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Preservice Teachers' Focus in 360 Videos: Understanding the Role of Presence, Ambisonic Audio, and Camera Placement

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Immersive 360 videos are increasingly being used in pre-service teachers (PST) education. There is preliminary evidence that this technology may benefit future educators' focus and attention to classroom settings and events. However, more analytical efforts are needed to better understand its potential impact on reported focus of attention (RFA) among future educators. This article addresses this gap by presenting the findings of a study on 360 videos that involved 92 PSTs. Three predictors of RFA were addressed: 1) the construct of presence as the feeling of *being there* within the 360 environment, 2) the use of 3D realistic audio (also called ambisonic audio) in the recording (related to *perceptual capacity*), and 3) different camera locations or placements. Results show that presence is a positive predictor of RFA. Moreover, 3D audio is a positive predictor of RFA but only with specific camera placement. The study provides support for examining presence in 360 videos for PSTs. Findings also point to the use of 3D audio to mitigate camera placement and support RFA within these mediated environments.

INTRODUCTION

There has been an increased use of 360 videos in preservice teacher education (Joglar & Rojas-Rojas, 2019; Kosko et al., 2021). The potential of this *eXtended Reality* (XR) innovation for improving future educators' reflection and situational awareness is promising due to the immersion that it provides (Ibrahim-Didi, 2015). With 360 videos of classroom settings, students can observe all around them; they are not limited to a static perspective like in standard videos. They can, therefore, experience and understand recorded instructional environments in a more complete and meaningful way (Zolfaghari et al., 2020). Additionally, students can decide where and what to focus on in 360 videos; therefore, this technology facilitates their autonomy and involvement with what watched (Huang et al., 2021; Roche & Gal-Petitfaux, 2017). These benefits are well aligned with the need of innovation and personalization suggested by Gaudin and Chaliès (2015) in their meta-review about learning videos for future educators. Despite this promise, there is a need for empirical and analytical efforts to better understand how this technology can be deployed in teacher education.

This paper focuses on possible predictors of the variance of *reported focus of attention* (RFA) among preservice teachers (PSTs) presented with 360 videos of elementary classrooms. RFA is a concept that is related to situated awareness. Drawing on data from 360 video use of PSTs, three potential predictors of RFA were investigated: 1) the construct of presence as the feeling of *being there* within the 360 environment, 2) the use of 3D realistic audio (also called ambisonic audio) in the recording, which refers to the concept of *perceptual capacity*, and 3) different camera placement.

The first section of this article describes the current literature related to 360 videos in teacher education, addressing the possible role of presence and describing perceptual capacity-related tools (i.e., ambisonic audio and camera placement) in understanding this technology. The next section focuses on the research design and methods deployed. The third section provides the results, and the paper concludes with a discussion of those results and implications for future development and research within teacher education.

LITERATURE REVIEW

360 Videos in Preservice Teacher Training

Educators have successfully deployed 360 videos in a variety teacher education contexts and content areas. It can be argued that this technology provides a setting that reproduces several aspects of real-life classroom settings (Walshe et al., 2021). Even if 360 videos are not a replacement of field experiences, they can work as a promising tool to expose PSTs to these environments (Joglar & Rojas-Rojas, 2019; Theelen et al., 2019; Zolfaghari et al., 2020)

There is preliminary evidence of the benefits of this technology in mathematics (Balzaretti et al., 2019), general secondary teacher education (Theelen et al., 2019), geography (Walshe et al., 2021), science (Joglar & Rojas-Rojas, 2019), art (Nortvig et al., 2020), and early childhood education (Paraskevaidis & Fokides, 2020). These benefits include an increased immersion with what is being watched (e.g., Roche & Gal-Petitfaux, 2017) as well as an overall understanding of related classroom events (e.g., Theelen et al., 2019).

