A Nonverbal Immediacy Treatment with Pre-Service Teachers Using Mixed Reality Simulations

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A Nonverbal Immediacy Treatment with Pre-Service Teachers Using Mixed Reality Simulations

Gloria L. Rosati-Peterson1, Jody S. Piro1*, Carrie Straub2 and Catherine O’Callaghan1

Abstract: The purpose of this mixed method embedded design study was to examine the effect of a treatment package consisting of video and reflection, video feedback, and coaching on pre-service teachers’ use of nonverbal immediacy behaviors as they delivered lessons to student avatars in mixed reality simulations. Pre-service teachers delivered lessons at three points of time over the course of a semester within a teacher preparation course. Following each simulation, participants received three components of a treatment package targeted at improving nonverbal immediacy behaviors of teachers. The quantitative data were collected via nonverbal immediacy scores. Qualitative data were collected via observations of simulations and participant exit interviews. Statistical analysis resulted in a significant difference in pre-service teachers’ nonverbal immediacy when Time 2 and Time 3 were compared. An analysis of qualitative data resulted in two findings. Finding one was: Video and reflection, video feedback, and coaching fostered pre-service teachers’ reflections on the simulated environment as they delivered lessons within the simulations. Finding two was: Video and reflection, video feedback and coaching within a mixed reality simulation environment improved pre-service teachers’ use of nonverbal immediacy behaviors in student interactions. Connections to literature and implications are provided.

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The authors research mixed reality simulations in educational settings related to constructs such as self-efficacy, liminal learning, and anxiety with pre-service educators. This current research examined nonverbal immediacy skills, which are behaviors such as smiling, eye contact, use of gestures, and having a relaxed body position, that decrease the physical and perceived psychological distance between teachers and students to promote positive student outcomes.

PUBLIC INTEREST STATEMENT

Mixed reality simulations are an emerging technology that allow for pre-service teachers to interact with student avatars to practice skills and rehearse teaching strategies in a safe environment without impacting real students. This study examined how the use of video and reflection, video feedback, and coaching within mixed reality simulation environments were utilized within a teacher preparation program to develop teacher nonverbal immediacy skills that aligned with high leverage practices.
Subjects: Newly Qualified Teachers; Newly Qualified Teachers; Teachers & Teacher Education; Technology in Education

Keywords: Immediacy skills; pre-service teacher education; simulation learning technology in teacher education

The art of teaching is communication-rich, employing verbal, nonverbal and written modalities. Teachers and students, consciously and subconsciously, send and receive messages that can convey cognitive and affective information as they interact in the classroom (Miller, 2000). Research in communication indicates that the majority of what we communicate is done through nonverbal behaviors (Burgoon et al., 1996). Teachers must be able to effectively communicate with students to promote positive learning outcomes (Hunt et al., 2002), including communicating in non-verbal ways.

Nonverbal immediacy skills include nonverbal communication behaviors such as smiling, use of proximity, gesturing, and having a relaxed posture that indicate openness for communication. Teachers’ use of nonverbal immediacy behaviors have positive effects on students (Burroughs, 2007; Christophel, 1990; V.P. Richmond et al., 2003; Witt et al., 2004). Students of teachers who are perceived as more immediate exhibit more compliant classroom behaviors (Burroughs, 2007; Kearney et al., 1988), be more motivated to attend class, and experience positive learning outcomes (LeFebvre & Allen, 2014; Witt et al., 2004). Pre-service teachers may be able to practice and refine nonverbal immediacy skills within technology rich environments, such as mixed reality simulations.

Mixed reality simulation environments are an emerging technology that allow for pre-service teachers to interact with student avatars to practice skills and rehearse teaching strategies in a safe environment without impacting real students (Dieker et al., 2017; L Dieker et al., 2008; Dieker et al., 2013). Mixed reality environments lie in the middle of a continuum between actual reality and virtual reality (Milgram & Kishino, 1994). A mixed reality simulation environment combines elements of reality and virtual reality. Teacher candidates interact in a classroom with virtual student-avatars as they deliver lessons (Dieker et al., 2013; O’Callaghan & Piro, 2016). Simulated learning environments allow for pre-service teachers to practice communication and pedagogical skills with student avatars before honing their competencies with live students (Dieker et al., 2017, 2013; Pankowski & Walker, 2016).

There is an emerging body of research within the field of education on the use of virtual learning environments in teacher preparation programs (Dieker et al., 2013; Judge et al., 2013); however, few studies have examined the impact of using mixed reality simulations to promote communication competencies (Taylor et al., 2017; Walker et al., 2016). This study examined how the use of video and reflection, video feedback, and coaching within mixed reality simulation environments were utilized within a teacher preparation program to develop teacher nonverbal immediacy skills that aligned with high leverage practices.

1. Literature review

1.1. Immediacy

The immediacy construct, often proposed to be grounded in approach-avoidance theory (Mehrabian, 1971; Witt et al., 2010, 2004), evolved from the work of Albert Mehrabian (1971, 1972)) who described his “principle of immediacy” and stated that, “people are drawn toward persons and things they like, evaluate highly, and prefer; and they avoid or move away from things they dislike, evaluate negatively, or do not prefer” (Mehrabian, 1971, p. 1). Immediate communication behaviors decrease the perceived physical or psychological distance between people and include verbal and nonverbal behaviors that convey warmth, positive affect, approachability, and availability for communication (Andersen, 1978, 1979; Mehrabian, 1971; V. P. Richmond et al., 2008; Velez & Cano, 2008). Nonimmediate behaviors can signal unfriendliness, disinterest, and even hostility (V. P. Richmond
et al., 2008). Immediate behaviors relate to an approach tendency while nonimmediate behaviors relate to an avoidance tendency (Mehrabian, 1971; V. P. Richmond et al., 2008). V. P. Richmond et al. (2008) suggest a communication immediacy principle from the communicator’s point of view in that, “the more communicators employ immediate behaviors, the more others will like, evaluate highly, and prefer such communicators; and the less communicators employ immediate behaviors, the more others will dislike, evaluate negatively, and reject such communicators” (p. 191). Mehrabian (1971) also addressed the reciprocal nature of immediacy stating that, “immediacy and liking are two sides of the same coin. That is, liking encourages greater immediacy and immediacy produces more liking” (p. 77). Thus, in human communication interactions, the sender’s use of immediate behaviors influences perceptions by the receiver in the communication dyad.

Within educational contexts, verbal immediate behaviors include addressing students by name, using inclusive pronouns (e.g., “we” versus “I”), including personal examples, praising students, and using humor in class (Gorham, 1988). Nonverbal immediacy behaviors include smiling, eye contact, use of gestures, and having a relaxed body position (Andersen & Andersen, 2005; McCroskey & Richmond, 1992; V. P. Richmond et al., 2008; Woolfolk & Brooks, 1985) that can decrease the physical and perceived psychological distance between teachers and students to promote positive student outcomes (Gorham, 1988; Mehrabian, 1971; Nayernia et al., 2020).

Teacher’s use of nonverbal immediacy behaviors has been shown to affect students’ levels of motivation, compliance, affective learning, and academic achievement (Burroughs, 2007; Christophel, 1990; Kyaruzi et al., 2019; Witt et al., 2004). To understand the construct of immediacy in the educational context, and its impact on positive educational outcomes, a focused review of empirical research was conducted. Explorations included the effect on student learning, motivation, and behavior management for successful student academic outcomes. Most of the literature on the impact of teachers’ nonverbal immediacy on student educational outcomes are studies that were conducted within higher education settings and are included in the review.

1.2. Immediacy and teacher effectiveness

The construct of immediacy was first applied to the educational context by Andersen (1978, 1979) in her seminal work which examined the construct of teacher immediacy and its impact on teacher effectiveness (Ozmen, 2010) and spurred subsequent investigations of teacher immediacy and its relationship with student learning (Witt et al., 2004). Teacher effectiveness was conceptualized as the ability of teachers to produce cognitive, affective, and behavioral student learning.

Teacher nonverbal immediacy was examined as a possible predictor of cognitive, affective, and behavioral learning (Andersen, 1979). Data were collected from 238 college students enrolled in an introductory communications course (n = 238) taught by 13 different professors (n = 13) simultaneously. Four aspects of affect were examined in the study. Student affect toward the communication practices suggested in the course, the content of the course, the course instructor, and the course in general, was measured using previously validated scale instruments. Two aspects of students’ behavioral commitment, the likelihood of attempting to engage in practices suggested in the course and the likelihood of enrolling in another course of similar content, were measured using four semantic differential scales (Andersen, 1979). Student performance on a 50-item multiple choice exam served as the measure of cognitive learning for this investigation. The construct of immediacy was measured using two instruments, the Behavioral Indicators of Immediacy Scale (BII) and the Generalized Immediacy Scale (GI). The BII, a 15-item, Likert-type scale instrument, examined specific nonverbal behaviors related to the immediacy construct (e.g., instructor use of gesturing, smiling, eye contact, and vocal expressiveness) while the GI scale, a 9-item scale instrument, measured the students’ general perception of the level of immediacy of their instructor (Andersen, 1979).

Multiple regression statistical analysis was employed to determine the predictive role of teacher nonverbal immediacy in affective, behavioral, and cognitive learning. Andersen (1979) found that
immediacy contributed 21.93% of the variance in student affect toward communication practices suggested in the course \( F(2/235) = 33.01, 19.19\% \) of the variance in student affect toward the content of the course \( F(2/235) = 27.90, 13.37\% \) of the variance in student affect toward the course in general \( F(2/202) = 15.59 \) and 46.32% of the variance of student affect toward the instructor \( F(2/235) = 101.41 \). Andersen (1979) found that with respect to behavioral commitment and students’ likelihood of engaging in the communication practices as suggested in the course, immediacy predicted 18% of the variance \( F(2/235) = 25.80 \). Additionally, Andersen’s (1979) results revealed that teacher immediacy also predicted 18.31% of the variance in students’ likelihood of enrolling in a course of similar content \( F(2/235) = 26.34 \).

Teacher immediacy, however, did not significantly predict students’ measure of cognitive learning in the study. Andersen (1979) noted that the single score on the exam may not have accurately measured cognitive learning. Additionally, she suggested the possibility that the timing of the measure, administered early in the semester, may not have allowed for the relationship to develop. Andersen (1979) suggested that “teacher-student relationships may be improved by teaching teachers to be more immediate,” (p. 557) as the results indicated that nonverbal immediacy is a strong predictor of student affect toward the instructor.

1.3. Teacher immediacy and student learning

The introduction of a measure of cognitive learning, a perceived “learning loss” measure (Richmond, McCroskey, & Johnson, 2003), spurred several studies that were used to explore the relationship of nonverbal immediacy and perceived cognitive learning (Witt et al., 2004). The “learning loss” score was obtained by asking participants to rate their level of learning in a class on a zero through nine scale (Richmond, McCroskey, et al., 1987). Secondly, respondents followed the same procedure about their level of perceived learning had they had an ideal instructor. The first rating was subtracted from the second, which resulted in a “learning loss” score. This measure served to adjust the initial rating of cognitive learning to consider students’ preconceived attitudes toward certain classes (Richmond, McCroskey, et al., 1987).

In their meta-analysis of 81 studies \((n = 24,474)\), Witt, Wheeless, and Allen (2004) examined the relationship between immediacy and student cognitive, affective, and perceived learning. The scholars created a “perceived learning” category before conducting their investigation “…because of the large number of studies using the learning loss measure and the questions surrounding the validity of learning loss as a cognitive measure” (Witt et al., 2004, p. 198). Results of the meta-analysis revealed a strong, positive relationship was found between overall teacher immediacy and overall student learning, average \( r = .500, \text{var.} = .037, k = 81, n = 24,474 \) (Witt et al., 2004). Overall student learning included studies that examined cognitive learning and used traditional measures (i.e., tests), affective learning which included behavioral aspects, and perceived learning which used the self-reported measure. Similar results were obtained \((average \ r = .481, \text{var.} = .040, k = 68, n = 21,171)\) when only the effect of nonverbal immediacy on overall student learning was examined (Witt et al., 2004).

