Leveraging Virtual- and Augmented - Reality for Social Learning: Preservice Teachers' Experiences and Perceptions

This study examines preservice teachers' (PTs)' experiences and beliefs regarding extended reality (XR) for social learning and teacher development. A cross-sectional survey design was adopted with a total of 197 participants. The results showed that about half had no or only limited knowledge of XR and only 15% reported very or extremely familiar with XR technology. Among other results, PTs were generally skeptical regarding the potential of XR both for student social development purposes and for teaching support.

This study focuses on a critical, yet understudied area, by exploring preservice teacher (PT) beliefs about using extended reality (XR) to enhance social learning. In this paper, XR refers broadly to immersive technologies, including augmented reality (AR), virtual reality (VR), and mixed reality (MR).

The new advanced technologies such as the immersive XR tools bring about new possibilities to teach and learn. XR, an emerging technology with high educational potentials (Brown et al., 2020), is predicted to achieve a global market value of over $826 billion in 2032 from around $42 billion in 2023 (Skyquest, 2025). XR has a unique ability to manipulate reality through simulating the existing world, reproducing a different terrain, or creating a brand new reality (Slater, 2017). Users experiencing perceptual illusions in an immersive environment, from the illusion of having a virtual body, to experiencing a virtual event, is a unique yet powerful characteristic of XR. These illusions send cues to our brain, which in turn, can influence our beliefs and behaviors (Liu et al., 2017). One example is the Proteus effect which refers to one's perceptual illusion of owning a virtual body as his/her own body. For instance, some experiments have showed that peoples' digital representations have impacted their behavior, such as the height of people's virtual bodies was associated with their level of confidence in negotiating tasks (Yee & Bailenson, 2007). XR, thus, affords new promises in education. In fact, review studies, including several meta-analyses, have reported significantly higher learning gains in varied XR environments than in traditional classrooms (e.g. Merchant et al., 2014; Smetana & Bell, 2012; Vogel et al., 2006; Wu et al., 2020).

At the same time, in education, it is widely accepted that social interactions play a significant role in learning. Well-established social cognitive theory and social learning theory (Bandura & Walters, 1977; Vygotsky, 1978) have offered solid theoretical foundation, highlighting social interaction as a critical force in human development. In an XR environment, the reality can be manipulated, meaning one's behavior can be transferred either naturalistically (i.e. the same way as in face to face situations) or altered by computers (Blascovich & Bailenson, 2012). For example, a person whose appearance is unfriendly in real life may be programmed as a very happy/friendly individual in a virtual world. XR can also provide opportunities for learners with social anxiety to practice in

a low-risk setting. Thus, when social interactions occur within an immersive virtual world, new possibilities are brought about that otherwise would be impossible (Kramer, 2017).

While XR has been used extensively for professional training in various fields (e.g. industry, military, health, biology), its application in teacher education has only evolved very recently (McGarr, 2021). Further, though XR is not a new concept, it is not until now that the cost of XR technologies is low enough and XR applications are user friendly enough that classroom implementation becomes possible (Dick, 2021). With the rapid evolution of AI, AI-enhanced XR further amplifies its potential, pushing its transformational power of education to a new level. Researchers, after surveying the landscape of the field, have concluded that there is a dearth of research in XR and teacher education (Billingsley et al., 2019). This study aims to address an important gap that existed in literature: the lack of research examining how immersive XR technology can be used in teacher training, especially related to social learning.

Specifically, this study examines PTs' experiences and perceptions about XR in connection with social learning. The results can help reveal possibilities of these powerful technologies for fostering social learning, essential for preparing future teachers and potentially transforming education. The following research questions guide this study

1. What are preservice teachers' experiences of XR technology?
2. What are PTs' beliefs about how XR technology can promote student social learning in their future classrooms?
3. What are preservice teachers' beliefs about XR technology to support teacher training?
4. Does the PTs' self-reported familiarity with XR connect to their beliefs about XR for social learning skill development?

Related Literature

Theoretical Framework

This study is grounded in the social learning theory based on the pioneer work of Bandura and Vygotsky and the Technology Acceptance Model (TAM) (Davis, 1989). Social learning theory, a fundamental perspective in educational psychology, suggested that learning is influenced by watching, copying, and interacting with others (Bandura, 1977; Vygotsky, 1978). Social learning involves people learning from each other and benefiting from wider social-ecological systems (Reed et al., 2010). It emphasizes that learning occurs through interactions with others, highlighting the value of collaboration, communication, and observation. Stressing the critical value of social context in shaping individual cognition and behavior, social learning theory places collaborative learning, peer-to-peer interaction, and modeling at the center of education. In recent years, the emergence of XR technologies has opened new

avenues for exploring and enhancing social learning. These immersive technologies have the potential to transform traditional educational settings by creating interactive and engaging learning environments in ways not previously possible (Scavarelli et al., 2021). Framed by social learning theory, this study explores PTs' perspectives on how XR can support social learning in both their own development and their future students' learning.