More importantly, research has provided evidence that PSTs notice more meaningful events while using 360 videos than with standard videos (e.g., Joglar & Rojas-Rojas, 2019; Kosko et al., 2022; Walshe & Driver, 2019). This advantage has clear implications in terms of PSTs' reflection and awareness regarding classroom settings and processes (Gandolfi et al., 2021a; Theelen et al., 2019). More specifically, 360 videos are well suited to benefit PSTs' situated awareness, which can be defined as comprehending meaningful events and key processes in a given situation (Endsley, 2000)—something that has implications for both understanding and practice (Kosko et al., 2022). Indeed, situated awareness can be related to the ability to understand what is relevant and what is secondary (Marton & Booth, 1997). It is important to note that this awareness is filtered and mediated through perception and senses (Huang et al., 2021; Korthagen, 2010). In other words, teachers' behaviors and sensory reactions (e.g., where to watch, what to observe) in a given learning situation show how they interpret the situation itself.

The use of 360 videos allows users to see and focus more in comparison to standard videos (Ferdig & Kosko, 2020; Huang et al., 2021; Walshe et al., 2021). As such, situation awareness can be better assessed and facilitated because this technology supports a more active sensorial involvement (i.e., viewers can decide where to watch) (Ferdig & Kosko, 2020; Roche & Gal-Petitfaux, 2017). However, more efforts are needed to shed light on how this process works and what variables are at the stake. For instance, Huang et al. (2021) found that PSTs involved with immersive videos may miss important learning events when they are instructed to focus on classroom management rather than on students' actions. These authors discovered that the more an immersive video is characterized by disruptions, the less PSTs react to those events. These findings may suggest that immersive videos may trigger a cognitive overload in PSTs. At the same time, a study from Gold and Windscheid (2020) reported no significant differences between standard and 360 videos for PSTs in terms of working memory load. These highlights suggest that more analyses are needed about PSTs' noticing skills and factors involved.

A metric for measuring this construct is the reported focus of attention (RFA), or the location where PSTs reported to have paid attention while watching a classroom video. There is evidence to suggest that PSTs with more expertise have a better and broader control of the recorded environment when using 360 videos (Gandolfi et al., 2021b; Theelen et al., 2019). As such, a wide RFA may be a desired outcome in XR videos for future educators because it indicates a situated awareness covering the whole classroom observed rather than just specific locations (e.g., just one table of the classroom). As such and following this promising early research (e.g., Gandolfi et al., 2021b; Joglar & Rojas-Rojas, 2019), there is a need to better understand additional variables that may play a role in affecting RFA and PSTs' attention in immersive environments (Kosko et al., 2022; Reyna, 2018; Zolfaghari et al., 2020). This paper investigates two factors that may influence RFA in 360 videos for PST education.

Presence

The first factor is the concept of presence, which can be defined as the feeling of being immersed in the XR environment. From a user perspective, this term can be related to how the difference between real and virtual may fade away (Bianchi-Berthouze et al., 2007; Ferdig et al., 2018). As a consequence, presence has been documented as a desired outcome for XR experiences because it would imply that users are fully sensorially involved in the technologically-mediated setting (Lorenzo et al., 2013; Nardi, 2015). This construct is particularly important to evaluate XR applications for education (Ferdig et al., 2018; Lau & Lee, 2015). According to the concept of embodied cognition, thinking can be interpreted as "reactivation and reuse of processes and representations involved in perception and action" (Fincher-Kiefer, 2019, p. 10). Therefore, the higher the presence in XR environments, the more learners would be perceptually (and, therefore, cognitively) stimulated.

Following these premises, a few studies have addressed the role of this construct in the context of XR videos for preservice teachers. For instance, Gandolfi et al. (2021b) developed and validated the *eXtended Reality Presence Scale* (XRPS) for measuring presence in future educators involved with 360 videos. Their study highlighted how high presence can be described as a *mesmeric feeling of being there* (when technological mediation disappears) and is positively correlated with focus and attention while watching 360 video. Moreover, a further study deploying XRPS with future educators (Gandolfi et al., 2021a) described how presence is positively associated with the ability to notice students' activities and endeavors. Such an outcome is a desired behavior for preservice and inservice teachers (Barnhart & van Es, 2015; Dessus et al., 2016). In sum, a higher degree of presence seems to indicate a better situated awareness regarding 360 videos observed and, therefore, RFA.

