Physical interactions include manipulating, controlling, augmenting, staring, observing, and

rotating 3D objects between the users and virtual objects (Ryu et al., 2006) and support higher engagement. Verbal interactions are closely related to avatars' representations. Interactions with other avatars facilitate sophisticated interactions with the user. In this study, we designed AR interactions with the aim of increasing users' active engagement with student avatars in *SimTEACHER-M*. Scenario usefulness is another important consideration when attempting to maximize the potential of virtual simulations (Sabbagh et al., 2020). To develop highly immersive simulations, a user needs to perceive the simulated training to be as useful as possible. To do so, training simulation scenarios need to be constructed and continuously refined to reflect the complexity of the simulated situation (Lu et al., 2020; Sabbagh et al., 2020). The effectiveness of simulation training depends on the degree of its diversity and complexity (Sabbagh et al., 2020). Therefore, it is necessary to ensure that scenarios are designed with realistic, diverse, and complex details so that users perceive them to be useful for achieving their training goals.

## Method

### Participants

Forty-six undergraduate students enrolled in a flagship public university in the southwest region of South Korea voluntarily participated in this study. There were 27 female students (58.7%) and 19 male students (41.3%). The average age of the participants was 25.56 years ($SD$=10.89), ranging from 20 to 35 years. Table 1 shows the demographic information between the two groups. The participants are not all pre-service teachers, but they are diverse majors students. The AR group has 12 females (52.0%) and 11 males (48.0%), and the video group has 15 females (65.2%) and 8 males (34.8%). All participants were compensated after completing the study. Because of the limitations placed on the study protocol, the study was conducted via

a series of ZOOM meetings. All participants were randomly assigned to study groups and invited to join a video meeting individually according to their assigned group. Then, they were given the study directions with the assigned SimTEACHER-M conditions. The entire study session was conducted over 1 week with a small number of participants, ranging from three to eight each day.

Table 1

*Questions for Avatar Realism and Scenario Usefulness(N=46)*

| | Major | | | Grade | | | |
|---|---|---|---|---|---|---|---|
| | Engineering & Science | Humanities & Social | Miscellaneous | Freshman | Sophomore | Junior | Senior |
| AR | 7 | 11 | 5 | 3 | 9 | 1 | 10 |
| (*n*=23) | (30.4%) | (47.9%) | (21.7%) | (13.0%) | (39.1%) | (4.3%) | (43.5%) |
| Video | 6 | 14 | 3 | 1 | 3 | 8 | 11 |
| (*n*=23) | (26.1%) | (60.9%) | (13.0%) | (4.3%) | (13.0%) | (34.8%) | (47.9%) |

## Ethical considerations

The study was approved by the institutional review board (IRB) of Chonnam National University (1040198-200820-HR-090-02). All participants acknowledged their voluntary participation and rights to withdraw from the study at any time. All informed consent forms were collected on the Google Doc platform before participation in the study, as data collection was conducted online.

## Variables and Measures

The independent variable in this study was the type of interaction between the student avatars and the users in SimTEACHER-M: AR-enabled interactions vs. no interactions and viewing pre-recorded video clips instead. Participants in the AR interaction group downloaded the SimTEACHER-M application on their mobile phones before joining the study and actively interacted with student avatars using AR

in simulated classroom management scenarios. In contrast, students in the non-interactive video viewing group watched the simulation scenarios without interacting with student avatars.

The two dependent variables were the participants' perceptions of avatar realism and scenario usefulness that they experienced. To measure avatar realism, the student avatar's gestures, voice, and response to users were assessed using three survey items (Yang, et al., 2021a). Scenario usefulness was measured using the participants' perceptions of whether the scenario was appropriate, effective, and practical for classroom simulations using six survey items (Yang, et al., 2021b). All items used a 7-point Likert scale. The internal consistency (Cronbach alpha) of the avatar realism scale was .68 for the first scenario and .88 for the second scenario. The internal consistencies of the scenario usefulness scale were .82 and .87 for the first and second scenarios, respectively. The survey questions are presented in Table 2.