When the relationship of nonverbal immediacy and each of the three categories of learning were examined individually, meta-analysis revealed studies that examined nonverbal immediacy and perceived learning \((average \ r = .510, k = 44, n = 13,313)\) were similar to results from studies that examined the relationship of nonverbal immediacy and affective learning \((average \ r = .490, k = 55, n = 17,328)\). Outcomes of studies that examined nonverbal immediacy and cognitive learning, \((average \ r = .166, k = 11, n = 3,777)\), revealed the lowest associations. The authors noted that the studies included in their meta-analysis did not investigate cognitive learning over time, and that if affect provides motivation for cognitive learning over time, “then the statistically significant (albeit small) results provide credibility and have implications for future research” (Witt et al., 2004, p. 200). Longitudinal studies may offer more insight into the relationship of teacher immediacy on student learning.
1.4. Beginning teacher immediacy and student learning

The relationship between nonverbal immediacy of teaching assistants or beginning teachers, teaching in self-contained or lecture/laboratory settings, and students’ affective and cognitive learning, was recently studied at a mid-western public university (LeFebvre & Allen, 2014). In their investigation, 256 undergraduate students enrolled in one of 20 sections of an introductory public speaking course, taught by a total of 20 teaching assistants, were surveyed. The Nonverbal Immediacy Scale—Self Report (V.P. Richmond et al., 2003) was used to evaluate students’ perceptions of their instructors’ level of immediacy. Students’ perceptions of affective learning, which included their feelings about the course content and instructor, were collected utilizing the Affective Learning Measure (McCroskey, 1994). The students’ overall grade for the course served as the measure of cognitive learning.

No statistical difference ($t(254), p = .88$) on the level of immediacy was found between teaching assistants teaching in a self-contained setting ($M = 97.55$, $SD = 10.50$, $n = 139$) and teachers instructing in a setting which consisted of a combination of a lecture/laboratory ($M = 97.74$, $SD = 9.99$, $n = 117$). However, teacher immediacy impacted cognitive and affective learning of students in both settings. A significant, positive relationship between teachers’ nonverbal immediacy behaviors and students’ cognitive learning, as measured by the final grade for the course, was found ($r = .21$, $p < .001$, $n = 256$). Students that perceived their teachers to be more immediate received higher course grades. Additionally, immediacy correlated positively with students’ affective learning ($r = .43$, $p < .01$, $n = 256$). Student learning was impacted by immediacy regardless of the class format. The researchers concluded that the findings in the investigation supports the training and development of beginning teachers’ nonverbal immediacy skills to promote positive educational outcomes for students (LeFebvre & Allen, 2014).

1.5. Relationship among teacher immediacy, student motivation, and student perceived learning

Christophel (1990) sought to understand the relationship among teacher immediacy, student state motivation, and perceived cognitive learning. Students’ state motivation for learning is temporary in nature, and reflective of students’ attitudes toward a course at a period of time. Conversely, trait motivation is reflective of a student’s general level of motivation or attitudes toward learning that are consistent over time (Christophel, 1990).

Two separate studies comprised the total of this research. In the first study, 562 graduate and undergraduate students completed three survey instruments related to their perceived level of teacher immediacy, trait/state motivation or affective learning, and cognitive learning. In an effort to collect immediacy behavior data from a wide variety of teachers and classes, students were asked to rate the level of teacher immediacy and their perception of their level of trait/state motivation or affective learning from the class they were enrolled in that took place immediately prior to the class in which the surveys were administered. Teacher immediacy was measured via the Immediacy Behavior Scale which included items that reflected verbal immediacy (Gorham, 1988) and nonverbal immediacy (Richmond, Gorham, & McCroskey, 1987) behaviors. The Trait/State Motivation Scales (Christophel, 1990) measured perceived student motivation or attitudes for learning in general, and for the course immediately preceding the one in which they were enrolled. Perceived cognitive learning was measured using two items related to students’ perceived learning in the class and perceived learning had they had an ideal instructor. The resulting “learning loss” score (Richmond, McCroskey, et al., 1987), obtained by subtracting students’ rating in the first question from the second, generated the students’ overall cognitive learning scores. Affective learning, or positive attitudes about the instructor, the course in general and content, and likelihood of enrolling in a similar course or in a course taught by the same instructor, was also measured via an affective learning scale instrument (McCroskey et al., 1985). Six elements were measured and an overall affective learning score, as well as sub-scores, were computed.
In the second study, approximately half of the students in each class were asked to complete the immediacy and motivation scales and the other half of the students were asked to complete the motivation and learning scales based on the class in which they were currently enrolled. Correlational and regression analyses of data collected in the first study were conducted to determine the relationship among teacher immediacy, motivation, and learning. Results of correlational analyses found significant, positive relationships between overall teacher immediacy and student state motivation \( (r = .49, n = 562, p < .001) \), verbal immediacy and student state motivation \( (r = .47, n = 562, p < .001) \), and nonverbal immediacy and student state motivation \( (r = .34, n = 562, p < .001) \). Therefore, students who reported higher levels of immediate behaviors by their teachers also reported higher levels of student motivation. A positive, significant relationship between teacher immediacy and perceived cognitive learning \( (r = .45, n = 562, p < .001) \) was found; regression analysis indicated that nonverbal immediacy was more predictive of student learning than verbal immediacy. Partial correlation analysis revealed that much of the variance in learning scores predicted by nonverbal immediacy was due to the predictor variable, state motivation. According to Christophel (1990), the data suggested that nonverbal immediacy initially modifies student state motivation before affecting student perceived learning, which aligns with the approach-avoidance aspect of motivation theory.

In the second study, scores obtained from Group A \((n = 624)\) were comprised of student trait/state motivation and immediacy scales and represented half of the class. The remaining half, Group B \((n = 624)\), reported scores for the motivation scales and learning instruments. Group C, or “Classes,” were the average of reported scores of participants in Group A and B. Correlations and regression analysis of data obtained in the second study revealed similar findings as the first study. Teacher immediacy was positively correlated with student motivation \( (r = .60, n = 60, p < .001) \), cognitive learning \( (r = .40, n = 60, p < .001) \), and total affective learning \( (r = .53, n = 60, p < .001) \). Further data analysis exploring the degree that teacher immediacy and student state motivation were collinear predictors of learning, revealed similar findings as in the first study. Therefore, findings suggest that in general, teacher nonverbal immediacy initially modifies student state motivation to affect student perceived learning (Christophel, 1990).

1.6. A causal model: immediacy, affective learning, and cognitive learning
A causal model which explored the relationship of teacher immediacy and students’ affective learning as an intermediary outcome leading to potential higher levels of cognitive learning was investigated through meta-analysis by Allen et al. (2006). The researchers posited that teacher immediacy would function as a source of positive reinforcement for students, which would in turn motivate students to perform (Allen et al., 2006). Two-thirds of the required correlational data were obtained from another meta-analysis by the same researchers (Witt et al., 2004) and used to test the model. The relationship between immediacy and cognitive learning was estimated, \( r = .13, k = 16, n = 5,437 \). The relationship between immediacy and affective learning was estimated, \( r = .50, k = 81, n = 24,474 \). Eight studies were identified from the first study (Witt et al., 2004) that met the criteria to allow for estimation of an average correlation between cognitive and affective learning (Allen et al., 2006), and a positive correlation was found \( (r = .08, k = 8, n = 1,449) \). The model was tested, and results supported the notion that teacher immediacy behaviors predict student affective learning (Allen et al., 2006). Results suggested a direct relationship between teacher immediacy and affective learning and motivation and an indirect relationship with cognitive learning (mediated by student motivation). The scholars contended that teacher immediacy may have more of an impact on student learning than the data show, as the small effect revealed by the data reflected only a snapshot in time in an individual class. In their view, the cumulative effect of teacher immediacy should be considered (Allen et al., 2006).

1.7. Teacher immediacy and student behavior management
Teachers promote student learning by effectively establishing positive learning climates where students behave appropriately, are engaged in learning, and are motivated to complete
coursework that leads to positive educational outcomes (Barr, 2016). Kearney et al. (1988) investigated the interaction between teachers’ nonverbal immediacy behaviors and use of verbal prosocial and antisocial strategies to gain student compliance. Prosocial strategies were conceptualized as reward-based and meant to encourage students and convey concern for a student’s success. Conversely, antisocial strategies are punishment-based and foster competitiveness and erode students’ dignity (Kearney et al., 1988). The researchers hypothesized that teacher nonverbal immediacy and use of compliance-gaining verbal strategy would affect students’ resistance to comply with teacher requests. The researchers posited that “the use of verbal strategies that are asynchronous with teachers’ immediacy or nonimmediacy orientation may prompt more student resistance than the use of verbal strategies that are synchronous with teachers’ nonverbal immediacy” (Kearney et al., 1988, p. 58). Therefore, there would be less student resistance to immediate teachers employing prosocial strategies than antisocial strategies. However, nonimmediate teachers employing prosocial verbal strategies would be resisted more than instructors employing antisocial strategies, as the verbal and nonverbal messages are inconsistent, and may seem disingenuous (Kearney et al., 1988).

One of four scenarios or treatments were administered to undergraduate students enrolled in communication classes (n = 629). The scenarios described a teacher that exhibited one of four combinations of nonverbal immediacy and verbal strategies: nonverbally immediate, employing prosocial verbal strategies; immediate using antisocial strategies; nonimmediate utilizing prosocial strategies; and nonimmediate applying antisocial verbal compliance-gaining strategies.

Results of a two-way ANOVA were significant, $F(1,15) = 9.21, p < .01$, eta squared = 1%. Follow-up tests employing Tukey’s test for unconfounded means (critical value for mean differences = .712) revealed that student resistance to a teacher perceived as immediate and employing antisocial verbal strategies ($M = 8.5$) was significantly more than resistance to a teacher that was perceived as immediate employing prosocial verbal messages ($M = 7.7$). Student resistance was significantly more when the teacher was perceived as nonimmediate employing antisocial strategies ($M = 13.36$) than the immediate teacher using prosocial messages ($M = 7.7$). However, student resistance to the nonimmediate teacher employing prosocial verbal messages ($M = 15.2$) was resisted more than the nonimmediate teacher utilizing antisocial messages ($M = 13.36$). Therefore, the results suggest the important role of consistency when one considers the role of nonverbal behavior and verbal communication. Further statistical analysis that examined the main effects for immediacy ($F(1,1515) = 199.67, p < .001$, eta squared = .27) and strategy type ($F(1,1515) = 2.29, p > .05$, eta squared = .004%) revealed a significant immediacy effect ($F(1,1515) = 21.678, p < .001$), suggesting the important role of nonverbal immediacy behaviors and their effect on student behavior management (Kearney et al., 1988).

1.8. Video as a feedback tool
The use of video as a feedback tool for teacher self-reflection in teacher professional development is well-documented (Fukkink et al., 2011; Fuller & Manning, 1973; Tripp & Rich, 2012). In their analysis of 63 studies involving pre-service and in-service teachers where participants used video to examine and reflect on their own teaching performance, Tripp and Rich (2012) provided evidence for the use of video to foster teachers’ abilities to self-reflect and to make instructional changes. The use of video grounds the process of reflection in one’s actual performance of teaching instead of relying on a memory of the performance (Xiao & Tobin, 2018).

Microteaching, conceptualized in the early 1960s at Stanford University, involved the recording of teachers as they tried out an instructional strategy and the receipt of feedback and coaching by an expert for the purposes of teacher development (Knight, 2014). Today, instructional coaching is a collaborative process where the coach and teacher analyze, “...current reality, set goals, identify and explain teaching strategies to meet goals, and provide support until goals are met” (Knight, 2017, p. 2). The use of video analysis to ground the instructional coaching process is powerful, as often a truer picture of reality is illuminated. Video analysis allows for the focusing on specific
behaviors or strategies while helping to alleviate habituation or confirmation bias (Knight, 2014). This grounding in reality is critical for the processes of goal setting and the monitoring of progress toward meeting goals.

In their seminal work on video playback in education, Fuller and Manning (1973) described the viewing of one's performance on video as “self-confrontation,” and the identification of discrepancies between one’s perceived experience and observations from video playback as one’s ability to realistically assess one’s self. In focused observations, they asserted that behavioral changes could occur when an outside observer’s perceptions are compared with one’s own, the level of realism with respect to the experience is increased, and the outside observer possesses facilitating characteristics (Fuller & Manning, 1973). The researchers cautioned that the process causes one to intently focus on the self and may induce stress in some students (Fuller & Manning, 1973). However, Xiao and Tobin (2018) asserted that today’s students, raised in an age where sharing images and video of themselves via social media is common, may not experience the same feelings of discomfort as the students referred to by Fuller and Manning over 40 (Xiao & Tobin, 2018).

1.8.1. Video feedback, reflection, and pre-service teacher communication skills

Self-examination through the use of video technology can be an important part of a learning cycle which includes reflection, conceptualization and revision, and practice (Colb, 1984). The impact of a video reflection system on the communication skills of undergraduate pre-service teachers was investigated in a mixed methods study in Australia (Bower et al., 2011). Participants included undergraduate pre-service teachers enrolled in a mathematics methods course (n = 10) or a language methods course (n = 14).