Perceptual Capacity

The second factor is the construct of perceptual capacity (Eayrs & Lavie, 2018; Ferdig & Kosko, 2020). Perceptual capacity is defined as how a medium/technology is able to represent and communicate the main traits of a represented scenario (Ferdig & Kosko, 2020; Kosko et al., 2022) and, therefore, improve PSTs' understanding of what is observed (Ferdig et al., 2020). In the context of XR videos, perceptual capacity can be influenced by two technological components. The first is the use of ambisonic audio in combination with 360 video. Ambisonic audio is 3D audio that realistically mimics how sound should reach the viewer within a 360 video. Ambisonic audio shows promise because of its higher realism in comparison to monophonic audio (Ferdig et al., 2020), with implications in terms of situated awareness among PSTs. The second is camera placement; it relates to the perspective in which the recorded classroom is perceived. This trait is important because different camera placements may offer different watching experiences (i.e., covering alternative areas of the same classroom environment) leading to divergent learning outcomes (Kosko et al., 2021). Both conditions (ambisonic and camera placement) may influence the viewing experience and PSTs' RFA.

Summary of Literature Review

In sum, there is preliminary evidence that XR videos can facilitate teacher training and focus of attention (i.e., RFA). However, there are still gaps in the literature regarding what factors may influence PSTs' RFA when using this technology. Addressing these gaps would support a better understanding of the use of 360 videos in PST education *and also* point at best practices in developing and filming future videos.

Study Purpose

Following these premises, efforts are required to properly understand the potential impact of presence, ambisonic audio, and camera placement on PSTs' RFA variance. To respond to these gaps, three research questions were created:

- RQ1: Is the feeling of presence in 360 videos a predictor of RFA variance?
- RQ2: Is the use of ambisonic audio in 360 videos a predictor of RFA variance?
- RQ3: Is camera placement in 360 videos a predictor of RFA variance?

METHODS

The study relied on an online activity, which required participants to complete a survey and watch a 360 video twice. The research was approved and monitored by the authors' university institutional review board.

Sample

Participants included a pooled sample of 92 preservice teachers enrolled in an educational technology course in Fall 2020 (n=24) and Spring 2021 (n=68). The majority (88.0%) of participants self-identified as White (Black=5.4%; Latinx=2.2%; Biracial=2.2%; Asian/Middle Eastern = 2.2%), with 64.8% self-identifying as male and 35.2% as female (1.1% did not report their gender identity). Major areas of study included early childhood / elementary education (52.2%), secondary education (20.7%), art education (13.0%), or one of various other education specific majors (middle childhood, foreign language, music education, special education etc.). Prior to participating in the study, the majority of participants (55.4%) had used a VR headset, but only 32.6% had viewed a 360 video.

Procedure and Measures

The study was conducted 100% online due to COVID-19 guidelines; a Qualtrics-based survey was used for data collection. After providing consent and responding to some basic demographic questions, participants were asked to engage in a series of 360 video viewing activities. Prior to watching the 360 videos, participants were instructed to wear headphones and record the form they were using (earbuds, on-ear, or over-ear). Next, PSTs watched an embedded 360 video serving as a tutorial for how to watch a 360 video. The introductory video guided viewers how to move the camera perspective so different places in a virtual space were viewable.

Following the tutorial video, participants watched the 360 video of focus for the first time. The selected video included a fourth-grade lesson on comparing fractions with fraction strips and common denominators (5:26 in length). After viewing, participants were asked to describe key pivotal moments (e.g., "any moment you believe is important for the teaching and/or learning of mathematics") and, using a clickable map, to identify the "top ten locations" in the classroom where they focused their attention the most (see Figure 1) (the reference RFA). For this initial viewing, all participants viewed the 360 video in the central camera location (between the back-left and back-right tables) and were assigned to either the ambisonic or monophonic audio condition.

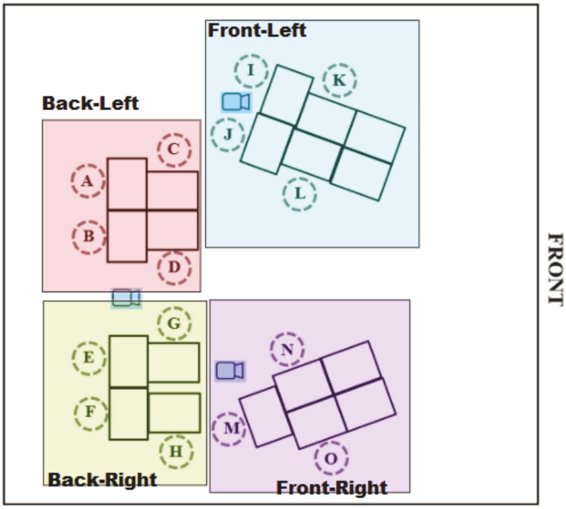

Figure 1. Classroom Map with Regions Labeled.