TAM explains why people decide to accept or reject a new technological tool. In this model, three key factors, namely *perceived ease of use, perceived usefulness,* and *attitude towards using*, contribute to the user's motivation for adoption (Davis, 1989). Since its inception, numerous studies in different domains, from e-learning to e-business, have confirmed the validity of TAM, making it a key model in predicting people's behavior towards accepting or rejecting a particular technology (Granić & Marangunić, 2019). In the current study, TAM complements social learning theory by linking PTs' familiarity with XR and their perceptions of its usefulness in both classroom and teacher education. Guided by TAM, this study focuses on PTs' perceptions and possible connection with their experience, providing insights into how these factors shape PTs' practice related to XR integration.

Preservice Teacher Beliefs & XR

Augmented reality (AR) and virtual reality (VR) are not new concepts. AR overlays machine-generated information on the user's view of the real world, offering an integrated perspective (Azuma, 1997). VR creates an interactive three-dimensional space with a sense of spatial presence for objects (Childs, 2023). These emerging technologies could offer interactive 3D models and simulations that help students visualize abstract concepts and develop practical skills, ultimately improving educational outcomes (Ardiny & Khanmirza, 2018). AR and VR environments could offer unique opportunities for creating immersive, interactive, and collaborative experiences to foster social interaction, communication, and knowledge construction in previously unimaginable ways. By simulating real-world scenarios, facilitating collaboration across distances, and providing access to diverse perspectives, XR could promote social dynamics of learning and create more engaging, inclusive, and effective educational experiences.

There is a growing and limited body of research examining PTs' familiarity with and beliefs about XR technologies. Current literature shown that while PTs were generally acquainted with XR technologies, they often lacked pedagogical strategies and technical training for effective classroom integration. For example, a study (Taggart et al., 2023) of 232 PTs in Ireland showed that PTs were aware of AR/VR technologies, but their actual experience using them was limited. Fewer than 2 % reported frequent use, and those instances were primarily for playful social interactions rather than educational applications. Similarly, a systematic review of 149 studies published between 2000-2019 showed the scarcity of VR integration in k-16 classrooms (Luo et al., 2021).

Research exploring PTs' beliefs reflects a similar trend. Taggart et al. (2023) conducted a mixed-methods study involving 232 PTs from different universities in Ireland. Through an online survey and follow-up focus group interviews, the study explored PTs' perceptions of using XR in educational contexts. The findings revealed that participants held generally positive beliefs about XR's potential to foster collaborative and creative learning experiences. Many viewed XR as a valuable tool for supporting social learning through project-based and interactive activities.

In the US, Fegely and colleagues (Fegely et al., 2024) surveyed 24 PTs and qualitatively analyzed their responses to open-ended questions focusing on PTs' perceived ease of use and usefulness of VR technology in their teaching practice. They found that PTs' acceptance and comfort with using new technologies, such as VR, played a crucial role in their likelihood to integrate them into their teaching practices. Likewise, Figueroa-Flores and Huffman (2020) explored PTs' perceptions of the strengths and limitations of XR. This qualitative study of 27 PTs found that PTs considered both AR and VR as useful to enhance engagement, motivate students and provide rich visual support.

Other studies focused on more specific contexts of XR use. Dalinger and colleagues (Dalinger et al., 2020) investigated PT candidates who engaged in short mixed reality simulations, covering scenarios such as teaching middle school students and engaging in parent-teacher conferences, in their teacher education courses. The qualitative analysis of data collected from interviews with 13 PTs revealed that the simulations enhanced the candidates' confidence and preparedness for actual classroom experiences. Participants reported a positive transfer of learning from the simulation to their fieldwork, particularly in their interactions with students and parents. However, they also identified challenges such as suspending disbelief. Overall, the PTs viewed the simulations positively and recommended early exposure to develop classroom management and instructional skills.

In Turkey, Sat et al. (2023) investigated 55 PTs' perceptions and experiences with AR after they participated in a five-day online seminar focusing on various AR tools. The mixed-methods study found that the PTs developed an overall positive outlook on AR tools after experimenting with AR, while also identifying major usability, technical and pedagogical challenges. Similarly, Ogegbo et al. (2024) conducted an online survey of 83 pre-service science teachers in South Africa to explore their attitudes toward using VR in classrooms. The results showed that while PTs were very interested in integrating VR into their future classrooms, their willingness to adopt the technology was mainly influenced by their peers and their confidence in using VR tools.