Table 2

*Questions for Avatar Realism and Scenario Usefulness*

| Variables | Questions |
|---|---|
| Avatar realism | ▫ The behavior of the student avatar was realistic.<br>▫ The student avatar's voice was natural.<br>▫ The student avatar reacted like a real person during a conversation. |
| scenario usefulness | ▫ This scenario will help pre-service teachers improve their teaching skills.<br>▫ If we use this scenario, we will be able to effectively educate pre-service teachers<br>▫ Through this scenario, I was able to experience possible situations that I may encounter in classroom.<br>▫ This scenario will be a useful example to include in simulated classes for pre-service teachers.<br>▫ The examples in this scenario provided valuable training for pre-service teachers.<br>▫ This scenario consists of what might actually happen, and I could feel the atmosphere in the classroom. |

## Architecture of SimTEACHER-M

SimTEACHER-M is a mobile simulation that runs on a smartphone with AR activation cards for interaction. From an architectural perspective, SimTEACHER-M consists of three modules: 1) scenario introduction, 2) student avatar interaction, and 3) evaluation. Figure 1 shows how the modules are connected to each other and built into SimTEACHER-M. First, the scenario introduction module provides the user with situational awareness of a classroom problem.

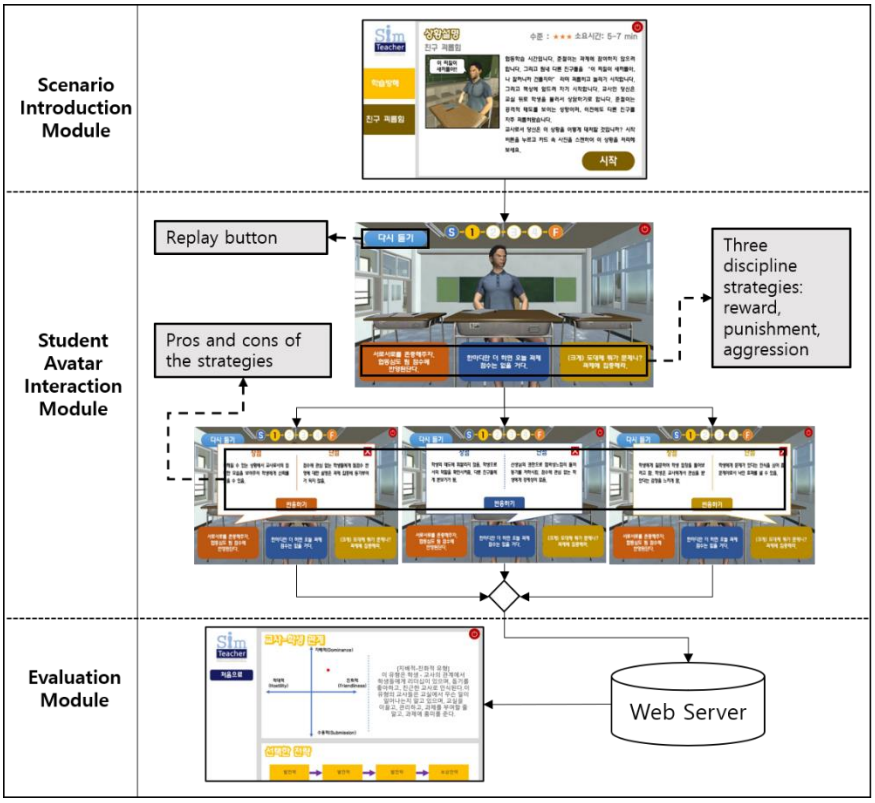


*Figure 1.* Modules of SimTEACHER-M (AR-group only)

Second, the avatar interaction module involves interaction with the student avatar. In this module, the student avatar engages in verbal interactions with gestures and

facial expressions to argue with the user, who is supposed to be a classroom teacher in this simulation. We applied the interpersonal teacher behavior model (Wubbels & Brekelmans, 2005) in which the relationship between teacher and student significantly affects the student's motivation and behavior. In this simulation, SimTEACHER-M presents three discipline strategies (Punishment, Recognition and Reward, and Aggression) on the smartphone screen. The user can select one of the three strategies (De Jong et al., 2014). During the avatar interaction module, the user's selection is sent to the web server to calculate the score for their interpersonal trait.