For the second viewing, participants were randomly assigned to either the left-hand camera position or the right-hand camera position. As illustrated in Figure 1, the camera on the right-hand side of the classroom was positioned between two tables, providing a potentially wider range of viewable student actions (see Figure 2). The camera on the left-hand side of the classroom was positioned between two students at a table. Although other tables were still viewable, the camera position was proximally closer to students' work and interactions (see Figure 2). The images presented in Figure 2 represent stretched views of the 360 video used; what being viewable in the spherical format is just a portion of all that is recorded. In each of the examples in Figure 2 is evident that student work and interactions were visible from each and every view, with specific tables in the initial view also observable in the second view.

Center Camera *Initial Viewing*

Left-Hand Camera *Second Viewing*

Right-Hand Camera *Second Viewing*

Figure 2. Classroom Map with Regions Labeled.

After viewing the video a second time, participants were reminded that although they previously reported several pivotal moments they noticed, they were now asked to focus on one pivotal moment. PSTs were then prompted to describe that key pivotal moment and explain why it was important for the teaching and/or learning of mathematics. As with the initial prompt, participants were then asked to identify the top ten locations they focused most during their second viewing. After watching the 360 videos and describing what they noticed, participants were asked to respond to the *Extended Reality Presence Scale* (XRPS) (Gandolfi et al., 2021b), which is described fully in the Measures and Covariates section. For the purposes of the present study, data from the XRPS, clickable map, and condition assignment were used. Analysis of participants' written noticing (i.e., explanations of pivotal moments in the 360 video) is discussed in a separate paper and lies out of the scope of the present study.

Measures and Covariates

The XRPS includes 22 items with a Likert-scale response (0 = Never to 4 = Always) Inspired by the *Multimodal Presence Scale* (Makransky et al., 2017), it includes items such as "I felt like I was with actual students in the classroom" and "I felt that my actions could affect what was happening in the classroom." The XRPS was initially validated by Gandolfi et al. (2021b) using the *Standards for Educational and Psychological Testing* (AERA et al., 2014). Focusing on these standards, validity evidence was collected towards: *test content*, or how well items assess the construct of presence; *response processes*, or how test takers' responses align with the intent of the items; *internal structure*, or how items conform to the presence construct, and *generalization*, or how the measure generalizes to new contexts.

Although the present study was not designed as a validation study, psychometric evidence for this administration of the XRPS provided various validity evidence. Likert-based scores were modeled using Rasch, such that the raw ordinal data of Likert scale responses were transformed logarithmically into a continuous scale (Bond & Fox, 2018). The XRPS was found to have sufficient item reliability (.98) with a separation index of 6.43, suggesting the XRPS can differentiate between items with higher and lower difficulty. Additionally, strong person reliability (.90), with a separation index of 3.00 suggests the XRPS can differentiate between different groups of people. Item fit statistics (*infit MSNQ* = .99, *Z* = -.19; *outfit MSNQ* = 1.02, *Z* = -.05) and person fit statistics (*infit MSNQ* = 1.06, *Z* = -.05; *outfit MSNQ*

= 1.02, Z = -.08) were all near Rasch modeled expectations of 1 and standardized fit Z values near zero. This suggested that the variance in modeled fit scores was generally in the acceptable range. Lastly, a Wright Map and Construct Key Map were constructed which visually illustrate the relative difficulty of items and their responses. Comparison with the Wright Map from Gandolfi et al. (2021b) suggests strong consistency with item difficulty. Collectively, these data suggest consistency with and support for findings from Gandolfi et al. (2021b) and prior validity argument claims. XRPS scores from the present study suggest a wide range in perceived presence (-1.24 to 4.03), where a score of 0.0 is considered 'average' on a Rasch scale (M = 0.471, SD = .943).