Finally, Van der Want and Visscher (2024) systematically reviewed 24 research publications on the potential of using VR in teacher education. They discovered that the studies on VR integration in teacher development were mostly exploratory and small-scale. While the reviewed studies adopted various methods, including case studies and quasi-experimental designs, no survey study existed. They concluded that there existed a growing interest and positive

outlook on the potential of VR technologies in teacher education, despite PTs' limited exposure to these tools.

Collectively, these studies demonstrate that research on XR in teacher preparation, particularly related to PT beliefs, is developing but still in its infant stage (McGarr, 2021). The limited studies conducted to date have either largely been situated outside the US or relied on small scale qualitative designs.

Beliefs related to social learning & XR

Despite the growing interest in XR applications in education, research on PTs' beliefs about XR in connection with social learning remains notably scarce. The few available studies suggested that teachers recognize the potential of XR to support students engaging in joint problem-solving tasks, team-based simulations, which aided in developing essential social competencies (Scavarelli et al., 2021).

PTs preferred virtual environments that supported social interactions, peer discussions, and reflective practices to enhance their professional development. A couple of studies conducted in Ireland (Taggart et al., 2023) and Australia (Lee et al., 2025) revealed that PTs saw virtual worlds as unique spaces where they could engage in dialogue, share experiences, and collaborate with colleagues and mentors, fostering a sense of community.

In a mixed-methods study, Lugrin et al. (2016) examined the experiences of PTs using a VR-based classroom management simulator. The study included 22 PTs in German who engaged with virtual student avatars in classroom scenarios. PTs believed that this practice enhanced their self-efficacy in managing social dynamics and fostering productive classrooms. The study found that PTs valued VR simulations for providing safe spaces to improve classroom management and interaction skills, leading to increased preparedness.

PTs also viewed XR as supporting observational learning and empathy development. Huang et al. (2022) surveyed 231 preservice teachers from Taiwan, testing an extended technology acceptance model related to VR use in classrooms. Participants reported that immersive VR simulations increased their empathy for students from varied backgrounds and provided valuable opportunities to observe complex classroom interactions.

In sum, though interest in XR in classrooms is on the rise, research on PTs' perceptions about the tools remain limited, with even fewer studies addressing the social dimensions of learning. The few studies that existed are either conducted in the context outside US, or on a small scale. To bridge this gap, the present study investigates PTs' perceptions of XR in relation to social learning.

Methods

Adopting a cross-sectional survey design, this study examined PTs' experiences with and perceptions of XR focusing on social learning. This design allowed collecting quantitative data at a single point in time, providing a snapshot of PTs' familiarity with and beliefs about XR. This study was part of a large project aimed at examining preservice teachers' views of emerging technologies in education. This study received institutional ethics approval, and all procedures followed approved protocols.

Participants

A total of 197 PTs participated, including 111 females, 34 males, others were either non-binary or unreported. They presented different stages of the pre-service teacher program, ranging from first year enrollment to the last year of study, including those at the Master of Teaching (MAT) level of the program. In terms of grade level, about 57% of the PTs anticipated teaching elementary students (i.e. kindergarten through 5th grade), around 13% in middle school (grades 6-8), and approximately 19% expected to teach at high school level (grades 9-12). Regarding content area, almost half (~46%) PTs wanted teaching English Language Arts (ELA), and a similar number (~41%) identified Global and Social Studies. A smaller portion (35% - 38%) were interested in STEM fields, around one-tenth in music. Amongst them, some PTs planned to teach multiple subjects.

Instrument

A survey instrument was developed by the research team with diverse expertise in educational research and educational technology. Adopting a 5-step process (Yaddanapudi & Yaddanapudi, 2019), the team first determined the content topic of interest. The second step involved a thorough review of existing literature on XR experience and XR-supported social learning. This review led to the identification of gaps in existing work in two areas: 1) PTs' perceptions of XR and social learning and 2) their views about designing AI supported, XR-enhanced environments for teacher training. Findings from this process guided the third step, in which an initial instrument was developed. Relevant scales and constructs identified in prior studies were adapted to develop the current instrument.

In step four, a team of experts in educational technology and research methodology from different fields evaluated the suitability and accuracy of the instrument. Their feedback guided the modification and refinement of the survey, including the elimination of inappropriate items. Finally, in step five, a total of five PTs representing the targeted sample pilot tested the instrument. Results from this step informed further refinements to the survey. The significance changes at this stage were mostly related to re-wording items and

adding details to a few items to avoid confusion. This modified version became the final survey instrument used (Mills & Gay, 2016).

The survey encompassed a total of five sections with the first section defining three key concepts, namely AI, AR, and VR. Specific examples were included in the definitions to ensure a common understanding of participants. The second section asked PTs to rate their familiarity with AI and XR through two 5-Likert scale questions. The third section started with this paragraph to set the scene: "Imagine that **you live in a perfect world and** are asked to teach your future students using AR/VR/AI tools and **have all the needed skills and technologies based on what you know now...**" [highlight original].