A video reflection system was used to facilitate pre-service teachers' self-reflection as part of a learning cycle aimed at improving communication skills. Pre-service teachers presented, reviewed their presentations individually via video technology, reflected on their performances and wrote reflections via a blogging tool, received peer feedback and viewed peers’ presentations, and revised practices to improve communication skills in a subsequent presentation (Bower et al., 2011). Over the course of one semester, pre-service teachers completed this process twice. Following the completion of both presentations, pre-service teachers completed an online questionnaire consisting of 10 questions about their performances, the video reflection process and its features, and suggestions for improvements in the process.

Between both courses, a total of 50 video posts which included self-reflections and 106 posts consisting of peer feedback were completed. Results of a two-sample two-tailed t-test revealed that the average rating of the second presentation was significantly higher than the first presentation, t (21) = 2.55, p = .02. Pre-service teachers’ average self-ratings of the first presentation was 5.1 out of 10. For the second presentation, the average of self-ratings was 6.3 out of 10 (Bower et al., 2011).

An examination of pre-service teachers’ qualitative data revealed that the teachers believed that nervousness and behaviors that convey anxiety (e.g., rigid or stiff posture) were underlying factors that contributed to the low scores of the first presentations. With respect to contributing factors that improved their scoring of the second presentations, pre-service teachers indicated that they felt more confident to present and intentionally tried to increase nonverbal behaviors such as eye gaze, gesture, and using an effective tone of voice (Bower et al., 2011). Overall, 86.3% of the teachers indicated that they felt the video reflection system helped them learn and improve in their ability to communicate and appreciated the opportunity to see and hear themselves perform. The process, which included peer-review, allowed the students to anchor their self-reflections while comparing their performances to those of their peers.

An analysis of student comments also illustrated that the opportunity to view one’s self using communication strategies with students, the process of self-critique, and the receipt of feedback and support from peers contributed to their growth in learning about classroom communication and its...
effect on students. According to the researchers, “student reflections on the physical aspects of communication (such as eye contact, body movements, pace of delivery) shaped their understanding of how to effectively construct meaning for the onlookers (their pupils)” (Bower et al., 2011, p. 323). The researchers point out that following the first video reflection process, pre-service teachers gained confidence in their abilities, and communication anxiety was reduced for the second presentation. Video analysis of their performances allowed for a comprehensive analysis of communication skills and promoted understanding of the effect of these behaviors on the receivers of the communication. This study supports the use of video technology to promote self-reflection combined with feedback to nurture growth in communication skills of pre-service teachers.

1.8.2. Video feedback, reflection, and embodied aspects of teaching

The impact of video for self-reflection on the use of nonverbal or embodied aspects of teaching behaviors was explored in a study of 23 pre-service teachers enrolled in an early childhood education certification program (Xiao & Tobin, 2018). Students’ videotaped lessons taught during a field experience and narrative reflections served as the main source of data. Acknowledging the use of video in teacher preparation focusing on verbal aspects of teaching, the researchers argued that video could be used as a tool to promote the embodied or nonverbal aspects of teaching, “… by drawing attention to aspects of teaching that are unplanned, tacit, and embodied such as pedagogical tact, the teacher’s use of materials, gaze, gesture, posture, positioning in the classroom, and withitness” (p. 329). Video can capture important nonverbal communication data.

At the midpoint and end of the semester in which participants were immersed in their first field experiences, pre-service teachers planned, taught, and videotaped themselves teaching a lesson and interacting with pre-kindergarten students (Xiao & Tobin, 2018). The pre-service teachers were instructed to watch their videos with sound and without sound, and to reflect on the lesson while focusing on nonverbal communication behaviors such as gesturing, posture, eye gaze, and touch. Additionally, the pre-service teachers reflected on the experience of videotaping themselves and the process of watching and assessing the videos through written narratives (Xiao & Tobin, 2018).

Following the first round of video data and narrative collection, the instructor presented information about embodied aspects of teaching such as use of gestures, voice, facial expressions, and touch. The class and instructor then reviewed the students’ videos, pointing out effective and ineffective pedagogical practices related to embodied aspects of the pre-service teachers as they taught their lessons (Xiao & Tobin, 2018). These procedures were duplicated at the end of the semester, and students’ video submissions were coded for eight embodied aspects of teaching including use of gestures, posture, and touch as well as non-embodied aspects of teaching, such as use of wait time (Xiao & Tobin, 2018). Students’ narrative reflections were coded and a content analysis procedure was completed that classified reflections into one of three categories—embodied aspects (e.g., eye gaze), non-embodied aspects of teaching (e.g., wait time) and other aspects of the video (e.g., comments about being videotaped). Video data analysis consisted of identifying and counting the categories of embodied teaching techniques used in lessons at the midterm and end of the semester, yielding frequency counts for each category. Once an identified embodied technique was used, it was counted once, even if used multiple times throughout the lesson. Frequency counts of body techniques that were mentioned in students’ narrative reflections were also obtained in addition to students’ reflections about the experience of being videotaped (Xiao & Tobin, 2018).

When video data from the midterm were compared to the final, the number of categorized embodied teaching techniques increased 11%, with the most marked increases in the techniques of positioning and touch (Xiao & Tobin, 2018). At midterm, 15 students utilized positioning in their lessons, while at the end of the semester, 21 students used positioning. Touch was used by seven students at midterm, while 11 students used touch as an embodied pedagogical practice during the final lesson. An analysis of students’ reflections revealed that students increased their comments on their use of bodily techniques by 13%, with body positioning mentioned by 13 students
at midterm, while all 23 students commented on their body positioning on the final reflections. The second largest increases in students’ mentions of behaviors were in the categories of touch and eye gaze; five more students reflected on these behaviors when the midterm and final reflections were compared. The researchers assert that based on the increases in embodied techniques displayed in lessons on the videos and mentioned in pre-service teachers’ reflection papers in their study, there is some evidence that bodily techniques used in teaching can be, “…learned, practiced, and improved” (Xiao & Tobin, 2018, p. 337).

Qualitative data analysis of students’ narrative reflections indicated that many students felt they were better able to focus on the embodied aspects of their teaching when they viewed the video with the sound off, allowing for a more focused review of the nonverbal facets of their teaching. Some students indicated they had a better understanding of the power of some embodied teaching techniques for presenting information, such as the use of gesturing, following reviewing their video and receiving peer feedback (Xiao & Tobin, 2018). An analysis of the final reflections on the experience revealed that although some students found the experience initially awkward, they grew more comfortable with the process as the semester progressed. Data indicated that students began to assess themselves more positively, as the ratio of positive to negative comments about their embodied teaching behaviors grew from a ratio of 2:1 at midterm to a ratio of 3:1 at the end of the semester (Xiao & Tobin, 2018). Taken as a whole, the study supports the use of video feedback and reflection as powerful tools in assisting pre-service teachers in developing their nonverbal teaching skills to communicate more effectively, manage classroom behaviors, and promote their students’ understanding of concepts (Xiao & Tobin, 2018).

2. Simulations
Sauvé et al. (2007) define a simulation as, “a simplified, dynamic, and accurate model of reality that is a system used in a learning context” (p. 253). Unlike games, simulations are non-competitive, serve as a model of real-life scenarios, are often tied to educational objectives, and allow learners to study real phenomena that is often complex in nature (Kaufman & Ireland, 2016; Sauvé et al., 2007). Simulations offer novices in fields such as medicine, business, and teaching the opportunity to practice and apply theoretical skills learned in coursework to realistic situations and environments (Bradley & Kendall, 2014; Dawson & Lignugaris Kraft, 2017; Dede, 2009; Dieker et al., 2017; Wang & Su, 2018). Simulations have been used for training purposes in complex and often risky fields such as aviation, the military, and medical fields for decades. In the field of education, however, the application of simulations is relatively new (Bradley & Kendall, 2014; Dieker et al., 2013; Kaufman & Ireland, 2016; Shaffer et al., 2001).

2.1. Simulations in education
In the educational context, simulations originated as written case studies, videos, or role-plays within teacher preparation classes for the purpose of learning targeted skills (Dieker et al., 2014). As technology evolved, simulations have evolved, and several types of simulations are available to be used for educational purposes. These simulations can be categorized as single user programs, Multi-User Virtual Environments, and mixed reality virtual puppetry simulations (Bradley & Kendall, 2014). Simulations that use virtual puppetry within a real learning laboratory allow the student to feel as though they are present within the virtual environment as they teach (Dede, 2009). Due to the scope and context of the present study, the discussion pertaining to mixed reality simulations is limited exclusively to the field of educational simulations and those using the fully immersive virtual puppetry environments via Mursion®.

2.2. Mixed reality simulations
A mixed reality simulation environment, like augmented reality, combines elements of reality and virtual reality. According to Milgram and Kishino (1994), augmented reality and mixed reality environments lie in the middle of a continuum between actual reality and virtual reality. Effective simulations are realistic, personalized learning experiences where participants feel a sense of immersion and an impression of participation within the digital environment (Dede, 2009). Mixed reality
simulations allow for repeated practice of targeted skills without harm to others (Dieker et al., 2008; Dieker et al., 2014; Kaufman & Ireland, 2016). In the field of teacher preparation, mixed reality environments allow for virtual situated learning experiences (Brown et al., 1989) that enable teacher candidates to take on the role of a teacher and practice communication and pedagogical skills in an immersive environment (Dieker et al., 2013; Dieker et al., 2014).

A multidisciplinary group of educators and scientists at the University of Central Florida created the TeachLiv® mixed reality simulation environment, now commercialized as Mursion®, to help recruit and prepare pre-service math, science, and special education teachers for the demands of the complex teaching environment (L Dieker et al., 2008; Hudson et al., 2018). Mursion® provides simulation environments for the development of technical and interpersonal skills of personnel in fields such as business, health care, defense, and education (Mursion, Inc., 2019a).

Pre-service teachers, in this environment, begin to apply their understanding of diversity in utilizing their knowledge of teaching strategies with student avatars of differing personalities, abilities, and cultural backgrounds that are reflective of real classrooms (Dawson & Lignugaris/Kraft, 2017; Dieker et al., 2013). In this environment, the pre-service teacher can practice a teaching strategy, behavior management technique, or other targeted practice while having the opportunity to pause the simulation to correct any errors or to get feedback and restart the simulation (Dieker et al., 2013; Dieker et al., 2014). The controlled environment, unlike a real classroom, allows for pre-service teachers to engage in multiple rehearsals of a practice without affecting live students or taking up valuable classroom instructional time (Dieker et al., 2013; Dieker et al., 2014).

2.2.1. Mixed reality simulations and coaching for teacher training
Garland et al. (2012) examined the effect of coaching within mixed reality simulations on special education teachers’ development of an evidence-based teaching strategy that is recommended for students with Autism Spectrum Disorder (ASD). The use of the simulation environment, TeachLivETM, was used to train four special education teachers in the learning and implementation of a teaching technique known as Discrete Trial Teaching (DTT). The technique, rooted in applied behavior analysis, breaks down objectives into smaller components and utilizes positive reinforcement when objectives are met (Garland et al., 2012). A student avatar exhibiting behaviors consistent with students with ASD was used throughout the course of the study to train special education teachers in the practice of DTT. A multiple baseline research design across four female participants examined the effect of coaching within the mixed reality simulation on the participants’ implementation of the DTT teaching strategy, as measured by an evaluation rubric aligned to the DTT technique (Garland et al., 2012).

Data were collected from four baseline sessions, in which teachers were given instruction in the DTT teaching strategy and practiced implementing the technique with Austin, a student avatar in the simulation environment. The treatment consisted of a review of participants’ previous simulation session, feedback, and coaching in the components of the DTT teaching strategy. Following the training session, participants then interacted with the avatar and performed ten discrete trials which were scored using a rubric.

Results showed consistent and positive gains in scores from baseline to treatment phases of the study. Overall, the average gain in scores was 49.9% over three participants that participated in all treatment sessions; while an increase of 41% was obtained for a participant who completed only one treatment session (Garland et al., 2012).

Interview data revealed that teacher participants appreciated the opportunity to practice learning about and implementing the teaching strategy with the student avatar that could be manipulated so a focus on the technique could be achieved, and the student avatar could not be harmed like a real student (Garland et al., 2012). The small number of participants is a limitation to this study; however, the results show that positive results in the learning and implementation of
a specialized technique, DTT, were realized when the mixed reality environment and follow-up coaching was used for special education teacher professional development.

2.2.2. Data-driven feedback and coaching within mixed reality simulations for teacher training

DeSantis (2018) examined the impact of data-driven feedback and coaching on pre-service teachers’ sense of self-efficacy and on the development of higher order questioning strategies to elicit student thinking. In the mixed method study, a quasi-experimental treatment and control group design was employed where the treatment group (n = 15) experienced data-driven feedback and coaching related to the participants’ use of higher order questioning techniques as they delivered lessons to student avatars in a mixed reality simulation environment. Participants in the comparison group (n = 15) did not receive the feedback and coaching but did experience the mixed reality simulation environment.

