

A systematic scoping review of 360-degree videos in teacher education

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education

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Abstract

Purpose – 360-degree video is recorded with omnidirectional or multi-camera systems that capture all directions at the same time in a spherical view. With immersive technologies gaining momentum and reducing educational cost, it has attracted the interest of the academic community. However, little is known about using 360-degree video in teacher education. The purpose of this study is to conduct a systematic scoping review through a systematic process based on 15 included studies to determine the characteristics, impacts, strengths and weaknesses of the 360-degree video applied to teacher education.

Design/methodology/approach – This study combines scoping and systematic review based on the PRISMA paradigm.

Findings – This paper explores that 360-degree videos are applicable to teacher education, specifically with their positive effects on pre-service teachers' immersion, noticing, reflection and interpersonal competence. However, as for learners' reactions, physical discomfort is reported, like motion sickness.

Research limitations/implications – First, some recently published studies on the subjects were partially accessible, which precluded the authors from adding their findings to this study. Second, the sample of articles is constrained to the search and selection strategies described in the methods section, which increases the possibility that pertinent research may be omitted. Furthermore, this study's summary of the selected research may be inadequate. Third, only English-language publications were included in this study. Future researchers can expand on this topic by gathering additional relevant empirical data from publications in other languages.

Practical implications – Practically, findings in this study reveal the positive effects of 360-degree video in teacher education. The results may help researchers and preservice teachers better understand 360-degree video and use it more frequently in teaching. Instructional video technologies have been found to have a nearly medium effect on learning effectiveness in educational practice from a broader perspective.

Originality/value – The findings in this study can shed light on future educational technology research on instructional video technologies and technology-enhanced teacher education.

Keywords 360-degree video, Teacher education, Scoping review

Paper type Literature review

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Introduction

The interest in applying immersive technologies to education has grown in recent years in parallel to a reduction in the cost of equipment, such as virtual reality (Pellas *et al.*, 2021) and augmented reality (Lin and Yu, 2023a). Immersive technologies identify a range of digital tools and environments, including virtual reality (VR, a computer technology that simulates an environment with which a user may interact), augmented reality (AR, an interactive experience that combines the real world and computer-generated content) and 360-degree video. 360-degree video, also called immersive videos or spherical videos, refer to video recordings in which views in every direction are recorded at the same time (Wohl, 2019) by using a specific camera with a fish-eye lens (Ranieri *et al.*, 2022). The differences between 360-degree video and VR are that the former is generated from the real world, while the latter is created by computer programs. Additionally, VR enables users to interact with objects in simulated digital environments (such as picking up an object or opening a door), but the 360-degree video only permits left-right and top-bottom viewing within an enclosed circular region limited by the filmmakers' views (Snelson and Hsu, 2020).

With the rapid development of visual media technology and the desire for more realistic visual experiences in all aspects of learning, work and leisure, 360-degree video is gaining increasing attention and is widely used in education. Due to the accessibility of the device, 360-degree video is mainly used in higher education (e.g. Kosko *et al.*, 2020). Especially during the COVID-19 pandemic, the use of 360-degree video can effectively reduce the impact of the outbreak on 360-degree users. Furthermore, for pre-service teachers, the immediate consequence of the pandemic's effect on teacher education was a dramatic decrease in the availability of field experiences for them. As a result, many teacher educators have increased their use of 360-degree videos in classroom practice, allowing the viewers to adjust their viewing perspectives in any direction (Ferdig and Kosko, 2020).

In teacher education, only a few exploratory studies and projects have been conducted on using 360-degree videos. Besides, few studies systematically sort out and integrate the specific impact of 360-degree videos on pre-service teacher education. By systematically summarizing and organizing the selected literature, this study establishes its significance, enabling readers to understand the specific impacts, advantages and disadvantages of using 360-degree video clearly and quickly in teacher education. Through this study, we will provide a detailed understanding of the impacts of 360-degree video applications on teacher education, including the characteristics of the studies, impact dimensions and advantages and disadvantages.

Literature review

Research questions in this study were derived from literature filtration and viewing the 360-degree video examples. Different methods were used to investigate 360-degree videos in the existing literature. For example, some researchers combined qualitative and quantitative methods, including experiments, questionnaires, interviews, or intervention designs (the video lecture combination) (Walshe and Driver, 2019; Kosko *et al.*, 2021; Ferdig and Kosko, 2020). By using mixed methods, it aimed to test how 360-degree video impacts pre-service teachers' professional noticing (a form of situation awareness) (Kosko *et al.*, 2020) and reflection (In teacher education, it was defined as the framing and solving of teaching problems and the summing up of lessons learned.) based on scientific research. Besides, the qualitative method was used, such as one case study, based on self-interview confrontation (Theureau, 2002) and literature research (Roche and Gal-Petitfaux, 2017; Kosko *et al.*, 2021; Roche *et al.*, 2021). Considering diverse research designs and methods in the existing studies, this study aims to explore patterns and trends of research methods used in 360-degree video research in teacher education. In addition, different research methods might be adopted for different research purposes. Therefore, this study would examine the following research question.