Participants responded to 16 items on potential use of XR technologies, following the instruction: "*On the scale of 1 – 5 (1 = Not at all useful, 5 = Extremely useful), how much do you agree or disagree with the following statements: As a future teacher I believe AR & VR will be useful by…*". These items addressed both social-emotional support (e.g. helping students communicate and interact effectively) and instructional tasks (e.g. customizing learning materials, providing timely feedback, improving classroom management). The fourth part, consisted of eight 5-Likert scale items, examined PT's views on designing AI-supported XR environments for teacher training focusing on social learning. The last section of the survey collected PTs' demographic information.

Analyses

The anonymous survey was conducted in one of the two formats: 1. An online version using Qualtrics, and 2) a paper and pencil survey. Several instructors in an education college voluntarily helped distribute the survey in their preferred format (i.e. paper-pencil or online). PTs were fully informed about the objectives of the study and their rights as participants. PTs were reminded that if they had already completed the survey, they should not participate again.

Descriptive data analysis and correlation measures of the responses were used to answer the research questions. Descriptive statistics were used to answer research questions one to three, examining the perceptions and beliefs of preservice teachers about XR tools and their potential to support social learning and improve student communication. Pearson's r correlation coefficients were used to answer research question four, investigating the relationship between preservice teacher familiarity with XR tools and their views on AR/VR environments for teacher training focusing on social learning.

Results

Experience

The first research question examined PTs' experience with XR by assessing their level of familiarity with the technology. Almost half (~47%) stated either they had no or only limited knowledge of AR/VR technology. About one in three (~33%) believed they had *moderate familiarity* while just over 15% of survey respondents claimed to be *very* or *extremely familiar* with AR/VR technologies (see Table 1).

Table 1. *PTs' familiarity with XR*

Level of familiarity with AR/VR	Frequency	Percent (%)
Not familiar at all 1	27	13.7
Slightly familiar 2	66	33.5
Moderately familiar 3	66	33.5
Very familiar 4	26	13.2
Extremely familiar 5	4	2.0

XR & Social Learning

The second research question focused on PTs' beliefs about how XR could promote social learning and support teaching in their future classrooms. Social learning aspect focused on these three key dimensions: 1) personal development and self-expression skills, 2) emotional expression and social interaction, and 3) cognitive discernment skills.

Personal development & self-expression skills

The first dimension of social learning examined PTs' perceptions on self-expression skills, encompassing both self-representation and argumentation (Table 2). When asked about the potential of XR to support self-representation, under half of participants (45%) ranked XR tools as minimally or not at all beneficial. Only 30% considered XR moderately useful, while under one in four (24%) thought the tools would be very or extremely valuable.

Regarding using XR to foster argumentation skills, under half (~46%) PTs judged XR to be of little or no value in this respect. About one in three (32%) saw moderate potential, while only 22% considered XR to be *very* or *extremely useful* in enhancing students' argumentation skills.

Secondly, personal development skills, which included self-awareness and confidence, showed similar patterns. Regarding self-awareness, the majority (52%) felt XR as having limited or no utilization in helping students recognize their own strengths and weaknesses. Just over a quarter (26%) viewed it as moderately helpful and only one fifth (21%) believed it to be *very* or *extremely useful*. Similarly, in relation to confidence-building, almost half (45%) expressed

skepticism about XR's effectiveness, with close to one third (31%) indicating moderate usefulness. Again, only one in four (25%) found XR to be very or extremely beneficial in this area.

Table 2. *Beliefs about XR supporting Personal development & self-expression skills*

As a future teacher I believe AR & VR will be useful by...	**Not at all useful (1)**	**Slightly useful (2)**	**Moderately useful (3)**	**Very useful (4)**	**Extremely useful (5)**
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Using avatars or optimized self-representation (e.g. altered one's appearance/ sex/race or behavior) to better interact with others such as students	29 (17.5%)	46 (27.7%)	51 (30.7%)	28 (16.9%)	12 (7.2%)
Helping students develop argumentation skills (e.g. using visual data representation to support arguments)	21 (12.6%)	55 (32.9%)	54 (32.3%)	30 (18.0%)	7 (4.2%)
Allowing students to identify their own strengths and weaknesses	37 (22.2%)	50 (29.9%)	44 (26.3%)	31 (18.6%)	5 (3.0%)
Helping students build confidence when sharing ideas	29 (17.4%)	45 (26.9%)	52 (31.1%)	34 (20.4%)	7 (4.2%)

Emotional expression and social interaction:

The second key dimension of social learning addressed emotional expression and social interactions. This investigation considered PTs' perceptions of XR's potential to support three interaction-related skills: 1) emotional development, 2) collaboration skills, and 3) interaction skills between peers and teachers to build positive relationships.