When the number and type of higher order thinking questions (HOTs) generated between the groups were analyzed via a Chi-Square analysis, a statistically significant difference (\( \chi^2 = (1) = 47.56, p < .01 \)) between basic knowledge and comprehension questioning (K/C) and HOT questioning performance between the treatment and comparison groups resulted. Follow-up analysis of the participants’ creation of HOT questions via a Sign test procedure revealed statistically significant results for all pairwise comparisons of scores among the treatment group; \( p \) values ranged from .002 to .005. However, no statistically significant differences in scores were found for any of the pairwise comparisons among scores of the comparison group. An examination of pre-post self-efficacy scores, as measured by the Teacher’s Sense of Self-efficacy Scale (TSES), did not reveal a statistically significant result when the treatment and comparison groups’ scores were analyzed. Therefore, results from the TSES appear to indicate that while the treatment did not affect pre-service teachers’ sense of self-efficacy, an impact on the skill of generating higher order thinking questions was realized. The researcher noted that the participants typically experienced six mixed reality simulations as part of their program prior to the study, and the TSES focuses on perceptions of self-efficacy with respect to teaching overall, not on just the skill of higher order questioning practices. Qualitative analysis of interview and coaching data revealed that pre-service teacher-student participants in the treatment group appreciated the data-driven feedback and coaching treatment and recognized their overall growth in their ability in utilizing higher order questioning techniques, lesson planning, and lesson delivery. Comparison group participants expressed they did not experience growth in the skill of higher order questioning, and some members expressed confusion as to the basics of the strategy. Results of the study indicated that data-driven feedback and coaching within mixed reality simulations can help foster the development of higher order questioning techniques among pre-service teachers.

2.2.3. Mixed reality simulations and instructional skills

An exploration of the effect of virtual professional development on teachers’ application of pedagogical knowledge and improvement in student outcomes in mathematics was conducted in a large-scale national research study (Dieker et al., 2017). Participants were in-service middle school mathematics teachers (n = 135), teaching in 10 schools across six states. A quasi-experimental four-group randomized trial research design measured teachers pre-post in their classrooms and, as the case with two of the groups, four times in the mixed reality simulation environment (Dieker et al., 2017).

Each participant in all four groups was provided a lesson plan aligned to Common Core Standards in Mathematics, while different types of professional development were implemented with three of the four groups. Group 1 received the lesson plans only and served as the comparison group (Dieker et al., 2017). Group 2 received professional development in the form of one 40-minute online session that focused on formative assessment strategies and included the teachers’ analysis of student work samples and follow-up discussion of teacher questioning and feedback strategies (Dieker et al., 2017). Teachers in Group 3 received four 10-minute sessions in the TeachLivETM simulator (now known as Mursion®) over the course of four
to six weeks. Participants in this group reviewed the same student work samples as those used in Group 2 and taught a whole class discussion to the five student avatars under the premise the work samples were from these virtual students (Dieker et al., 2017). Following the simulation session, participants took part in a review process that included their individual reflections on their performance with respect to the use of higher-order questioning and feedback strategies, and the receipt of feedback in the form of data on their frequencies of those strategies during the session. Upon completion of this review process, participants completed another 10-minute simulation session and, approximately one month later, experienced two additional 10-minute simulations that included the review process after leading a discussion with the student avatars (Dieker et al., 2017). Participants in Group 4 received the 40-minute online professional development experienced by participants in Group 2 as well as four, 10-minute simulation sessions. However, participants in this group did not participate in the review process (Dieker et al., 2017).

Qualitative and quantitative data were collected pre-post treatment utilizing the Teacher Practice Observation Tool (TPOT) to measure teachers’ practices in their actual classrooms (Dieker et al., 2017). Frequency data with respect to teachers’ use of high leverage practices, specifically higher-order questioning techniques, type of feedback, and amount of wait time, were collected during classroom observations (Dieker et al., 2017). Frequency data on the specific high leverage practice targeted in a simulation session were also collected for participants experiencing the sessions as part of the treatment condition. Additionally, teacher data were collected on eight modified sub-constructs from the 2011 Danielson Framework for Teaching Evaluation Instrument and qualitative field notes. Student data, specifically 10 items from the National Assessment of Educational Progress (NAEP) assessment were collected pre-post intervention.

For data analysis purposes, teaching practices were measured pre-post intervention along three dimensions: describe/explain questions (DE), specific feedback (SF), and score on the TPOT instrument (Dieker et al., 2017). A two-factor mixed design ANOVA was employed to analyze whether differential effects on teacher performance occurred over four 10-minute simulations, depending on whether participants received online PD. Time served as the within-subjects factor while condition (online PD or no online PD) served as the between-subjects factor; SF and DE were the dependent variables. Results indicated no differential effects with respect to DE questions ($F(3,171) = .735$, $p = .532$, $\eta_p^2 = .13$) nor SF given to student avatars ($F(3,168) = 1.989$, $p = .118$, $\eta_p^2 = .034$) based on whether teachers experienced online PD. However, there was a significant large effect for time when DE questions were analyzed ($F(3,171) = 9.993$, $p = .000$, $\eta_p^2 = .149$) and a significant effect for time when SF was analyzed ($F(3,168) = 2.306$, $p = .079$, $\eta_p^2 = .040$). Teacher performance scores, with respect to those high leverage practices, significantly increased over the four sessions of the simulations regardless of whether they received the online PD.

The researchers investigated whether differential effects of development of targeted skills in the simulation environment transferred to teachers’ practices in their actual classrooms (Dieker et al., 2017). Results of a three-way mixed ANOVA examining the effects of the simulations, online PD, and time on the percentage of DE questions asked during a 45-90 minute classroom lesson indicated no statistical differential effect of time for online PD when combined with the simulation sessions ($F(1,130) = .168$, $p = .682$, $\eta_p^2 = .001$). However, there was a statistically significant interaction between time and the simulations ($F(1,130) = 3.479$, $p = .064$, $\eta_p^2 = .026$). Teachers who participated in the simulations asked a significantly higher ($t(132) = 3.198$, $p = .002$) percentage of DE questions post-intervention ($M = 24\%$) than teachers who did not experience the simulations ($M = 14\%$). The results indicated that the targeted skill developed in the simulations transferred to actual classroom environments and support the efficacy of mixed reality simulations as a professional development tool to support teacher learning that is applied to actual classrooms (Dieker et al., 2017). Please see Dieker et al. (2017) for further analyses, findings, implications, and limitations of the study.
2.2.4. Mixed reality simulations, teacher education, and behavior management

Results of a research study (Pas et al., 2016) over the course of a school year in which mixed reality simulations were embedded within a formal coaching framework, indicated positive effects on teachers’ use of behavior management strategies and student classroom behavior. An intervention employing the use of a mixed reality simulation environment within a coaching model targeted toward teachers’ use of behavior management strategies was conducted with 19 special education teachers working in non-public schools (Pas et al., 2016). Participants taught in self-contained classrooms that served students aged 5–13 (n = 10) and 14–21 years (n = 9). Students were identified as those with moderate to severe needs in terms of academic, emotional, and behavioral supports and included students with Autistic Spectrum Disorder (ASD).

The research employed the use of a formal coaching model, the Classroom Check Up (CCU) designed to support effective classroom behavior management strategies aimed at proactive teacher behaviors that help prevent student behavior issues before they occur (Reinke, 2018). These strategies include active supervision, use of praise, and communicating clear behavioral expectations (Reinke, 2013). Coaches, following the CCU model, observed teachers in their classrooms and worked with teachers at the beginning of the study to identify and select one or two target teacher behaviors to improve positive student behavior in the classroom (Pas et al., 2016). Teachers then practiced the identified skills in the mixed reality simulation environment. Teachers practiced with middle school or high school avatars, depending on the grade level taught, for 10 minutes while being observed by the coach and another teacher (Pas et al., 2016). Following the simulation, each teacher received immediate feedback from the coach and observed the other teacher practice the targeted skills and receive feedback. This procedure was then repeated for a total of two practice sessions within one simulation (Pas et al., 2016). After the first simulation, the coach then observed the teacher in their classroom to determine the extent to which the teacher was able to apply the skills that were practiced in the simulator to their classroom (Pas et al., 2016). During classroom observations, coaches provided feedback to teachers to support their use of identified classroom management strategies. Teachers experienced a total of three TeachLivE™ simulations over the course of about 10 weeks (Pas et al., 2016).

Frequency counts of individual teacher and student behaviors, as well as overall rating scales of behaviors, were collected by research assistants via the Assessing School Settings: Interactions of Students and Teachers (ASSIST) instrument at three time points throughout the study (Pas et al., 2016). Data were collected before the coaching/mixed reality intervention which served as baseline data, following the coaching/mixed reality intervention, and then after about 3 months’ time, which served as follow-up data (Pas et al., 2016). Frequencies of individual teacher behaviors collected via this instrument were proactive behavioral expectations, reactive behavior management, approval, disapproval, and opportunities to respond. Frequencies of individual student behaviors were collected and consisted of noncompliance, disruptions, profanity, verbal aggression, and physical aggression (Pas et al., 2016). The ASSIST instrument consists of overall rating scales of teacher and student behaviors using a 5-point Likert scale (Pas et al., 2016). Overall ratings of teacher and student behavior with respect to teacher positive behavior management, teacher control, teacher monitoring, teacher anticipation, teacher and student meaningful participation, student compliance, and student socially disruptive behavior were collected using this instrument (Pas et al., 2016).

Frequency data of teachers’ classroom management strategies and students’ classroom behaviors were collected and analyzed via repeated measures MANOVA. When teachers’ classroom management behaviors over time were examined, significant results for time (F(2, 13) = 4.33, p = .04, partial η² = .40), frequency counts of teacher behaviors (F(3,12) = 43.36, p < .01, partial η² = .92), and the interaction between time and frequencies (F(6,9) = 5.25, p = .01, partial η² = .79) were obtained indicating that teacher behaviors varied across individual behaviors and changed over time. Follow-up data analysis employing ANOVAs revealed significant increases in frequencies of teachers’ use of proactive behavioral expectations (F(2, 28) = 6.73, p < .01, partial η² = .33), and
approval ($F(2, 28) = 8.12, p < .01, \text{partial } \eta^2 = .37$). Moderate to large effects were observed between baseline and follow-up data for teachers’ use of proactive behavioral expectations ($d = .092$) and use of strategies related to approval of student behavior ($d = 1.06$). When differences in student behaviors over time was examined via a repeated measures MANOVA, a significant result for frequencies of student behaviors ($F(4, 11) = 10.72, p < .01, \text{partial } \eta^2 = .80$) was realized. No significant results for time nor an interaction between time and frequencies of behaviors were obtained. Follow-up data analysis employing the ANOVA statistic revealed significant results over time for student non-compliance ($F(2, 28) = 3.58, p = .04, \text{partial } \eta^2 = .20$).

When overall observer ratings of teacher behavior and student behavior were analyzed, significant results of the MANOVA were obtained for teacher behaviors over time ($F(2, 8) = 10.64, p < .01, \text{partial } \eta^2 = .73$), scale ($F(7, 3) = 46.17, p < .01, \text{partial } \eta^2 = .95$), and an interaction for time by scale ($F(4, 6) = 19.28, p < .01, \text{partial } \eta^2 = .97$). With respect to student rating scales, significant results for time ($F(2,13) = 7.60, p < .01, \text{partial } \eta^2 = .54$), by student rating scale ($F(2, 13) = 564.24, p < .01, \text{partial } \eta^2 = .99$), and an interaction between time and student rating scale ($F(4, 11) = 9.34, p < .01, \text{partial } \eta^2 = .77$) were obtained. Taken together, improvements in teachers’ use of behavior management strategies and students’ classroom behaviors were realized over time.

Significant results of follow-up data analysis via ANOVAs were obtained for observer ratings of teacher proactive behavior management ($F(2, 28) = 6.92, p < .01, \text{partial } \eta^2 = .33$), teacher control ($F(2, 28) = 17.11, p < .01, \text{partial } \eta^2 = .55$), teacher monitoring ($F(2, 28) = 14.10, p < .01, \text{partial } \eta^2 = .50$), teacher and student meaningful participation ($F(2, 28) = 9.81, p < .01, \text{partial } \eta^2 = .41$), indicating that ratings for these teacher scales increased significantly over time. A significant result for ratings of student social disruption ($F(2, 28) = 3.19, p = .057, \text{partial } \eta^2 = .19$) indicated improvements in ratings over time.