Third, the evaluation module is presented to the user to show the interpersonal trait result. The information for the result is sent from the web server to SimTEACHER-M, and in the evaluation module, the average score for discipline strategies is presented using a two-dimensional coordinate system.

## Scenarios

For this study, two scenarios were presented. The first scenario emulated a student disrupting the classroom and was designed as a low-intensity emotional intervention. In this scenario, the student avatar argues that he cannot concentrate on the lesson. Finally, he exhibits poor behavior, such as talking to others, knocking on the desk, or asking questions unrelated to the class. When the student avatar starts to whine at the user, three teacher behaviors are shown on the screen for selection. The second scenario was designed as a high-intensity intervention with aggression toward peers. In this scenario, the student avatar expresses aggressive behavior, including not participating in a group activity, bullying peers, cursing, and becoming violent. This scenario involves a higher level of conflict than the first scenario, and it requires a stronger emotional intervention.

Butler and Monda-Amaya (2016) listed challenging behaviors that preservice teachers perceive as being difficult to handle according to intensity. "Physical aggression" and "bullying" were determined to be the most difficult behaviors to handle, but "talking out of turn" and "being late to class" were perceived as the least

difficult behaviors. The first scenario, "classroom disruption," involves "making noises" and "side conversations during lecture or activity," which rank 21st among the 27 most challenging behaviors. The second scenario, "aggression toward peers," involves "bullying" and "angry" behavior, which are the third and ninth most difficult behaviors. Thus, the first scenario (classroom disruption) is less challenging than the second scenario (aggression toward peers). Each scenario consists of a total of four decision steps. The four steps progress to become more serious: trigger, agitation, acceleration, and peak. These four steps are based on a seven-phase model for describing acting-out behavior (Colvin & Scott, 2014).

## Experimental design

This study employed an experimental design approach with a one-way multivariate analysis of variance (MANOVA) with repeated measures. The repeated factor in this study was the level of emotional intensity presented by student avatars in two subsequently presented scenarios. The first scenario presented a class management case involving a mild classroom disruption by a student avatar with low emotional intensity.

Table 3.
*Experimental design(N=46)*

| Group | Scenario 1 (Classroom disruption) | Scenario 2 (Peer bullying) |
|---|---|---|
| AR-interaction Group($n$=23) | $O_1$ | $O_2$ |
| No interaction Group($n$=23) | $O_3$ | $O_4$ |

$O_1$, $O_3$: answer to questionnaire after scenario 1 experience (avatar realism, scenario usefulness)
$O_3$, $O_4$: answer to questionnaire after scenario 2 experience (avatar realism, scenario usefulness)

The second scenario presented a class management case involving extreme peer bullying by a student avatar with high emotional intensity. The presentation sequence of the two scenarios was identical between the AR interaction group and the video viewing group. The AR-enabled interaction was employed as a between-group treatment, while the level of emotional intensity was analyzed as a within-effect. Table 3 shows the experimental design.

## Procedure

The experiment was conducted on the ZOOM meeting platform. The moderators and the participants accessed the ZOOM meeting room, and the participants were instructed to download SimTEACHER-M on their own mobile phones. The experiment moderator explained how to use the application and classroom situation. Figure 2 describes how the experiment was conducted via the ZOOM meeting.