First, Regarding the use of XR for creating safe spaces for students to express their emotions, over one third (37%) viewed XR as only *slightly* or *not at all useful*, with another third (34%) considering XR *moderately useful*. Less than one third (29%) considered XR to be *very* or *extremely useful* for this purpose.

Next examination centered on PTs' views about using XR to support the development of collaboration skills. Roughly half (49%) of participants perceived XR as *slightly* or *not at all useful*. Over one in four (29%) considered

XR to be *moderately useful* while under one in four (22%) considered it to be *very* or *extremely useful* to support collaboration skills.

Finally, PTs beliefs about using XR to motivate social interaction and relationship building were explored. While the same trend can be seen here, PTs seemed even less optimistic for the potential support XR tools could provide in these areas.

For peer interaction, more than half (52%) viewed them as *slightly* or *not at all useful* while under one in three (31%) viewed them as *moderately useful*. Few participants (17%) viewed XR as *very* or *extremely useful* to support peer interaction. Perceptions on XR support for student teacher interaction followed similar patterns with well over half (54%) of participants considering it to be only *slightly* or *not at all* useful. Just under a third of participants (32%) perceived it to be *moderately useful* while about one in six (14%) believed it would be *very* or *extremely useful* for this type of social interaction.

Regarding positive relationship building skills, under half of the participants (~45%) believed XR as having little to no usefulness in supporting the development of this social learning skill. One in three (33%) believed XR *moderately useful*, while around one in five (22%) viewed XR as *very* or *extremely useful* in this area. Table 3 presents details.

Table 3. *Beliefs about XR supporting Emotional expression and social interaction*

I believe AR & VR will be useful by...	**Not at all useful 1**	**Slightly useful 2**	**Moderately useful 3**	**Very useful 4**	**Extremely useful 5**
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Creating safe spaces for learner to express their emotion in a virtual learning world	18 (10.8%)	43 (25.7%)	57 (34.1%)	36 (21.6%)	13 (7.8%)
Encouraging students to interact and or collaborate with others	27 (16.2%)	55 (32.9%)	49 (29.3%)	30 (18.0%)	6 (3.6%)
Motivating students to interact with PEERS	40 (24.0%)	47 (28.1%)	51 (30.5%)	23 (13.8%)	6 (3.6%)
Motivating students to interact with TEACHERS	46 (27.5%)	44 (26.3%)	54 (32.3%)	18 (10.8%)	5 (3.0%)
Helping students learn positive relationship building in a simulated world	29 (17.4%)	46 (27.5%)	55 (32.9%)	29 (17.4%)	8 (4.8%)

Cognitive discernment skills

The third key dimension of social learning was cognitive discernment skills including: 1) supporting situated interactions, 2) decision making and risk takings skills, and 3) self-reflection skills.

First, with regards to using XR for situated interactions such as virtual tutors or peers, one in three (~33%) participants felt that XR offered little to no value for simulating these types of interactions. Another 37% considered XR as moderately beneficial, while the remaining 30% believed it to be very or extremely effective for this purpose.

Second, in relation to developing decision-making skills, almost half (~47%) believed XR offered little to no benefit. Over one in three (~37%) rated XR as moderately useful while only about one in six (16%) believed it to be very or extremely useful in supporting decision-making development.

Lastly, regarding the cultivation of risk-taking skills and learning from mistakes, PTs views were similarly mixed. About one in three (35%) felt XR tools were of limited or no use in encouraging risk taking. Just over one in four (28%) believed them moderately useful, while over one in three (37%) believed that XR tools could be very or extremely valuable to support risk taking skill development. When considering learning from mistakes, one in three (32%) expressed skepticism about XR's usefulness, one third (34%) saw moderate value, and a notable 52% regarded XR as *very* or *extremely useful* in this area. Table 4 shows details.

Table 4. *Beliefs about XR supporting cognitive discernment skills*

I believe AR & VR will be useful by...	**Not at all useful 1**	**Slightly useful 2**	**Moderately useful 3**	**Very useful 4**	**Extremely useful 5**
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Using virtual acting agents to simulate situated interactions (e.g., serve as virtual tutors or peers)	16 (9.6%)	38 (22.9%)	62 (37.3%)	38 (22.9%)	12 (7.2%)
Helping students practice responsive decision making	31 (18.6%)	48 (28.7%)	61 (36.5%)	21 (12.6%)	6 (3.6%)
Encouraging students taking risks in a simulated world	18 (10.8%)	41 (24.6%)	47 (28.1%)	47 (28.1%)	14 (8.4%)
Allowing students to learn from mistakes in a simulated world	18 (10.8%)	36 (21.6%)	56 (33.5%)	41 (42.6%)	16 (9.6%)

Support teaching

Research question two also investigated PTs' perceptions of XR support teaching in their future classrooms, focusing on the areas of learning material customization, providing just-in-time feedback, and classroom management skills.