The acceptability of coaching and the use of the TeachLivETM simulations were examined, as data were collected from coaches and teachers about their perceptions of the coaching experience using the coach–teacher alliance scales and ratings of the TeachLivETM simulations (Pas et al., 2016). A zero to four (never to always) 5-point Likert scale was employed, and overall results for both coaching and the TeachLivETM simulations were positive. Teachers’ scores for coaching which examined the working relationship, process, investment, and perceived benefits from the experience ranged from an average of 3.13 to 3.69; teachers scored the TeachLivETM simulations more moderately ($M = 2.77, SD = .60$; Pas et al., 2016). Coaches’ ratings for the coaching experience ranged from an average of 2.5 to 3.26; coaches scored the TeachLivETM simulations higher than the teachers ($M = 3.05, SD = .39$; Pas et al., 2016). Overall results of this study appear to indicate the viability of the use of mixed reality simulations and coaching to promote positive changes in special education teachers’ use of behavior management strategies that positively impact students’ behaviors in classrooms. Moreover, the results show that some positive changes were sustained, as follow-up data appear to indicate.

2.2.5. Mixed reality simulations and pre-service teachers’ perceived self-efficacy

The possible effect of increased levels of exposure to mixed reality simulations on pre-service teachers’ sense of self-efficacy was conducted within a teacher preparation program (Gundel et al., 2019). In the study, participants ($n = 53$) experienced 30, 60, or 90 minutes of mixed reality simulations embedded within their teacher education coursework. A repeated measures, one group with three levels, pretest/posttest design was employed to examine the effect of exposure level on pre-service teachers’ sense of self-efficacy, as measured by the Teachers Sense of Self Efficacy Scale (Tschannen-Moran & Hoy, 2001). An analysis of the data, employing a $3 \times 2$ one-between-one-within subjects ANOVA, and follow-up t-tests, revealed a significant main effect for exposure ($F(2, 50) = 5.91, p < .01$) and a significant interaction between total exposure and time before and after simulations ($F(2, 50) = 5.45, p < .01$). The self-efficacy scores of participants in the 90 minute exposure group were significantly different than scores of participants in the 30 minute or 60 minute groups. The researchers noted that for the 60-minute exposure time, a small,
nonsignificant decrease in scores from before exposure to after exposure was revealed, and this drop in scores were observed in other studies (Bautista & Boone, 2015).

2.2.6. Mixed reality simulation and coaching—communication skills
A pilot study was conducted to explore the effect of a mixed reality simulation environment on the learning of interprofessional communication skills of doctoral-level physical therapy students (Taylor et al., 2017). This simulation environment requires a human simulation specialist who operates, through digital puppetry, avatars that represent students or adults in various roles and interacts with the simulation participant in real time (L Dieker et al., 2008). For this study, the specialist was a teacher, trained in school-based education, and was made familiar with physical therapy medical terminology and the scenario for the simulation (Taylor et al., 2017). The simulations were guided by a scenario which centered around making recommendations for mobility, including a wheelchair, for a 13-year-old girl who experienced a traumatic brain injury. Adult avatars represented three adult stakeholders—a parent, teacher, and physician. Three participants experienced the simulation environment and interacted with each adult stakeholder for a period of five minutes. After each session, a 5-minute period for feedback and reflection took place. The participant then experienced communicating with the same adult avatar for another five minutes for a second simulation session. This process was repeated for all three adult avatar stakeholders; each participant experienced the simulation environment for a total of 60 minutes (Taylor et al., 2017). A quasi-experimental, pre-test and post-test case study design was employed, and each of the three participants were scored using a modified version of the Situation, Background, Assessment, Recommendation (SBAR) tool, which provides a framework for medical professionals when communicating with health team members (Institute for Healthcare Improvement, 2019). Results of the study revealed that all three participants, following the simulations which included a period for feedback and reflection, were able to more effectively communicate situational and background information, as well as discuss treatment and make recommendations with all three adult stakeholders in the scenario (Taylor et al., 2017). Among all three participants, interactions with the parent avatar were the most challenging, whereas interactions with the physician avatar were the most successful (Taylor et al., 2017). However, each participant scored higher for every adult avatar interaction following the first simulation. Therefore, the results of this pilot study provide support for the use of a mixed reality simulation environment in developing interprofessional skills of medical personnel.

2.3. Conclusion
The use of video as a feedback tool in teacher professional development is well-documented (Fuller & Manning, 1973; Knight, 2014; Tripp & Rich, 2012) and coaching within mixed reality simulations has been shown to impact teachers’ targeted behaviors (DeSantis, 2018). However, mixed reality simulation environments are an emerging technology, and there is a lack of research in this area (L Dieker et al., 2008; Dieker et al., 2014). Additionally, pre-service teachers’ use of nonverbal immediacy skills within technology-rich environments, such as mixed reality simulations, offers another gap in the literature.

3. Research questions
Teacher immediacy skills are important in developing positive student–teacher relationships and have been shown to positively affect student motivation and learning (Christophel, 1990; LeFebvre & Allen, 2014), and align with high-leverage teaching practices. High-leverage practices are foundational teaching practices that are critical to advance student learning and teacher pedagogical skills (Ball & Forzani, 2010; Teaching Works, 2020). Further study is needed to determine the effectiveness of the emerging technology of mixed reality simulations within teacher preparation programs to impact teacher learning and practice to positively affect students (L Dieker et al., 2008) and specifically, to understand pre-service teachers’ immediacy behaviors those simulations. The purpose of this study was to explore the effect of video and reflection, video feedback and coaching within mixed reality simulations on pre-service teachers’ nonverbal immediacy skills.
within a teacher preparation program. To guide this inquiry, the following research questions were addressed:

1. Using the Nonverbal Immediacy Scale—Observer Report (NIS-O), is there a statistically significant difference over time between pre-service teachers’ nonverbal immediacy behaviors for three rounds of data collected, before, during, and at the conclusion of a semester, in which a video and reflection, video feedback, and coaching treatment package is administered following mixed reality simulations?

2. What are the perceptions of pre-service teachers’ reflection and use of nonverbal immediacy behaviors over the course of a semester in which they received video, video feedback, and coaching while utilizing a mixed reality simulation environment?

4. Method

The overall design was an embedded mixed methods research design (Creswell & Plano Clark, 2011). Quasi-experimental quantitative, one-group-within-subjects design (Gall et al., 2003; Hinkley et al., 1998) was utilized to address the quantitative research question. Time served as the independent variable and scores obtained via the NIS-O (V.P. Richmond et al., 2003) was the dependent variable. A qualitative case study design (Creswell & Poth, 2018; Yin, 2014) was used for the qualitative data, which were secondary and supported triangulation of data sources.

4.1. Setting and participants

The current study took place at a university located in the northeastern United States. A total of 15 ($n = 15$) undergraduate pre-service teachers participated in the study; 10 participants identified as female, while 5 participants identified as male. Twelve participants indicated they were Caucasian while the remaining 3 participants stated their ethnicity as Hispanic/Latino. Most participants had experienced the mixed reality simulations a total of two previous times as part of previous coursework within their teacher preparation program.

Pre-service teachers were in their second, third, or fourth year of study and were enrolled in a second course in a series of two-part coursework in educational psychology. The simulations employed the use of scenarios (Piro & O'Callaghan, 2016b) that were aligned with the high leverage teaching practice of using questioning techniques to elicit student thinking (Ball & Forzani, 2010; Teaching Works, 2020). The course embedded mixed reality simulations within its curriculum and focused on verbal teaching strategies, namely higher order questioning skills. There was no focus on nonverbal communication skills within the course curricula and the majority of participants indicated they had never received training in nonverbal communication. The curriculum for the course embedded three simulations and a field experience.

4.2. Simulation lab

The Mursion® environment looks much like an elementary, middle school, or high school classroom and includes props such as whiteboards, books, and desks (Dieker et al., 2014; Mursion, Inc.). Sitting at a desk are a diverse group of student avatars representing a range of personality types and abilities, that can exhibit certain behaviors depending on the objectives of the simulation (Dieker et al., 2014). Simulation specialists are trained to control the student avatars to enable learners to “…become empathetic to the emotions, abilities, and circumstances of the avatar” (Mursion, Inc., p. 2). In this environment, the pre-service teacher can practice a teaching strategy, behavior management technique, or other targeted practice while having the opportunity to pause the simulation to correct any errors or to get feedback and restart the simulation (Dieker et al., 2014; Dieker, Rodriguez, Lignugaris/Kraft, Hynes & Hughes, 2013). The controlled environment, unlike a real classroom, allows for pre-service teachers to engage in multiple rehearsals of a practice without affecting live students or taking up valuable classroom instructional time (Dieker, Rodriguez, Lignugaris/Kraft, Hynes, & Hughes, 2013; Dieker et al., 2014). The simulations provide pre-service teachers the opportunity to deliver lessons to student avatars of different
personalities, abilities, and cultural backgrounds that are reflective of real classrooms today (Dawson & Lignugaris/Kraft, 2017; Dieker, Rodriguez, Lignugaris/Kraft, Hynes, & Hughes, 2013). Figure 1 illustrates the participant view of the virtual classroom.

4.3. Quantitative design
A quasi-experimental, one-group within-subjects design, with three levels (Time 1, Time 2, and Time 3), was employed within the embedded mixed method design to address research question one (Gall et al., 2003; Hinkle et al., 1998). The independent variable was time, with three levels (Time 1, Time 2, and Time 3) and the dependent variable was the scores obtained from the NIS-O instrument. Observations with analysis and the administering of the three components of the treatment package were conducted as shown in a visual representation of the quantitative design in Figure 2.

4.4. Qualitative design
A case study design (Creswell & Poth, 2018; Yin, 2014) was employed to address research question two. The case was bounded by enrollment and participation in an educational psychology course over one semester where mixed reality simulations were embedded into the curriculum (Creswell & Poth, 2018; Yin, 2014).

5. Treatment package introduction
A video analysis process following each of three mixed reality simulations experienced by pre-service teacher participants preceded the treatment. Participants received a treatment package following each simulation consisting of three components: video and reflection, video feedback,
and coaching, that was targeted at improving the pre-service teachers’ nonverbal immediacy skills as they delivered lessons to student avatars.

5.1. Treatment instruments

Mixed Reality Simulation Video Capture. The mixed reality simulations were recorded using a customized recording system that captured both participants and student avatars as the pre-service teachers delivered lessons and interacted with the simulated students (see Figure 3). The video recording captured each entire mixed reality simulation session for all participants in one video file.

The professor of the course and pre-service teachers enrolled in the course were captured in the background. Image used with permission (Mursion, 2019b).

Nonverbal Communication Behavior Observation Tool (NCBOT). The researcher-created NCBOT collected frequencies and durations of participants’ use of nonverbal immediacy behaviors with student avatars within simulations via video reviews of performances. The nonverbal immediacy behaviors of gesturing, smiling, proximity, eye contact, relaxed posture, varied tone of voice, and touch were identified, however, the behavior of “touch” was not included in data collection or analysis due to the nature of simulations. Video time stamp information, total length of the video of the simulation, and researcher notes were also collected via this observational tool.

The NCBOT was utilized to administer the video feedback and coaching components of the treatment package and to inform scoring and ensure consistency in rating the Likert items on the validated NIS-O instrument. The first and second authors met in data meetings for the purpose of assessing the degree of agreement to score the NIS-O instrument. They simultaneously re-watched and re-scored the observation tool (NCBOT) until they reached 100% agreement with respect to nonverbal immediacy behaviors, and their rating on the NIS-O survey instrument. A scoring guide was established following the analysis of participants’ baseline performances (pre-treatment) during the first mixed reality simulation session. This criterion-referenced scoring guide for observed frequencies and durations of nonverbal behaviors and the related Likert category (“never,” “rarely,” “occasionally,” “often,” and “very often”) employed on the NIS-O was utilized to evaluate all three mixed reality simulation sessions. See Table 1.

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Figure 3. The mixed reality simulation video capture recorded the face and body of the standing pre-service teacher participant and the seated student avatars as the pre-service teacher delivered a lesson and interacted with the avatars.
Based on the first session, nonverbal behaviors related to gesturing and smiling were established from this baseline information; most participants’ observations fell within the middle “occasionally” and “often” categories. For the nonverbal communication behaviors of relaxed posture, eye contact, and use of varied tone of voice, the rating on the rubric corresponded to the percentage of length of observations in quarters. For proximity, most participants did not move toward or away from the avatars and thus their observations related to the “never” category. Due to the nature of simulations, the nonverbal communication behavior of touch was not observed, and each participant was rated “never” for that behavior.

**Semi-Structured Coaching Protocol.** A semi-structured coaching protocol informed by the “objective, reflective, interpretive, decisional” (ORID) focused questioning technique was used (Stanfield, 2000). This protocol was used to gather information about participants’ reflections on their use of nonverbal immediacy behaviors during each of the three simulations embedded within the course and informed a coaching intervention aimed at improving pre-service teachers’ use of such behaviors in subsequent simulations. Participants were asked questions about their nonverbal immediacy behaviors as they interacted with the avatars and their overall assessment of their performance in the simulation. The third and final coaching session utilized the protocol to provide not only feedback on the third simulation session but also provided summative information to the student participants about their use of nonverbal immediacy behaviors over the course of the study.