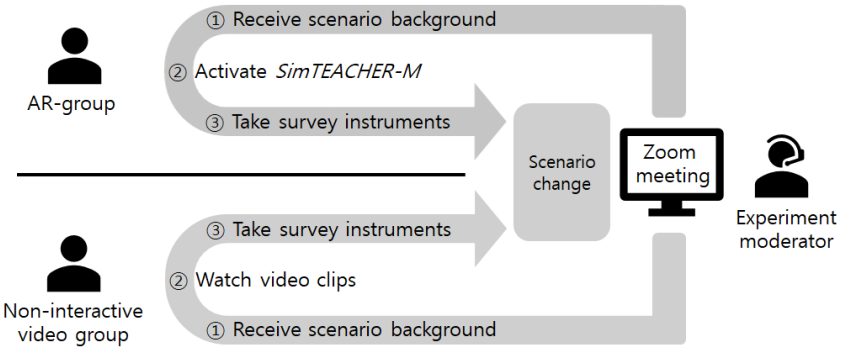


*Figure 2.* Experimental procedure for the two groups in a ZOOM meeting

The AR group was asked to launch SimTEACHER-M; then, a trigger image was shown on the ZOOM screen to activate the first scenario. When the participants completed the interaction, the questionnaire link was provided so they could complete a Google survey. After all the participants submitted the questionnaire on the first scenario, the second trigger image was shown on the ZOOM screen. The

participants followed the second cycle to complete the experiment. In the non-interactive video group, the participants were asked to watch a video clip. The video clip was provided through a URL link. In this group, the participants could not select a response, and just watched the most common response choice for each scenario.

The interactive AR group took approximately 7 minutes to complete each scenario. The video group took approximately 4–5 minutes to watch each video. The total time to complete the experiment for each participant was about 25 minutes. Figure 3 shows a participant in the interactive AR group performing the experimental task. For this study, a one-way MANOVA with repeated measures was conducted using SPSS v.25. The significance threshold was set at .05.

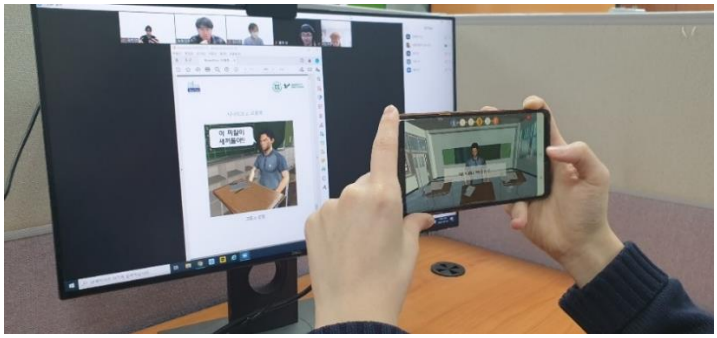

*Figure 3. AR-group participation*

## Results

(RQ1) What are the effects of AR-enabled interactions in SimTEACHER-M on users' perceived avatar realism and scenario usefulness?

In the data analysis, the main effects of the interaction type were tested for two dependent variables: scenario usefulness and avatar realism. The significance level for all analyses was set at $a < .05$ (Field, 2013). A one-way MANOVA with repeated

measures was conducted with a between-subject factor of interaction levels (AR interaction group vs. non-interactive video group). Preliminary analyses revealed that all required assumptions were not satisfied. For the mean score of avatar realism, the results of Levene's test were $F$ (1, 44) =.78 with $p$ = .382 and $F$ (1, 44) = 6.41 with $p$ = .015 for avatar realism in the "classroom disruption" and "aggression toward peers" scenarios, respectively. The mean scores for scenario usefulness were similar. The results of Levene's test were $F$ (1, 44) =.45 with $p$ = .507 and $F$ (1, 44) = 5.20 with $p$ = .028 for the "classroom disruption" and "aggression toward peers" scenarios, respectively. However, a further analysis was performed because of the equal sample sizes of the treatment groups. It was concluded that there were no outliers in the data.

Table 4.