As detailed in Table 5, PTs expressed mixed views on the usefulness of XR tools in these areas. When it came to customization of learning materials, one in three (35%) of PTs felt XR to be of little to no value, while about an equal

number (~36%) of participants rated it could be very or extremely effective in this area. Another 29% considered XR moderately useful.

With regard to feedback, participants' perceptions were even less optimistic. Half (50%) believed XR tools were of no use or only slightly useful for this area. Under one third (30%) saw moderate potential, while only one in five (21%) found XR tools to be very or extremely beneficial in delivering timely feedback to students.

Perceptions of XR in supporting classroom management showed similar patterns: over half (51%) reported little to no value, one in three (33%) found it moderately helpful, and just one in six (16%) recognized strong potential for XR in helping improve classroom management.

Table 5. *Beliefs about teaching support of XR in future classrooms*

I believe AR & VR will be useful by...	**Not at all useful 1**	**Slightly useful 2**	**Moderately useful 3**	**Very useful 4**	**Extremely useful 5**
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Helping teachers to customize learning materials	13 (7.8%)	46 (27.5%)	48 (28.7%)	41 (24.6%)	19 (11.4%)
Providing student just in time feedback	44 (26.3%)	40 (24.0%)	48 (28.7%)	26 (15.6%)	9 (5.4%)
Helping teachers improve classroom management	38 (22.9%)	47 (28.3%)	55 (33.1%)	20 (12.0%)	6 (3.6%)

XR-Supported Social Learning in Teacher Preparation

The third research question investigated PTs' preferences for designing XR-enhanced virtual environments that foster their own social learning, with a focus on three subcategories: 1) interaction and visual design elements, 2) customization characteristics, and 3) narrative design elements (see Table 6).

When asked about using avatars to interact with peers and teachers, a vast majority (74%) of participants *somewhat* or *strongly disagreed* that XR would enhance these interactions. Just under one in five (~19%) remained neutral, and very few (~8%) *somewhat* or *strongly agreed* with those statements. Considering visual design elements, most participants (~62%) preferred to use a more realistic avatar, while about one in five (~20%) were neutral. Another 18% preferred or somewhat preferred a more cartoony representation of avatar design.

The PTs preference of customization features was the second subcategory examined. Almost half of participants (49%) *agreed* or *strongly agreed* that it was important to choose their own avatar. Over a quarter (28%) were neutral, while about one-fifth (22%) disliked the option of avatar selection. When considering customization, more than half (56%) indicated a moderate to strong preference for this design feature. About a quarter (24%) were neutral, while roughly one in five (22%) did not prioritize the ability to customize.

The third subcategory referred to PTs' preferences of XR supported gamified designs, including narratives and other game-based elements. Most (60%) PTs preferred or strongly preferred human-like voices for narratives, while over a fifth (21%) were neutral and remaining one-fifth (~19%) favored synthetic voices. Similarly, over half (52%) preferred XR simulations with a compelling narrative, about one in four (28%) were neutral, and one-fifth (~20%) favored a non-narrative design.

Beyond realistic and narratively driven XR preferences, PTS demonstrated openness to gamification. About 41% agreed or strongly agreed that they would prefer the simulated design to have a reward based or gamified features. One in three participants (33%) were neutral on this design element and about one-quarter (~26%) preferred not to have any gamified elements in the simulated environment design. Table 6 shows details.

Table 6. *Preferences of XR design to enhance social learning*

If AR/VR is used to enhance social learning…	**Strongly disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
I prefer to learn through my avatar to interact with other students	74 (46.0%)	46 (28.4%)	30 (18.5%)	8 (4.9%)	4 (2.5%)
I prefer to learn through my avatar to interact with the teacher.	83 (51.2%)	36 (22.2%)	30 (18.5%)	11 (6.8%)	2 (1.2%)
I prefer the learning environment to have a more realistic visualization rather than a cartoony visualization	15 (9.3%)	14 (8.6%)	32 (19.8%)	47 (29.0%)	54 (33.3%)
I would like to choose my own avatar in the learning environment	20 (12.3)	16 (9.9%)	46 (28.4%)	47 (29.0%)	33 (20.4%)
I would like to customize my own avatar in the learning environment	23 (14.3%)	12 (7.5%)	36 (22.4%)	53 (32.9%)	37 (23.0%)
I prefer to learn in an environment involving reward system like gaming point system and leaderboard that can be shared between each other	23 (14.2%)	19 (11.7%)	54 (33.0%)	46 (28.4%)	20 (12.3%)
I would like the AR/VR to have real people narratives/voices rather than computer-generated voices	20 (12.3%)	11 (6.8%)	34 (21.0%)	48 (29.6%)	49 (30.2%)
I would like an educational AR/VR simulation wrapped in a compelling story/narratives	20 (12.3%)	12 (7.4%)	46 (28.4%)	55 (34.0%)	29 (17.9%)

Relationship between XR Familiarity and Perception

To answer research question four, Pearson's correlation coefficients were used between the participants familiarity with AR/VR tools and their perception of said tools for social learning skill development.