RQ1. What are the main characteristics, including methods and aims of studies using 360-degree videos for teacher education?

The existing literature specifically explored the impacts of 360-degree video mainly on one certain aspect of teacher education. Some scholars studied that 360-degree video, with its capacity to provide total immersion (Observers have the feeling to get immersed in the situation.) (Roche and Gal-Petitfaux, 2017) in the classroom, may play a part in assisting such pedagogical transformation by improving teachers' comprehension of the interactions taking place in their classrooms (Cross *et al.*, 2022; Ferdig and Kosko, 2020; Gold and Windscheid, 2020). Several pieces of research showed that pre-service teachers who watched the 360-degree video were able to notice more students' actions compared to those who watched a standard video of the same scene (Buchbinder *et al.*, 2021). That means the viewer using 360-degree video can simultaneously be able to select a person or a group to focus on. (Kosko *et al.*, 2020) Teacher reflection, which is considered a situated, body-dependent process, has been explored in teacher education through the use of 360-degree video, including teacher's reflective noticing, teachers' reflection on microteaching activities and the quality of student teachers' written reflection to name but a few (Buchbinder *et al.*, 2021; Walshe and Driver, 2019; Richte *et al.*, 2022). Some studies focused on how 360-degree video influenced pre-service teachers' interpersonal competence (activities that promote strong connections between teachers and students). Less-developed interpersonal behaviors could lead to professional anxiety. Therefore, with the help of 360-degree videos, not only can anxiety be reduced, but also teacher-student relationships can be promoted (Theelen *et al.*, 2019, 2020, 2022). However, few review articles on 360-degree video have summarized the specific aspects of 360-degree video's impact on teacher education. Therefore, this study would answer the following research question through a systematic scoping review.

RQ2. What are the impacts of using 360-degree videos for teacher education?

Most research on 360-degree video in teacher education concentrated on their advantages, but little has been done to elaborate on their disadvantages. 360-degree video may hold promise for improving teacher education. Investigations were made into the benefits of 360-degree video in teacher education where the users are the key beneficiaries. For example, teachers are able to freely choose the angle of video observation and enhance their teaching skills (Buchbinder *et al.*, 2021; Walshe and Driver, 2019; Ferdig *et al.*, 2020; Theelen *et al.*, 2020). Roche *et al.* (2021) used a SWOT analysis, which was more thorough in terms of the strength, weaknesses, opportunities and threats, to examine the use of 360-degree video in teacher education. However, they focused only on the negative effects of 360-degree video on users, not on the drawbacks of the 360-degree video itself. Therefore, to provide researchers and pre-service teachers with a more comprehensive understanding of 360-degree video, the following research question would be addressed in this review.

RQ3. What are the benefits and drawbacks of using 360-degree videos for teacher education?

Methodology

This review combined methods of scoping and systematic reviews to examine the literature on 360-degree video in teacher education (Arksey and O'Malley, 2005; Levac *et al.*, 2010). Scoping reviews were performed to "scope" a broad topic in a research field. Daudt *et al.* (2013) suggested the following definition of scoping studies: "Scoping studies aim to map the literature on a particular topic or research area and provide an opportunity to identify key concepts; gaps in the research; and types and sources of evidence to inform practice, policymaking, and research" (p. 48). The process of the scope review methodology is largely based on the framework proposed by Arksey and O'Malley (2005): (1) identifying research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating,

summarizing and reporting the results and (6) an optional consultation stage. The first five stages were conducted as explained below, and the optional stage was not conducted due to the exploratory nature of the review and lack of stakeholder involvement. Literature selection in this study followed the Preferred Reporting Items of Systematic review and Meta-Analysis (PRISMA) paradigm that helped organize and carry out systematic reviews to ensure that all recommended information is recorded. The use of PRISMA could be advantageous to many stakeholders. Readers could evaluate the applicability of the methodologies and, consequently, the trustworthiness of the findings. PRISMA and scoping reviews could answer queries that individual research would not normally be able to (Page *et al.*, 2021). The following sections would be devoted to explaining details in each step of this review.