The second primary measure included in the analysis was the unalikeability coefficients (U_2) for participants' self-reported focus in viewing 360 videos (i.e., where participants clicked on the classroom map illustrated in Figure 1). As described by Kader and Perry (2007), the unalikeability coefficient creates a continuous variable to examine how alike the distribution is amongst nominal or categorical variables. The U_2 statistic ranges from 0 to 1 with lower scores representing less variance (i.e., the distributions are less alike) and higher scores representing more similar distributions. To illustrate, consider the distributions shown in Table 1 where PSTs tended to have higher unalikeability in the first viewing of the 360 video ($\overline{U_2}$ = .72, SD = .06) than the second viewing ($\overline{U_2}$ = .63, SD = .14). Specifically, there is a noticeable skew for the second view within the front-left position leading towards a lower U_2 statistic. The U_2 statistics for the first and second viewings were distinguished as U_2Pre and U_2Post respectively.

Table 1

Distribution of Focus by Region and Viewing

	Back-Left	Front-Left	Back-Right	Front-Right	Elsewhere	Total
First View	211 *234.30*	120 *277.91*	230 *291.22*	156 *262.39*	203 *279.39*	920
Second View	106 *82.70*	256 *98.09*	164 *102.78*	199 *92.61*	175 *98.61*	900
Total	317	376	394	355	378	1820

In addition to participants' presence scores and U_2 statistics, it was important to understand if the statistical effects were associated with participants assignment to the ambisonic or monophonic condition. This was designated with a dummy-coded variable for monophonic audio (*d_Mono-*

phonic, $n = 24$). A dummy-coded variable was also used to indicate if participants were assigned to the left-hand side of the classroom for their second viewing (*d_Left*, $n = 44$).

Analysis and Results

Multiple regression analysis was used to examine the statistical effects of initial variance in viewing the 360 video (U_2Pre), perceived presence (*presence*), and assigned conditions for audio (*d_Monophonic*) and second viewing position (*d_LeftCam*) on the variance associated with participants second 360 video viewing (U_2Post). The regression equation is presented in Equation 1.

Equation 1:

$$U_2Post = B0 + B1 \cdot (U_2Pre) + B2 \cdot (Presence) + B3 \cdot (d\_Monophonic) + B4 \cdot (d\_LeftCam) + e$$

Results from the initial model were statistically significant, with the model explaining 34.7% of the variance ($F(df{=}4){=}9.718$, $p<.001$). Both the unalikeability statistic for the first viewing ($B_1 = .493$, $p = .018$) and participants' reported presence ($B_2 = .034$, $p = .012$) were statistically significant and positive. This suggested that PSTs with a higher sense of 'being' in the classroom, and with a wider range in areas of focus in the initial viewing, tended to report focusing on a wider range of regions in the classroom in their second viewing. Both the *d_Monophonic* ($B_3 = -.093$, $p = .001$) and *d_LeftCam* ($B_4 = -.106$, $p < .001$) conditions were found to be statistically significant and negative, suggesting that these facets decreased the variance in focus participants reported in the second viewing. However, patterns in the data prompted the inclusion of an interaction effect between these variables (*d_Monophonic* & *d_LeftCam*) for the final model. Inclusion of this interaction effect is illustrated in Equation 2 and represents the final model.

Equation 2:

$$U_2Post = B0 + B1 \cdot (U_2Pre) + B2 \cdot (Presence) + B3 \cdot (d\_Monophonic) + B4 \cdot (d\_LeftCam) + B5 \cdot (Monophonic \times LeftCam) + e$$

The final model was found to explain 34.7% of the variance in PSTs second viewing unalikeability ($F(df{=}5) = 8.914$, $p < .001$), with overall results presented in Table 2. Noticeably, the interaction effect explained much of the statistical effect of the monophonic condition, and a portion of the left-hand camera position. As with the initial model, results suggest that variance in focus for the first viewing (central camera position) and PSTs' sense of presence in the recorded classroom each had a statistically significant and positive effect on their reported spread of focus in the second viewing. However, the negative effect associated with the monophonic condition was explained by the interaction effect. While the negative effect associated with the left-hand side of the classroom (second viewing) was partially explained by the interaction effect, it was still statistically significant and meaningful in magnitude. Results suggest that the statistical effect of audio on the variance in PSTs' reported viewing in the 360 video was strongly associated with their position of viewing (and listening) in the classroom. More specifically, PSTs viewing from the right-hand side of the classroom tended to have similar unalikeability for both monophonic ($\bar{U}_2$=.65, SD=.12) and ambisonic ($\bar{U}_2$=.69, SD=.08) conditions. However, this was not true for monophonic ($\bar{U}_2$=.48, SD=.20) and ambisonic ($\bar{U}_2$=.62, SD=.12) conditions on the left-hand side of the classroom.