Table 7 shows correlations between PTs' levels of familiarity with XR and their perceptions of how XR could support student social learning skill development.

Among the constructs examined, only three showed significant correlations with familiarity. First, the belief that XR could help create safe spaces for learners to express their emotions was positively correlated with familiarity, $r(165) = 0.14$, $p < 0.05$. A second significant relationship emerged for the social learning skill of allowing students to learn from mistakes in a simulated world, $r(165) = 0.19$, $p < 0.05$. Finally, a positive correlation was observed for the perception that XR could help teachers customize learning materials, $r(165) = 0.23$, $p < .001$. Thus, the greater familiarity with XR, the more likely PTs were to perceive it as a tool for creating supportive emotional spaces, enabling students to learn from mistakes, and assisting teachers in customizing learning materials.

Table 7. *Correlation between XR familiarity and perception of XR for social learning skills*

Social Learning Skills	Correlation Coefficient	Sig. (2-tailed)	df
Using avatars or optimized self-representation (e.g. altered one's appearance/sex/race or behavior) to better interact with others such as students	0.04	.558	164
Creating safe spaces for learners to express their emotion in a virtual learning world	0.14*	.028	165
Helping students develop argumentation skills (e.g. using visual data representation to support arguments)	0.12	.071	165
Using virtual acting agents to simulate situated interactions (e.g., serve as virtual tutors or peers)	0.12	.072	164
Encouraging students to interact and or collaborate with others	0.02	.739	165
Helping students learn positive relationship building in a simulated world	0.09	.162	165
Helping students practice responsive decision making	0.08	.200	165
Allowing students to identify their own strengths and weaknesses	0.06	.384	165
Encouraging students taking risks in a simulated world	0.12	.067	165
Allowing students to learn from mistakes in a simulated world	0.19*	.004	165
Helping students build confidence when sharing ideas	0.10	.144	165
Motivating students to interact with PEERS	0.07	.313	165
Motivating students to interact with TEACHERS	0.02	.747	165
Helping teachers to customize learning materials	0.23*	<.001	165

Providing student just in time feedback	0.05	.431	165
Helping teachers improve classroom management	0.05	.469	164

Discussions

This study examined PTs' experiences and perceptions related to XR and learning design of AI enhanced XR environments, with a particular focus on social learning. The results revealed important patterns, with a few worthy of further discussion.

The fact that almost half of PTs have no or limited knowledge of XR, and only 15% have reported very familiar with it, highlights that a vast majority do not have a good understanding of the scope of XR available at their disposal. This aligns with previous research findings that pre-service teachers are aware of AR/VR but lack practical experience and pedagogical training in using them (Cherner et al., 2025; Taggart et al., 2023). Most participants in this study reported limited exposure to XR, and such experiences may have been primarily non-educational in nature. This confirms that XR technology is still rarely used in schools, underscoring the need for teacher education programs to provide more opportunities for PTs to gain hands-on experience and develop pedagogical strategies for integrating AR/VR into their future classrooms.

Findings from this study show a relatively consistent trend when examining PTs' beliefs on AR/VR tools supporting student social learning skills. PTs are generally skeptical regarding the potential of XR both for student social development purposes and for teaching support. Across almost all aspects of the three key dimensions of social learning – ranging from personal development and self-expression skills to social interaction to cognitive discernment - about half of PTs view the tools as of minimal use, suggesting a broader hesitation to integrate XR in classroom for social learning. The only exception is the potential of XR to create safe spaces for students to express emotions, which showed a more balanced distribution across low, moderate, and high levels of perceived usefulness. One possible explanation may be PTs view affective functions of XR are more plausible than its potential to support other social learning skills. However, this pattern of relatively equal distribution may also indicate uncertainty. Given that most participants had limited exposure to AR VR, it is not surprising if they lacked sufficient experience to judge whether or how XR could be support emotional sharing. For teaching support functions of XR, "customization materials" is the only aspect that showed a slightly more evenly proportions across low, moderate and high usefulness, suggesting that PTs had no clear consensus regarding the usefulness of XR in the area.

When considering the design of AI supported XR environments, PTs generally dislike using avatars to interact with others – whether students, teachers, or peers. Instead, they prefer realistic visual and aural design of virtual environments. Autonomy, such as allowing PTs to choose and customize their own avatars, also appears to be valuable. Further, PTs are generally receptive to

gamify XR environments by including game elements such as compelling storylines and reward systems.