**Researcher Video Analysis Process.** Video recordings of pre-service teachers’ mixed reality simulations and collected data with respect to pre-service teachers’ use of nonverbal immediacy behaviors in their interactions with the avatars were analyzed. A video analysis protocol (see Figure 4) was utilized and six views of each video recording allowed for the collection of frequencies and durations of nonverbal immediacy behaviors via an observational tool, the NCBOT. Half of the views were with the sound off to enable a better focus on certain nonverbal behaviors (Xiao & Tobin, 2018). Notes were captured via the NCBOT throughout the video analysis process. The frequencies and durations of nonverbal immediacy data and researcher notes collected via this tool helped to inform the administering of the three components of the treatment package. Figure 4 demonstrates the observational protocol for analyzing the video.

5.2. Treatment fidelity

Standardization of procedures employed in this research helped to promote reliability and validity of the study. The treatment package, consisting of video and reflection, video feedback, and coaching, was implemented solely by the researcher, and employed the use of a semi-structured...
coaching protocol to ensure consistency across participants. All participants, for every simulation, received a video of their performance within 24 hours of the session. The three components of the treatment package were typically provided within 10 days of the simulations, after participants had indicated they had reviewed their video. Before administering the three components of the treatment package to a participant, the researcher reviewed the video recording of the simulation and utilized the NCBOT to inform the treatment session. A treatment session typically lasted about 15 minutes; each component was about 5 minutes in duration. Simulations typically lasted about three minutes and students delivered lessons that focused on pre-service teachers’ employment of strategies to elicit student thinking while utilizing higher order thinking questioning techniques. No coursework or professor feedback related to the use of nonverbal communication in teaching. All participants received the treatment package prior to any subsequent mixed reality simulations.

5.3. Instrumentation—data collection
There were four modes of data collection: video capture, NIS scale, exit interviews, and demographic survey.

5.3.1. Mixed reality simulation video capture
As for the observations for the treatment, the mixed reality simulations were recorded using a customized recording system that captured both participants and student avatars as the pre-service teachers delivered lessons and interacted with the simulated students (See above Figure 2).

5.3.2. The nonverbal immediacy scale (NIS)
Nonverbal immediacy behaviors include behaviors such as smiling, nodding of the head, looking, gesturing, and having a relaxed posture that create physical or psychological closeness and convey approachability, warmth, and availability for communication (Mehrabian, 1971). The Observer-Report version of the instrument, the NIS-O, was used to measure student participants’ overall level of nonverbal immediacy behaviors while interacting with student avatars in a mixed reality simulation environment. The NIS-O was developed as “a reliable nonverbal immediacy measure which could be used as a self-report instrument or (with modified wording) as an observer-report instrument” (V.P. Richmond et al., 2003, p. 505). The only difference between the Self-Report (NIS-S) version of the instrument and the Observer-Report version (NIS-O) version is the beginning pronoun of each item making up the instrument (e.g., “I” versus “He/She”). The instrument contains 26 items that are rated on a 5-point Likert scale (1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Often, 5 = Very Often). Half of the items are positively related to nonverbal immediacy behaviors and the remaining half are negatively related to nonverbal immediacy behaviors. Examples of positive nonverbal immediacy behaviors include the use of smiling, having a relaxed posture, and using a varied tone of voice. Conversely, negative nonverbal immediacy behaviors include frowning, having a stiff or rigid posture, and using a monotone voice. Examples of items that are positively related to the use of nonverbal immediacy behaviors include questions about whether the person being observed uses gesturing and having a relaxed posture when talking to others. Examples of items that are negatively related to the use of nonverbal immediacy behaviors include questions about whether the person being observed speaks in a monotone or dull voice, or if they avoid using eye contact when verbally communicating with others.

A nonverbal immediacy score was obtained by a three-step process. The scorer first adds scores of the instrument’s items that are related positively to nonverbal immediacy. Second, the scorer adds the scores of items that are negatively related to immediacy. Finally, the scorer adds 78 to the score obtained in the first step, then subtracts the score obtained in the second step to get an overall nonverbal immediacy behavior score (V.P. Richmond et al., 2003). Reliability was determined to be .90 or above for both versions of the instrument (V.P. Richmond et al., 2003). The researchers concluded that content validity was strong, and predictive validity of the instrument ranged from “… moderate to very high” (V.P. Richmond et al., 2003, p. 516).
5.3.3. Participant semi-structured exit interview protocol
A researcher-created semi-structured interview protocol was employed immediately after the third and final coaching session to address research question number two. This instrument gathered data about the participants’ perceptions of nonverbal immediacy behaviors and the treatment package within the mixed reality simulations. Pre-service teachers were asked about their beliefs about the effectiveness of the treatment following their mixed reality simulations in improving nonverbal immediacy behaviors.

5.3.4. Pre-service teacher demographic survey
A pre-service teacher demographic questionnaire was administered just prior to the start of the first mixed reality simulation session. The survey asked respondents to indicate their current student status, major of study, anticipated level of teaching, and prior experiences with the mixed reality simulations. Additionally, students were asked questions about their gender identity, ethnicity, and employment status.

6. Data collection and analysis
Prior to commencing the data collection phase of the study, the Institutional Review Board (IRB) granted approval. Data collection began immediately following obtaining consent from pre-service teachers just prior to their first mixed reality simulation experience.

6.1. Quantitative data collection and analysis
Simulations were recorded via a customized screen within a screen (DeSantis, 2018; Gundel et al., 2019) recording system utilizing a Dell® Alienware laptop computer, Open Broadcaster Software (OBS), and appropriate hardware and peripherals, including a webcam with built-in microphone. Video recordings are utilized by the education and educational psychology departments at the university for research purposes. A session-long recording of pre-service teachers’ simulation experiences was created through the university’s customized system. On average, simulations for each participant lasted 3 minutes and 23 seconds. Observations were conducted during the participants’ performances within the simulation lab and via the video recordings.

Quantitative data for this study consisted of pre-service teacher participants’ scores on the NIS-O. At the start of the research study, Microsoft® Excel® for Office 365 was used to create a record of all data collected. All data were then imported into Statistical Package for the Social Sciences v. 26 (SPSS) from the Microsoft® Excel® spreadsheets and descriptive statistics were performed to help ensure the accuracy of the data (Meyers et al., 2006).

Data collected via the NIS-O instrument were analyzed using the nonparametric paired Sign test (Gibbons & Chakraborti, 1992; Laerd Statistics, 2015; Sign Test Calculator, 2020). The Sign statistic calculates whether the differences between paired observations are statistically significant to 0. To explore differences among three points of time over the course of a semester, participants’ nonverbal immediacy scores were compared for Time 1 and Time 2, Time 2 and Time 3, and Time 1 and Time 3. This procedure was used to test for a median difference in pre-service teachers’ nonverbal immediacy, as measured by the NIS-O, between two points of time. Pairwise comparisons were conducted between Time 1 and Time 2, Time 2 and Time 3, and Time 1 and Time 3. The Sign test allows for comparisons at the individual participant level, and for pairwise comparisons for all three sessions. The dependent variable was scores obtained via the NIS-O and the independent variable was time (Time 1, Time 2, and Time 3). The Sign test was employed using an online calculator (Sign test calculator, 2020) to determine whether there were significant differences in participants’ levels of nonverbal immediacy between the sessions being compared.

First, the assumptions were met: 1) one dependent variable, continuous or ordinal in nature, was analyzed. The continuous variable considered was pre-service teachers’ levels of nonverbal immediacy, as measured by the NIS-O survey instrument; 2) one independent variable consisting of two related groups. Pairwise comparisons were analyzed for Time (Time 1 and Time 2, Time 2 and Time
3, and Time 1 and Time 3). The same pre-service teachers were measured on the same dependent variable, levels of nonverbal immediacy, during three different times over the course of one semester.

The data were checked for outliers, or extreme scores (Hinkle et al., 1998). The means, standard deviations, minimum and maximum values for each group, Time 1, Time 2, and Time 3 are shown in Table 2.

To assess the normality of the data, the skewness and kurtosis of the NIS-O scores collected for Time were examined. All values for skewness fell between ± 1, the acceptable range (Meyers et al., 2006).

Data collected for Time 3 fell within the acceptable range. Values for kurtosis of the distribution of the scores indicated kurtotic distributions for Time 1 and Time 2, as the values fell outside the acceptable ± 1 range; therefore, the nonparametric Sign test statistic was used to analyze the data.

6.2. Qualitative data collection and analysis

All participant interviews were conducted immediately following the third and final coaching session, via phone, and were recorded using a Sony ICD-PX470 digital voice recorder with a built-in USB. Recordings were uploaded to the web-based transcription service site, Otter.ai. When transcriptions were complete, they were checked against the audio recordings simultaneously for accuracy; appropriate edits were made when necessary. Participants’ pseudonyms were assigned to each participant and a database was created using Microsoft® Excel® for Office 365, where data were organized. In addition to interview data, observational data were collected for triangulation purposes. The NCBOT collected researcher notes during live and recorded simulations about participants’ use of nonverbal immediacy behaviors and student avatars’ interactions.

Qualitative data were analyzed consistent with case study design (Creswell & Poth, 2018; Yin, 2014). Researcher notes collected during observations of simulations about participants’ use of nonverbal immediacy behaviors and reactions of the avatars were analyzed for data triangulation purposes. Participant interview data were analyzed through a systematic process employing both inductive and deductive analyses (Miles et al., 2019). A first cycle of coding (Miles et al., 2014; Saldaña, 2016) employing descriptive, process, and in vivo coding methods was used to develop initial codes. Deductive codes, informed by the research question and the literature on nonverbal immediacy, mixed reality simulations, video feedback, and coaching, were used to analyze chunks of data. Inductive coding methods (Miles et al., 2014) allowed for the emergence of additional codes. A second cycle of coding employed pattern coding methods (Miles et al., 2014; Saldaña, 2016) to further condense the data, and allowed for the emergence of categories and themes (Saldaña, 2016). Analytic memos (Saldaña, 2016) generated throughout the analysis process assisted with critically thinking about the data, making meaningful connections, and reporting findings. The initial codes that resulted from the first level of coding were grouped into categories which were organized into themes and finding statements (Miles et al., 2014; Saldaña, 2016). Two overarching finding statements emerged through analysis of the data.

| Table 2. Descriptive statistics: pre-service teachers' nonverbal immediacy scores |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Session | Minimum | Maximum | Mean | Std. Deviation |
|---------|---------|---------|------|----------------|
| Time 1  | 76      | 113     | 96.933 | 13.247          |
| Time 2  | 83      | 113     | 97.933 | 10.700          |
| Time 3  | 89      | 115     | 102.933 | 7.659           |
6.3. Threats and trustworthiness

Due to the nature of the one group design, several threats were identified (Campbell & Stanley, 2015) with respect to internal validity. Internal threats to validity were controlled in several ways to help ensure quality of results. Maturation is a threat that relates to the passing of time and the natural course of human development (Fraenkel et al., 2012; Gall et al., 2003). This threat was medium level threat; however, participants were adults similar in age, and the study took place over the course of only one semester. Testing was a moderate-level threat as participants were observed, on three occasions, and measured on their level of nonverbal immediacy. This threat was mitigated as observations occurred at least four weeks apart. Instrumentation threat was controlled through the use of an observational instrument that included reflexive notes to promote consistency in scoring. Additionally, the first two authors scored the observational protocol until 100% agreement in scoring the instrument based upon videotaped observations prior to any participant scoring. External threats were addressed by using a detailed standardized procedure when administering the treatment. Additionally, there was consistency across participants with respect to the timing of the treatment. An external validity threat included population validity (Gall et al., 2003). To address any potential personological complications, a demographic survey was employed in an effort to thoroughly review participants and discover any personal or psychological characteristics among individuals that might have differed from the variety of members within the group (Gall et al., 2003). No personological impediments were found. The participants, as well as the university itself, were selected via non-random sampling. Therefore, caution should be used when generalizing the results to a larger population (Gall et al., 2003).

Regarding trustworthiness, credibility was addressed by using multiple data sources; transferability was addressed by using a detailed description of the methodology; confirmability was addressed through a detailed audit trail that tied the data directly to participant utterances within text.

7. Results

7.1. Research question one

Research question asked if there was a statistically significant difference over time between pre-service teachers’ nonverbal immediacy behaviors before, during, and at the conclusion of a semester in which a video and reflection, video feedback, and coaching treatment package is administered following mixed reality simulations.