Table 2
Regression of PSTs' Unalikeability of Focus on
Presence and Conditions of Viewing

	Unstandardized coefficients		Standardized coefficients		
	B	*SD*	*β*	*t*	*p*
Intercept,	.282	.146		1.931	.057
U_2 Pre,	.546	.202	.245	2.710	.008
Presence,	.033	.013	.227	2.557	.012
d_Monophonic,	-.033	.040	-.105	-.821	.414
d_LeftCam,	-.076	.029	-.276	-2.669	.009
Interaction (Mono × Left),	-.115	.056	-.292	-2.051	.043

These results suggested that when viewing 360 video of classroom practice, PSTs' sense of presence is positively associated with their self-reported situated awareness in the classroom. However, both camera placement and realism of the audio can affect (and interact) to decrease such situated awareness. A subpar or different camera placement for 360 video may be mitigated by other technological factors, such as ambisonic audio in this analysis. However, future study is needed to fully understand these various factors.

DISCUSSION

This study was created to explore the potential role of presence, ambisonic audio, and camera placement in affecting RFA variance. The main objective was to understand if and how these factors should be considered when designing and implementing XR videos for preservice teachers. RQ1 explored whether the feeling of presence in 360 videos was a predictor of RFA variance. The study's results point at presence as a positive predictor of RFA variance, reinforcing previous evidence that promotes the use of 360 videos for PSTs (Gandolfi et al., 2021b; Huang et al., 2021; Roche & Gal-Petitfaux, 2017). The feeling of being immersed in the recorded environment seemed to be associated with PSTs ability to 'own' the classroom, map relevant events across the setting observed, and become more aware.

Additional investigations are needed to shed light on this presence and how to properly support it. For instance, studies could focus on the content of the 360 videos watched (e.g., grade level, content area). Future research could also examine PSTs' traits (e.g., major, academic standing) (Gandolfi et al., 2021a). Such a recommendation is aligned with Korthagen (2010), Huang et al. (2021), and Kosko et al. (2022), who all highlighted how PSTs' awareness strongly relies on perception and embodiment processes. This aspect suggests additional studies targeting XR technologies and related potential in terms of sensorial environment are required.

RQ2 asked whether the use of ambisonic audio in 360 videos was a predictor of RFA variance. Results suggested that the role of ambisonic audio played an important role in improving RFA variance but only in the subsample using the perspective at the left-hand side of the classroom. This finding may be related to the fact that with poor camera placement, 3D audio can make a difference in improving situated awareness among PSTs, working as a counterbalancing feature. This is an important finding considering conflicting evidence from the literature may have resulted from different camera placement (e.g., Ferdig & Kosko, 2020; Huang et al., 2021); said differently, 3D audio may have changed the results of those studies. Such a result expands our understanding of how ambisonic audio can be implemented (Ferdig et al., 2020). Moreover, it ties in with RQ3 ("Is camera placement in 360 videos a predictor of RFA variance?") to suggest that camera placement does have an impact on RFA of PSTs. Therefore, these two factors interact in influencing PSTs' RFA and related perceptual capacity.

Implications

There are two major implications of this study. First, presence needs to be recognized as an important factor to promote and facilitate in XR experiences designed for PSTs (Makransky et al., 2017). Research has provided evidence that PSTs often experience more feelings of presence in 360 videos compared to standard video (Ferdig & Kosko, 2020; Roche & Gal-Petitfaux, 2017). As such, teacher educators should consider the use of immersive technologies like 360 video for teacher training (e.g., Gandolfi et al., 2021b; Lorenzo et al., 2013). By promoting an embodied experience (Fincher-Kiefer, 2019), such technologies allow PSTs to be more immersed and present within the video.