*Means and Standard Deviations for Avatar Realism (N = 46)*

| | Scenarios | AR-group ($n$ = 23) | Video-group ($n$ = 23) | Total |
|---|---|---|---|---|
| Avatar realism | Classroom Disruption | 6.25 (*SD*=.66) | 5.80 (*SD*=.83) | 6.02 (*SD*=.77) |
| | Aggression toward Peers | 6.57 (*SD*=.53) | 5.67 (*SD*=1.20) | 6.12 (*SD*=1.03) |
| | Total | 6.40 (*SD*=.47) | 5.73 (*SD*=.79) | |

[a] Avatar realism was measured using the Likert scale ranging 1-7

Table 4 presents the means and the standard deviations for two dependent variables, scenario usefulness and avatar realism, for the two groups. The results indicated that there was an overall significant difference between the AR interaction group and the non-interactive video group, $F$ (2, 43) = 8.60, $p$ = .001; Wilks' $\lambda$ = .71, partial $\eta^2$ = .29. A further univariate analysis of variance (ANOVA) for each dependent variable revealed a significant difference in avatar realism, $F$ (1, 44) = 12.22, $p$ = .001, partial $\eta^2$ = .22, between the AR interaction group ($M$ = 6.40, $SD$ = .47) and the non-interactive video group ($M$ = 5.73, $SD$ = .79). However, there

was no significant difference in scenario usefulness between the two groups, $F$ (1, 44) = .09, $p$ = .764, partial $\eta^2$ = .00.

(RQ2) To what extent does the student avatar's emotional intensity level expressed in a scenario influence users' perceived avatar realism and scenario usefulness?

To determine the effect of the student avatar's emotional intensity, the effect of the within-subject factor of emotional intensity level was assessed in a low emotional intensity scenario and high emotional intensity scenario, which were viewed consecutively. Table 5 presents the means and standard deviations for avatar realism and scenario usefulness to compare the two scenarios. The results indicated that there was an overall significant difference between the low emotional intensity and the high emotional intensity scenarios, $F$ (2, 43) = 9.03, $p$ = .001; Wilks' $\lambda$ =.70, partial $\eta^2$ = .30. A further univariate ANOVA for each dependent variable revealed a significant difference in scenario usefulness between the low emotional intensity ($M$ = 5.97, $SD$ = .63) and the high emotional intensity scenarios, ($M$ = 6.26, $SD$ = .61), $F$ (1, 44) = 15.95, $p$ = .000, partial $\eta^2$ = .27. However, there was no significant difference in avatar realism between the two scenarios, $F$ (1, 44) = .36, $p$ = .553, partial $\eta^2$ = .01.

Table 5.

*Means and Standard Deviations Scenario Usefulness (N = 46)*

| | Scenarios | AR-group ($n$ = 23) | Video-group ($n$ = 23) | Total |
|---|---|---|---|---|
| Scenario usefulness | Classroom Disruption | 5.95 ($SD$=.56) | 5.99 ($SD$=.70) | 5.97 ($SD$=.63) |
| | Aggression toward Peers | 6.33 ($SD$=.45) | 6.20 ($SD$=.74) | 6.26 ($SD$=.61) |
| | Total | 6.14 ($SD$=.46) | 6.09 ($SD$=.66) | |

[a] Scenario usefulness was measured using the Likert scale ranging from 1-7.

# Discussion and Conclusions

## Discussion

In this study, a mobile adaptation of a teaching simulation, SimTEACHER-M, is presented as a potential training tool for preservice teachers in online classes or as a means to support their independent training when on-site field experiences are not feasible. The research also empirically examines two primary design elements of SimTEACHER-M: the mode of interaction and the emotional intensity of student avatars in simulation scenarios. The study investigates how these design elements influence users' perceptions of avatar realism and scenario usefulness. The empirical findings reveal that participants rate student avatars as significantly more realistic when interacting with them through AR interfaces than merely observing a simulation video with minimal interaction.

Moreover, participants report a significantly elevated level of simulation usefulness when the student avatar's emotional intensity is high rather than low. Given that attaining a high level of realism and usefulness for SimTEACHER-M is a priority to ensure users experience authentic and realistic teaching simulations, these findings illuminate the design factors that contribute to the successful implementation of SimTEACHER-M.