The exact paired Sign test (Gibbons & Chakraborti, 1992; Laerd Statistics, 2015; Sign Test Calculator, 2020) analyzed the effect of a treatment package on pre-service teachers’ level of nonverbal immediacy behaviors. Each pairwise comparison was analyzed by subtracting the Nonverbal Immediacy score obtained from an earlier time point, from the more recent mixed reality simulation for each participant. Positive signs indicated growth in nonverbal immediacy while negative signs indicated a decline for the pairwise comparison. For instances where there was no difference in scores between the two time points, an “NA” value was attributed, and the result was not counted in the overall calculation.

Refer to Table 3 for pairwise comparisons for Time 1 and Time 2, Time 2 and Time 3, and Time 1 and Time 3. A significance level of $p < .05$ was used.

Scores for Time 1 and Time 2 showed 7 participants improved and 7 participants declined in their level of nonverbal immediacy while one participant scored the same for both time points. There was no statistically significant result in nonverbal immediacy, as measured by the NIS-O, when participants’ scores between Time 1 and Time 2 were compared ($z = 0.000$, $p = 1.00$).

When Time 2 and Time 3 pairwise comparisons were conducted, 11 participants increased their level of nonverbal behaviors, 2 participants’ scores decreased, and 2 participants’ scores remained constant. An exact Sign test was conducted and a statistically significant increase in nonverbal immediacy, as measured by the NIS-O, resulted ($z = 2.496$, $p = .013$). For Time 1 and Time 3. There
was no statistically significant increase in nonverbal immediacy, as measured by the NIS-O scores ($z = 1.732, p = .083$).

See Table 4 for a summary of results for all three pairwise comparisons of NIS-O scores for each simulation session.

### 7.2. Research question two

Research question asked what were perceptions of pre-service teachers’ reflection and use of nonverbal immediacy behaviors over the course of a semester in which they received video, video feedback, and coaching while utilizing a mixed reality simulation environment? Participant interview data were analyzed through a systematic process employing both inductive and deductive analyses (Miles et al., 2014).

Analysis of the qualitative data revealed two overarching finding statements. The first finding statement, which was supported by three themes was: Video feedback and coaching fostered pre-service teacher reflection on the simulated environment as pre-service teachers delivered lessons within the simulation. The second finding statement, which was supported by four themes was: Video feedback and coaching within a mixed reality simulation environment improved pre-service teachers’ use of nonverbal immediacy behaviors in student interactions.

### Table 3. Paired sample sign test for nonverbal immediacy scores by participant for time 1 time 2 and time 3

| Participant | Time 1 | Time 2 | Time 3 | Sign T2-T1 | Sign T3-T2 | Sign T3-T1 |
|-------------|-------|-------|-------|-----------|-----------|-----------|
| Kate        | 76    | 83    | 89    | +         | +         | +         |
| Winnie      | 76    | 83    | 99    | +         | +         | +         |
| Callie      | 80    | 96    | 99    | +         | +         | +         |
| Samuel      | 83    | 85    | 105   | +         | +         | +         |
| Sheila      | 90    | 89    | 90    | -         | +         | NA        |
| Renee       | 95    | 93    | 100   | -         | +         | NA        |
| Bob         | 98    | 94    | 98    | -         | +         | NA        |
| Linda       | 98    | 104   | 103   | +         | -         | +         |
| Steven      | 101   | 112   | 110   | +         | -         | +         |
| Arnold      | 102   | 92    | 104   | -         | +         | +         |
| Annie       | 109   | 100   | 103   | -         | +         | -         |
| Maria       | 109   | 104   | 108   | -         | +         | -         |
| Rose        | 112   | 113   | 115   | +         | +         | -         |
| Sylvia      | 112   | 108   | 108   | -         | NA        | +         |
| Patrick     | 113   | 113   | 113   | NA        | NA        | NA        |

### Table 4. Summary of paired sign test results

| Session Comparisons | Significance |
|---------------------|--------------|
| Session 1 and Session 2 | $p = 1.000$  |
| Session 2 and Session 3  | $p = .013^*$  |
| Session 1 and Session 3  | $p = .083$  |

Note. * indicates significance at the .05 level.
Both finding statements and their supporting themes are described in the following sections. Citations of quotes from interview transcripts are noted with the letter “I” and the line number(s) of the transcript where the quote is found. Citations of observations are noted with the letter “O” followed by the number of the simulation session where the observed behavior occurred.

7.3. Finding statement one
The first finding statement was: Video feedback and coaching fostered pre-service teacher reflection on the simulated environment as pre-service teachers delivered lessons within the simulation. This finding statement was supported by three themes: objectivity of reflection, layering of reflection with addition of coaching, and comfort and confidence in teaching. See Figure 5

Theme one related to a degree of objectivity of pre-service teachers’ reflections with the use of video to ground the teaching episode. In lieu of a memory of the teaching session, pre-service teachers utilized a video recording of their teaching performance to review their nonverbal immediacy behaviors and interactions with student avatars as they delivered a lesson. Theme two referred to the degree of objectivity of the pre-service teachers’ reflections with the addition of coaching. Coaching offered pre-service teachers opportunities to consider a more experienced outsider’s point of view of the teaching performance. Theme three referred to pre-service teachers’ perceptions of changes in their levels of comfort and confidence in delivering lessons over the course of a semester in which they received video feedback and coaching while experiencing mixed reality simulations.

7.3.1. Theme 1: objectivity of reflection
Participants indicated that the use of video provided objectivity when they reflected on their teaching performances. Video recordings of pre-service teachers’ performances allowed for a review of teaching after feelings of stress experienced while delivering the lesson had subsided. Annie, a junior majoring in music education, described her appreciation of having the opportunity to view her teaching when she was emotionally ready when she stated in the interview:

When [the simulation] happens in the moment, it feels like it’s all a blur and it just happens so quick because of the nerves and the time constraint and everything. So being able to review what I did once I calmed down and I can actually soak in everything … it’s just a great reflective practice to improve on myself for the next time. So, I found it very beneficial. (I: 90–93)

Linda, a junior studying secondary social studies also described how the video recordings helped illuminate a more accurate depiction of her teaching when she stated, “I think the videos are helpful to have. In the moment, everything is just kind of ‘go, go, go,’ but when you get to watch [the simulation] back, you can see a lot of different things and see how you actually did” (I: 278–280). She further explained, “[The video] was really helpful because in the moment, you always think you didn’t do very well, but then you watch it back and see what you were successful at and what was a little rough” (I: 286–287). She added, “watching the videos, you can kind of see okay, okay, it wasn’t that bad” (I: 295–296).

7.3.2. Theme 2: coaching layered pre-service teachers’ reflections
According to Joyce and Showers (1981), coaching is a collaborative activity “… characterized by observation and feedback cycle in an ongoing instructional or clinical situation” (p. 170). Coaching involves “… analysis of teaching for the purpose of integrating mastered skills and strategies into a curriculum, a set of instructional goals, a time span, and a personal teaching style” (p. 170). In their definition, contextual applications of skills are considered as “… the teacher and ‘coach’ examine appropriate places in the curriculum for use of specific strategies, evaluate the effectiveness of observed lessons, and plan for future trials” (p. 170).
Finding Statement One:
Video and reflection, video feedback and coaching fostered pre-service teacher reflection on the simulated environment as pre-service teachers delivered lessons within the simulation.

Theme 1: Objectivity of Reflection (n=45)
Theme 2: Layering of Reflection with Addition of Coaching (n=32)
Theme 3: Comfort and Confidence in Teaching (n=82)

Figure 4. Video analysis protocol used to analyze pre-service teachers’ nonverbal immediacy behaviors.
Participants spoke about how the treatment coaching added to their personal reflections on their use of nonverbal immediacy behaviors with the student avatars. Arnold, a secondary mathematics education student in his junior year, stated:

I see myself and I can, you know, do my own self-evaluation which is pretty good and I also like your calls so you can give me feedback and, you know, advise and tell me what to do next and what should I not do also. (I: 150-154)

Callie, a junior studying secondary social studies education, appreciated the feedback and discussion involved in the coaching and relayed, “I just think the biggest part that helped me the most is being able to watch my simulation after the fact and then being able to talk about it so the coaching helps you I’d say” (I: 230–231). Samuel, a 24-year-old junior majoring in elementary education articulated how coaching helped focus his reflection and said, “The videos are actually very helpful and in reflecting I was able to pick up on some things like, for example, when you told me about my leg being bent that I like, really paid attention to that” (I: 122–123).

7.3.3. Theme 3: comfort and confidence in teaching
Pre-service teachers who received a video feedback and coaching treatment package focused on their nonverbal immediacy behaviors as they utilized a mixed reality simulation environment believed their comfort level and confidence in teaching increased over the course of the semester. Twelve participants described their growth in the level of comfort or confidence in being able to deliver lessons, engage students, and manage student behaviors.

Steven shared his perceived increase in confidence in using nonverbal immediacy behaviors and communication to engage students and manage behavior as a result of receiving the treatment when he stated:

I think just having that in mind like having it in the back of my head helped me to think about it while I was teaching. It kind of helped me become more self-confident but in a positive a way making sure that I’m that I have a body language that’s engaging or one that’s going to keep them on task. (I: 175-178)

Linda also described a similar view and relayed, “I think definitely with confidence in learning how to talk to a group of people and learning how to settle down a class” (I: 205–206). Linda also added, “I’ve kind of been able to change things on the fly a lot better” (I: 219–220).

Annie described how her perceived confidence in utilizing nonverbal immediacy behaviors in her teaching will allow her to apply that learning in a real classroom environment and stated:

Through the coaches [in the treatment], I learned some new things to try out. And now I would feel more comfortable using them in the classroom because I got to test them out on the avatars and see like, oh, worked here. So now I’m going to try it [with real students]. (I: 160-162)

7.4. Finding statement two
Finding statement two was: video feedback and coaching within a mixed reality simulation environment improved pre-service teachers’ use of nonverbal immediacy behaviors in student interactions. This finding was supported by four themes: building relationships, student engagement, behavior management, and transference of nonverbal immediacy skills to practice (see Figure 6).

Theme 1: Building relationships. The teacher–student relationship is an interpersonal one; establishing interpersonal rapport can promote positive student learning outcomes (Worley et al., 2007). Six participants indicated that the use of video feedback and coaching focused on
Finding Statement Two:

Video and reflection, video feedback, and coaching within a mixed reality simulation environment improved pre-service teachers’ use of nonverbal immediacy behaviors in student interactions.

Figure 5. Qualitative finding statement one. The figure depicts the three themes that emerged from the data related to the first of two overarching finding statements.
their use of nonverbal immediacy behaviors with the student avatars, helped them understand the importance of nonverbal communication in establishing positive student–teacher relationships.

Participants expressed a desire to appear friendly and open to communication with students and the video feedback and coaching helped to foster their own use of nonverbal immediacy behaviors for that purpose. For example, Maria discussed the importance of student perception and how the feedback and coaching within the simulations assisted her and commented:

Working with students, you realize … you need to make fast decisions, you need to be confident in what you’re saying. If you’re confident in what you’re saying, they’ll be more apt to follow you and it’s all about perception, being friendly and open. So, doing the simulations has allowed me to open up like that. (I: 134-138)

Observational data from all three sessions supported Maria’s comments. Maria moved toward the student avatars when addressing them and used smiling, open hand gesturing, and eye contact at the beginning of the lesson (O: 1, 2, 3).

Observational data revealed that Sheila, after the first observation, used many nonverbal immediacy behaviors to help establish rapport with the student avatars. In the first observation, Sheila used eye contact with the avatars, but clasped her hands and did not appear relaxed throughout the session (O:1). However, during the second observation, Sheila used open hand gestures, smiling, and varied her tone of voice when beginning the class discussion (O: 2). Throughout the third simulation, Sheila began to use proximity with the student avatars, smiled, used open hand gestures, and had an overall more relaxed posture when delivering her lesson (O: 3).

**Theme 2: Student engagement.** Participants described their focus on increasing nonverbal immediacy behaviors to engage students. Linda described her reflection on her teaching fostered via the video feedback and coaching treatment, and her intentional use of nonverbal immediacy behaviors to engage students when she vocalized:

I think after watching the first one, I kind of saw what I did and didn’t do. And then the second and third one, I kind of learned from what I did and realized I had to be a little bit more animated, and a little bit more on top of it, I guess, with that kind of stuff. I couldn’t really just, even though they’re avatars, you can’t really just like stand there and just talk to them in a monotone voice for two and a half minutes. (I: 95-99)
Observational data revealed that Linda used eye contact and smiling nonverbal immediacy behaviors throughout all three simulations (O: 1, 2, 3). In her second and third simulations, however, Linda began to employ open gestures and her overall posture was more relaxed as she engaged the avatars in a lesson about the thirteen colonies (O: 2, 3). Linda also began to use proximity in her final simulation session (O: 3) after receiving two video feedback and coaching treatments.