There is a caveat with this implication. While data from RQ1 showed a relationship between presence and RFA, it also provided evidence that not all students had high levels of presence. In other words, as with all technologies, simply adding 360 video to a PST curriculum does not ensure positive teaching or learning outcomes. More work needs to be done to examine why students had varying levels of presence. A hypothesis, however, may come from the work of Yung et al. (2020). They argue that presence is part of a framework that includes immersion, engagement, and sensory fidelity. It could be easily argued that the 360 video combined with the ambisonic audio in the current study provided opportunities for both immersion and sensory fidelity. The study methodology, though, brought in PSTs that were not elementary majors and those who might not teach elementary math. This was the focus of the videos and may have significantly impacted the third part of their model—engagement. While such a hypothesis was not directly tested in this study, other research backs such claim. For instance, Gandolfi et al. (2021a) showed that learning gains through 360 video were related to the context of the videos being offered to the PSTs.

Future research could investigate presence (perhaps according to the model offered by Yung et al., 2020) to determine how context and content changes impacted outcomes (e.g., according to XR technologies used, users involved, and themes addressed). More analytical efforts would help teacher educators understand how to increase presence (e.g., activities recorded, instructions provided to PSTs before watching) and what factors should be considered (e.g., PSTs' content knowledge, previous field experiences, etc.). This is particularly important considering conflicting evidence about PSTs' noticing skills in immersive videos (see Gold & Windscheid, 2020 and Huang et al., 2021), and how different traits may impact their ability to focus.

A second implication relates to the affordances and constraints of the technologies used to record classroom video in the support of PST instruction. Camera placement is never going to be perfect (outside of a scripted event) because no one can predict where teachable moments are going to occur in the classroom (e.g., where the teacher is going to be, which students are going to say thing you wish to capture). This study outcomes lead to suggested ways to mitigate camera placement. For instance, the use of 360 video allowed students to look in multiple directions. Moreover, the inclusion of ambisonic audio with that 360 video allowed PSTs to focus their attention because they could tell the directionality of audio (as already suggested by Ferdig et al., 2020), even when camera placement was not ideal. Finally, multiple cameras were used in the study. While PSTs were not given the option to change between cameras, future implementations could allow for PST movement to enhance their attention in the classroom. Such implications obviously also call for future research addressing different camera placements.

Limitations

The study had five limitations. First, it relied on self-reported data, which can include biases and a lack of objectivity. Additional studies should rely on different data sources such as video recordings, eye-tracking, and teaching performance; in addition, alternative methodologies (e.g., qualitative analyses about PSTs' perceptions of immersive technologies, longitudinal investigations also involving the sample recruited for a follow-up) may be considered to triangulate this study's findings. Second, the study used RFA as a reference variable; however, additional measures like written noticings could have been considered (see Dick, 2017; Eröz-Tuğa, 2013). Third, the study relied on 360 videos focused on math education; future research should continue to explore other content areas. Fourth, the sample recruited was limited to PSTs with lacking field experience; further investigations should focus on educators with more expertise (e.g., in-service teachers) to test this study's results.

Finally, the role of the three factors analyzed deserves further investigation. For instance, the inclusion of ambisonic audio and 360-degree video may increase perceptual capacity for PSTs observing classrooms. Multiple cameras might also enhance both perceptual capacity and a sense of presence. However, it could also lead to cognitive overload as PSTs attempt to navigate to the right position. Moreover, presence mattered in this study. However, it was unclear what led certain students to feel presence while others did not. Future work should address feelings of presence, factors impacting the sense of presence, and how presence continues to impact RFA.

CONCLUSION

The present study was created to shed light on potential factors influencing PSTs' situational awareness in 360 videos. The study specifically focused on the feeling of presence, ambisonic audio, and camera placement. Results pointed to insights that can be used by practitioners and scholars to improve and refine the use of immersive videos for future educators. For instance, presence was found to be a positive predictor of PSTs' RFA variance; therefore, this construct should be evaluated and considered (i.e., examining what video features may support higher presence) when using 360 videos for PST education. Additionally, ambisonic audio showed promise in supporting PSTs' focus only with a specific camera placement (i.e., left-hand side of the classroom); this suggests that multiple technological factors need to be considered when using immersive videos for teacher training. At the same time, further lines of inquiry should be considered for expanding our knowledge of 360 videos (and other XR technologies) for teacher training and professional development. Outcomes from this study could serve as a foundation for those future studies.

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