First, participants indicate that avatars appear more realistic when interacting via the AR interface. Although interaction designs employing AR interfaces are not widely used in training simulations, AR has gained popularity for supporting training and learning models (Garzon et al., 2020) and has been extensively used across various educational levels due to its intuitive interaction support (Akçayır & Akçayır, 2017). As AR enables direct interactions with digital content, it creates a more robust perception of immersion than passive observation (Smink et al., 2020). While prior teaching simulation studies have focused on manipulating screenshots to observe avatar characters with varying psychological distances (e.g., Kim et al., 2017), this

study explores AR interactions' benefits. Student avatars were depicted on paper, displayed on-screen, and activated using a mobile phone. Initially, participants perceived student avatars as two-dimensional static images; however, upon activation on a mobile phone, they transformed into three-dimensional animated characters.

Consequently, interaction experiences through the AR interface likely influenced the participants' perceptions of the student avatar's realism. They actively engaged with AR interactions and were more immersed in interactions with the student avatars. This embodied interaction with technology has been found effective for learning and engagement (Lindgren et al., 2016).

Second, participants reported a higher degree of perceived scenario usefulness when the given scenarios were more realistic, detailed, and featured intense emotional expressions by the student avatars. Davis (1989) expounded in his Technology Acceptance Model that perceived usefulness is the extent to which a user believes technology would enhance their job performance (Davis, 1989). In other words, users are likely to believe that a training simulation would assist with their job if they perceive it as a helpful technology. Users' affective experiences significantly impact the outcomes of their subjective appraisals of tasks in the learning process (Pekrun & Perry, 2014). In particular, interest as an affective experience initiates the motivation to explore new tasks and encourages active information-seeking behaviors (Izard & Ackerman, 2000; Keller, 2010). In this study, the users showed strong interest when the intensity of emotional expressions increased in the simulation. Their affective experiences may have influenced their perception of the scenario's usefulness.

Ensuring that users perceive simulation scenarios as applicable and avatars as realistic is crucial. The users can perceive the simulation, enabling them to participate in the training with high motivation actively. The findings of this study provide not only insights into the design of the specific mobile-based teaching simulation but also empirical evidence to assist simulation designers in making informed design decisions.

## Conclusions

Based on the research findings, simulations should incorporate situations or events that engage and elicit users' emotions to increase their efficacy and relevance (Nordvall et al., 2014; Sabbagh et al., 2020). In conclusion, classroom training is essential for developing effective teachers. However, as the demand for distance education grows and field training becomes increasingly challenging, it is nearly impossible for preservice teachers to access such training opportunities. A mobile version of SimTEACHER can provide realistic, engaging, and valuable virtual classroom management experiences through scenario-based classroom simulations in augmented reality (Shin et al., 2020). This study's findings provide design considerations for fostering interactions between users and student avatars and creating realistic student avatars. Teacher training programs should contemplate the advantages of alternative training opportunities using mobile simulations for preservice teachers.

This study has several limitations. First, it was conducted remotely via the online conferencing system (ZOOM). Although we followed the study procedure with the experimental protocol, this data collection method was unfamiliar to participants and may have influenced their perceptions. Nonetheless, this novel approach demonstrated the potential for using online conferencing systems to conduct research during global emergencies.

Second, this study primarily examined two design factors for creating a highly realistic and helpful teacher training simulation but did not consider users' performance as an outcome variable. Since the ultimate objective of SimTEACHER-M is to enhance preservice teachers' confidence and self-efficacy in classroom management, future studies should investigate how utilizing SimTEACHER-M supports their classroom management performance. Additional research is required to explore how users' log data, stored on a cloud web server, can be analyzed to evaluate their behavior and decision-making in SimTEACHER-M. Moreover, the

designers of teaching simulations should be aware of technical challenges when implementing the simulation in authentic classroom settings. Key stakeholders, including teachers, trainers, and school administrators, must be considered to facilitate its integration into virtual training environments. Qualitative studies should be employed to understand their perspectives better and further explore detailed learning experiences and training needs.

Third, the study's participants were limited to individuals with diverse academic backgrounds. Although the research aimed to examine perceptions and experiences of scenarios and avatars, the ultimate stakeholders of this simulation are preservice teachers. As a result, future studies should focus on conducting experiments with preservice teachers to obtain more relevant data.

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Received: March 8, 2023 / Peer review completed: April 15, 2023 / Accepted: April 17, 2023