Steven also discussed how the treatment increased his confidence in using nonverbal immediacy behaviors to engage students when he said:

I think just having that in mind, having it in the back of my head helped me to think about it while I was teaching. It kind of helped me become more self-confident in a positive way making sure I have a body language that’s engaging or one that’s going to keep them on task. (I: 175-178)

Steven was observed utilizing immediate behaviors of eye contact, smiling, and much open gesturing while engaging the student avatars as he delivered his lessons (O: 1, 2, 3). However, in the first simulation, Steven was observed utilizing behaviors such as tugging at his shirt and shifting his feet throughout much of the simulation. These adaptive behaviors often nonverbally communicate a nervous or anxious internal state (Allen, 2019). In subsequent observations, Steven appeared to have a relaxed posture, began to move toward avatars while engaging them, and being animated as he delivered lessons (O: 2, 3).

**Theme 3: Behavior management.** Pre-service teacher participants indicated that they intentionally used nonverbal immediacy behaviors, such as using facial expressions, eye contact, and proximity, with student avatars to manage behaviors. According to Chesley and Jordan (2012), pre-service teachers in university preparation programs require training and multiple exposures to professional development that fosters learning ways to manage student behavior and to build relationships in the classroom. Participants in the current study practiced applying nonverbal immediacy communication in the simulated classroom with student avatars that displayed misbehaviors.

Annie described her new-found understanding and application of nonverbal communication in managing classroom behavior because of the video feedback and coaching treatment within the simulations and declared:

I always thought that when it came to management that all of it had to be verbal, that you had to say something or reprimand them or something like that. So, you know, through the simulations and the coaching, I've just learned that nonverbal communication is key. Like I said, I never had any training on this before, so it just kind of opened my eyes and I'm definitely going to be using some of these practices moving forward, so it will definitely affect my teaching in the future. (I: 138-143)

In the second simulation, one of the avatars stretched and yawned as Annie began to communicate her lesson. Annie looked directly at the avatar, maintained eye contact, and smiled as she addressed the student and said, “You've got that, Savannah?” Annie also varied her tone of voice and did not appear to be confrontational, but more conveying concern for the avatar’s well-being but also as a signal to attend to the lesson (O: 3).

At the beginning of the third observation, the avatars continued to talk despite Kate’s verbally telling them it was time for a math lesson to begin. Using eye contact, varied tone of voice, and proximity, Kate was able to settle the avatars and began to deliver her lesson. Soon after she began to teach, an avatar interrupted Kate, asking about the time on the clock on the wall of the university’s simulation lab. Kate once again looked directly at the avatar and varied her voice in redirecting him. Additionally, she used gesturing to signal that the discussion about the time on the clock was over, and she continued with the lesson and the avatar complied (O: 3).
Theme 4: Perceived transference of nonverbal immediacy skills to practice. All but one of the 15 participants described intentionally using nonverbal immediacy behaviors within the context of a field placement embedded in the course to establish rapport, engage students, or manage behavior when they were teaching real students.

Linda described using nonverbal immediacy behaviors to appear relaxed despite her internal feelings of stress when teaching in her field experience and acknowledged, “I had to try and be very relaxed, even though was very stressful, but I’d always try to smile and make it kind of a calm environment for them” (I: 177–178).

In his elementary classroom placement, Samuel conveyed how he used nonverbal immediacy behaviors to ensure he appeared approachable and willing to engage in conversation:

I’d just get close to the students and like, you know, hang out behind them or near them or always smile at any questions, make sure that they felt free to, you know, converse with me or approached me if they needed anything. (I: 166-169)

Callie also wanted to ensure she appeared open for communication and described her use of gesturing to convey openness for communication with the students in her 10th grade Modern World History class and relayed, “I kept in mind like I was able to walk around the classroom while they were doing their work. I didn't have anything in my hands, so I was able to give gestures and stay open” (I: 130–132).

7.5. Connections between quantitative and qualitative results
There was an iterative process where pre-service teachers, after rehearsing targeted skills with student avatars, engaged in self-reflections about their nonverbal immediacy behaviors. The rehearsals within the simulations and reflections, supported by video feedback and coaching, positively affected pre-service teachers’ perceived level of comfort and confidence in applying said skills within their teaching. Increased confidence not only positively affected practice of skills within the simulations, but participants learning regarding nonverbal immediacy behaviors were applied to actual classrooms in field experiences. Pre-service teachers indicated they were more comfortable and confident in their teaching as they experienced successes with rehearsal of skills within the simulations, and within their field placements. Therefore, the statistically significant quantitative finding was supported by the qualitative findings. The participants improved in their level of nonverbal immediacy as measured by the NIS-O and qualitative results reinforced the quantitative result.

8. Discussion of the findings

8.1. Research question #1
A statistically significant difference in nonverbal immediacy scores of pre-service teachers was found when a comparison between Time 2 and Time 3 was conducted. Similarly, Xiao and Tobin (2018) studied the effect of video feedback and coaching on early childhood pre-service teachers’ embodied aspects of teaching (e.g., posture, eye gaze, etc.). The results of that study indicated that developers of teacher education programs may utilize video and reflection, video feedback, and coaching within mixed reality simulations to provide pre-service teachers opportunities to practice strategies, such as nonverbal immediacy behaviors, that will prepare them for their professional practice.

In the current study, no statistically significant results were found for pairwise comparisons of Time 1 and Time 2, and Time 1 and Time 3 for pre-service teachers’ use of nonverbal immediacy behaviors. However, when individual scores were examined, it was found that between Time 1 and Time 2, seven participants decreased in their level of nonverbal immediacy, as measured by the NIS-O. Similarly, in a study that examined the effect of mixed reality simulations on pre-service
teachers’ perceived sense of self-efficacy (Gundel et al., 2019), an insignificant drop in participants’ perceived sense of self-efficacy for participants who experienced 60 minutes of simulations resulted. According to the researchers, this finding may relate to a dip in self-efficacy scores that was also found by Bautista and Boone (2015) and Pendergast et al. (2011) and may be due to a “reality shock” (Gundel et al., 2019; Pendergast et al., 2011) related to confronting the realities of classroom teaching after initial exposure to teaching. In the current study, several participants decreased their immediacy scores initially, and the decrease may be related to this reality shock phenomenon found by Bautista and Boone (2015) and Pendergast et al. (2011). The reality shock phenomenon may be true for other treatments that target skills or behaviors—such as the treatment for immediacy skills in the current study—with mixed reality simulations.

8.2. Research question #2

Results of research question two found that participants increased their use of nonverbal immediacy behaviors in their interactions with student avatars during mixed reality simulations to establish rapport, engage the avatars in learning, and manage classroom behaviors. Participants also reported that they intentionally utilized nonverbal immediacy behaviors with real students in field placements for the same purposes, thus supporting the transfer of their learning to actual practice, and the effectiveness of the treatment within simulation learning. Pre-service teachers in the current study indicated they applied their learning gained from receiving a treatment package, and rehearsal of nonverbal immediacy skills within mixed reality simulations, to their practice as they participated in a field experience embedded within the course. Similar outcomes relating to application of learning within mixed reality simulations to live settings were found in additional studies (Dieker et al., 2017; Walker et al., 2016).

In the current study, participants utilized open gestures, smiling, and having a relaxed posture to convey friendliness and warmth as they interacted with the avatars. Kinesics and proxemics were employed by the participants to engage students in learning and help motivate them to participate in discussions, learning tasks, and activities. These non-verbal immediacy skills from the current study are significant in that positive teacher–student rapport may promote feelings of classroom connectedness, affective learning, student participation, and academic achievement (Dobransky & Frymier, 2004; Frisby & Martin, 2010; Worley et al., 2007). Participants utilized nonverbal communication to manage classroom behaviors of student avatars within the simulations. Most often, participants used proximity for this purpose. When students are engaged in learning, better educational outcomes can be expected for students (Lei et al., 2018). Moreover, teachers’ ability to manage classrooms is essential for student learning and to help prevent teacher burnout and attrition (Aloe, Amo & Shanahan, 2014; Marzano et al., 2003).

Participants perceived their level of comfort and confidence in teaching increased over the course of a semester in which they received the treatment package focused on increasing nonverbal immediacy within mixed reality simulations. Similarly, Hudson et al. (2018) examined the effect of mixed reality simulations on undergraduate special education teachers’ perceptions of their ability to manage a classroom. Results indicated that following the Mursion simulations, pre-service teachers perceived they were better prepared to manage classroom behaviors over time.

In the current study, participants received individual coaching following the receipt of video feedback targeted at improving nonverbal immediacy behaviors. Coaching provided an additional layer for teachers’ reflections. Results of research question two found that teachers’ self-observations allowed for more objectivity within these reflections. The use of video for teacher self-reflection development is well-documented (Fukkink et al., 2011; Fuller & Manning, 1973; Tripp & Rich, 2012). The use of video grounds the process of reflection in one’s actual performance of teaching instead of relying on a memory of the performance (Xiao & Tobin, 2018). Video analysis to ground the instructional coaching process is powerful, as often a truer picture of reality is illuminated. This grounding in reality from reflection is critical for the processes of future goal setting and the monitoring of progress toward meeting goals (Knight, 2014). Additionally, video
analysis in the instructional coaching process allows for the focusing on specific behaviors or strategies while helping to alleviate habituation or confirmation bias (Knight, 2014).

9. Implications, recommendations, and limitations

There are several implications for teacher preparation programs. The first is that teacher education programs might consider the use of video and reflection, video feedback, and coaching within mixed reality simulations to support the development of nonverbal immediacy behaviors that promote positive student–teacher relationships, engage and motivate students to learn, and help manage classroom behaviors to foster classroom climates that are conducive to learning. Since participants indicated that they intentionally utilized nonverbal immediacy behaviors with real students in their field experiences, the treatment within the simulations appeared to be effective and participants may be better prepared for the realities of teaching. Additionally, developers of teacher preparation programs could incorporate the use of video to foster teacher reflections that are more grounded in reality and provide for opportunities to focus on specific teaching strategies or teacher behaviors while students deliver lessons within the curriculum of teacher preparation courses. Last, participants’ sense of confidence and comfort increased following the receipt of the treatment within simulations. Teacher educators might include the use of the treatment and rehearsals of delivering lessons within simulations to promote teachers’ perceptions of readiness for professional practice.

There are implications for school districts and businesses requiring high functioning of nonverbal immediacy behaviors with their employees. School districts, in an attempt to promote teachers’ employment of strategies that will engage and motivate students in learning and foster positive classroom climates, might consider utilizing the treatment within mixed reality simulations for professional development. Businesses that are in the service industry, and other sectors that require interpersonal competencies, such as health-care or counseling, could consider the use of video and reflection, video feedback, and coaching within mixed reality simulations to support the development and use of nonverbal immediacy behaviors of staff that, when applied to real contexts, may help foster positive client interactions.

Several recommendations for future studies are offered. A replication of the current study with a larger number of participants is recommended as the small number of participants (n = 15) was a limitation. A larger number of participants could support the use of a control group in the research design, which would help control for limitations that are inherent in one-group designs. The current study utilized the NIS-O instrument and employed the use of a researcher-created observational tool to help ensure consistency in scoring the validated instrument. The development of a new instrument to measure nonverbal immediacy behaviors could be considered. Future studies might explore the impact of the treatment on nonverbal immediacy behaviors or other targeted skills within remote learning or distance learning situations. An examination into the impact of each of the components of the treatment utilized within the current study to understand the impact of each could be considered.

Several limitations of the study are noted. The results of the current study may be due to participants’ ability to review their teaching via the video and make changes accordingly. This study did not attempt to separate the concepts of isolated review of video performance or application of selected components of the treatment package. To address this limitation, future studies could explore the impact of one or more components of the treatment package in an effort to determine which components, if any, provide more of a value-added approach to changing targeted behaviors. This small-scale research was contextual and findings should not yet be generalized to all settings. However, universities using simulations may find specific value in the findings for programmatic development. It is also important to consider that some nonverbal immediacy behaviors, such as eye contact and the use of gesturing, are cultural and the results of this study should be considered within the context of the research being conducted in the northeastern United States.
10. Conclusion
The purpose of this mixed methods study was to explore the effect of a video and reflection, video feedback, and coaching treatment package within mixed reality simulations. The results of the current investigation supported the use of the treatment package to promote the use of pre-service teachers’ nonverbal immediacy behaviors. These immediacy behaviors may impact students’ levels of engagement, motivation, affective learning, and academic achievement. Interestingly, post-treatment, participants conveyed they applied their learning to the context of classroom field placements. This research may contribute to the research on video and reflection, video feedback, coaching, and mixed reality simulations on pre-service teachers’ development of teaching strategies for application to professional practice.

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