Second, the correlation analysis shows that familiarity with XR technology does not necessarily translate into a positive perception of its usefulness, particularly regarding social learning skills. This suggests a gap between PTs' experience and knowledge of XR tools in classrooms, and their perceived usefulness of such tools to promote social learning. One possible explanation is that PTs may lack the needed pedagogical knowledge on how to integrate XR tools into teaching practices. This indicates the needs of more targeted education and professional development that focus not just on the technical aspects of XR tools but even more importantly on their pedagogical applications to enhance social learning.

In addition, PTs consider XR as helping students to customize learning materials but not to improve classroom feedback or management. It is plausible that a lack of practical experience makes it challenging for PTs to see how XR could support classroom management. Similarly, PTs believe XR can help students to learn from their mistakes but not significantly aid in decision-making. This pattern may reflect PTs' perceptions that XR simulations lack the authenticity and even complexity of real-world interactions.

Third, while most constructs examined in this study show no connections, three links with familiarity do emerge. PTs' greater familiarity with XR help them see its potential for creating safe spaces for emotional expression, learning from mistakes, and customizing instructional materials. However, these connections do not extend to other social skills, indicating PTs' narrow recognition of XR's value, particularly in supporting social learning, which aligns with the existing literature (Cherner et al., 2025).

Implications

The results from this study have both theoretical and practical implications. Theoretically, our study extends the literature on emerging technology and teacher education. To date, research on XR and teacher education is scarce with virtually no existing work that explores how teacher education can benefit from XR technology focusing on social aspects. Our work bridges the gap by examining people's beliefs, potentially helping identify and develop effective ways to use XR to support teacher training.

Practically, the results of this research are readily understandable to educators and researchers. Therefore, the results can easily be translated into teaching and learning approaches in different contexts. This information may, in turn, improve learners' academic and personal lives in this technologically advanced society. As well, it may offer ways for us to harness the power of emerging technology to effectively train teachers. Specifically,

1. The fact that a large portion of PTs are unfamiliar with XR suggests that teacher training should integrate more XR-based practice, providing

opportunities for PTs to be exposed to and interact with such powerful tools.

2. The results also show that familiarity with XR alone cannot be translated into recognizing its value, especially related to social learning. Thus, teacher education programs should provide integrated technological and pedagogical training, ensuring that PTs are equipped with adequate instructional and technical expertise to effectively apply XR into their practice.
3. When designing XR-enhanced virtual environments for PTs, several considerations stand out. Realistic design, both visually and aurally, is generally preferred. Providing users with enough control power, such as the ability to choose and customize avatar, is also important. In addition, gamifying the learning environment, such as compelling storylines and reward mechanisms, is another welcomed design feature to enrich PTs' learning experiences.
4. PTs' narrow understanding of XR's value highlights the importance of teacher education should explicitly model and scaffold how XR can support diverse social learning skills. This can broaden PTs' views on the potential of XR in promoting social learning in areas beyond emotional support and learning from mistakes.
5. Since PTs see the power of XR in creating safe spaces for emotional expression for social learning, teacher training can use this as entry point to bridge the gap between PTs' current perceptions and the broader possibilities of XR.

Limitations and future studies

This study has its own limitations. First, the nature of survey design indicates that the investigation of the PTs' perceptions regarding XR in supporting social learning, though broad, cannot go as deep as qualitative studies. Future studies are recommended to explore the same topics adopting qualitative approaches to deepen our understanding of PTs' beliefs and attitudes related to XR application for social learning.

Second, given the scope of this study, we did not collect data on PTs' prior experience with XR are primarily educational or not. Future work should explicitly explore the context of PTs' XR usage, as it can help clarify the sources shaping their beliefs. Additionally, future studies can examine how different XR experiences influence PT's pedagogical views.

Third, longitudinal studies are recommended to investigate the impact of interventions on PTs' perceptions and acceptance of integrating XR into their instructional practices. Experimental design studies can also provide valuable evidence on the effectiveness of different models for preparing PTs with the skills, knowledge and dispositions needed to harness the power of XR. Such information can provide important insights into best practices of teacher education and training.

Conclusions

XR is creating new means for education because it enables learning in a more immersive, engaging environment. Such emerging technologies, thus, have the potential to even transform education. Our study extends the literature on emerging technology and teacher education. To date, research on XR and teacher education is scarce with no research study existing that explores how teacher education can benefit from XR technology focusing on social aspects. Our work bridges the gap by examining people's beliefs, potentially helping identify and develop effective ways to use XR to support teacher training. Until we thoroughly understand PTs' perspectives and the pedagogical conditions under which XR can be effectively integrated, the full potential of these powerful tools cannot be realized.

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