Inclusion criteria

Based on the understanding of the emerging literature in the field, the researchers determined specific inclusion criteria to address the research questions of the review and distinctly outlined the scoping study's boundaries. The inclusion criteria were as follows.

- (1) Type of publication: peer-reviewed empirical journal articles and conference papers including a clear presentation of research questions, methods (quantitative, qualitative, or mixed-method strategies) and interpretations based on theory and evidence (Freeman *et al.*, 2007);
- (2) Language: English;
- (3) Geographical areas: all countries; and
- (4) Subject: studies that have specifically investigated the impacts, benefits and drawbacks of 360-degree videos in teacher education.

Dissertations, research abstracts and unpublished manuscripts were excluded. While there would be some unexpected and interesting studies in this type of publication, peer-reviewed studies would be preferable because of their higher authority and better reliability. Moreover, review articles and conceptual papers were not considered in the review. To focus on the impacts, advantages and disadvantages of 360-degree video for teacher education, publications reporting technological designs and immersive technologies' applications other than 360-degree videos had to be excluded.

Search strategy

To ensure broad coverage of peer-reviewed studies, eight scientific databases were identified: Sage Journals, Taylors, ScienceDirect, Wiley, Springer Link, LearnTechLib, IEEE Xplore Digital Library and Web of Science.

The keywords used in the search string adopted for searching the databases included (1) different wording for 360-degree videos (i.e. 360-degree video, 360° video, 360 video) and (2) different aspects of teacher education (i.e. teacher education, pre-service teachers, teacher reflection). Terms in plural form were not searched because they could be automatically converted to a singular form. The Boolean search operators "AND" and "OR" were used to compose the search string, while parentheses were introduced to order the search execution. Consequently, we adopted the following keywords for the literature search: (360-degree video OR 360° video OR 360 video) AND (teacher education OR pre-service teachers OR teacher reflection).

Identification of relevant papers

The literature search yielded 34 records (see Table 1). Besides, a search of the literature related to 360-degree videos and teacher education by Kosko *et al.* yielded three papers. These

Database	Result
Sage Journals	1
Taylor's	1
Science Direct	6
Wiley	2
Springer Link	2
Learning and Technology Library	9
IEEE Xplore	0
Web of Science	13
<i>Total</i>	<i>34</i>

Table 1.
Results of the search
for each database

Source(s): Table by authors

records were imported into Zotero, and the automated functions of this software removed duplicate records ($N = 13$). The remaining 24 records were scrutinized by considering their titles, keywords and abstracts according to the established inclusion criteria. After the first analysis, two papers about the scale design, one paper not related to the 360-degree video and one paper on the literature review were excluded, resulting in 20 relevant papers at this stage. In the next step, the researchers conducted a full-text check, including an analysis of paper references, to further identify relevant articles and excluded five papers with poor quality. The results were then discussed and compared, and at the end of the overall screening process, 15 journal articles and conference papers were included in the systematic scoping review. All of these were ticked in the references. The PRISMA flowchart below (Figure 1) summarizes the entire screening process and shows the number of relevant papers identified at each stage.

Findings

Characteristics of the studies (RQ1)

Research methods in the included studies. As Table 2 indicates, most of the included studies relied on mixed methods ($N = 12$) based on the search strategies of the selected studies. The most widely used methods were questionnaires, interviews, experiments and observations. Theelen *et al.* (2019) explored how the virtual classroom could improve pre-service teachers' level of interpretation of noticed classroom events as part of their professional interpersonal vision by using questionnaires, interviews and tags. Kosko *et al.* (2021) examined and compared teachers' perceived affordances of 360-degree video as a representation of practice and their professional noticing in mathematics teaching by using experiments, observation and questionnaires.

Qualitative methods were also used frequently, mainly through interviews and literature research. In physical education, Roche and Gal-Petitfaux (2017) proposed that the workshop was filmed, and the self-confrontation interview was realized after the workshop by watching the film produced during the workshop. The verbalization of the self-confrontation interview was analyzed using the categories of action processes: concerns, perceptions, emotions and knowledge that emerged from the situation. Roche *et al.* (2021) selected only SWOT papers, and these papers presented the advantages, disadvantages, opportunities and threats of using 360-degree video in education and training.

Aims of the included studies. Four articles analyzed the comprehensible understanding of 360-degree videos in detail. Ferdig and Kosko (2020) explored 360-degree videos for improving elementary mathematics teacher education, embodied in teacher education immersion, noticing and perceptual capacity. Roche and Gal-Petitfaux (2017) investigated pre-service teachers' feelings, concerns, perceptions, emotions and knowledge while watching

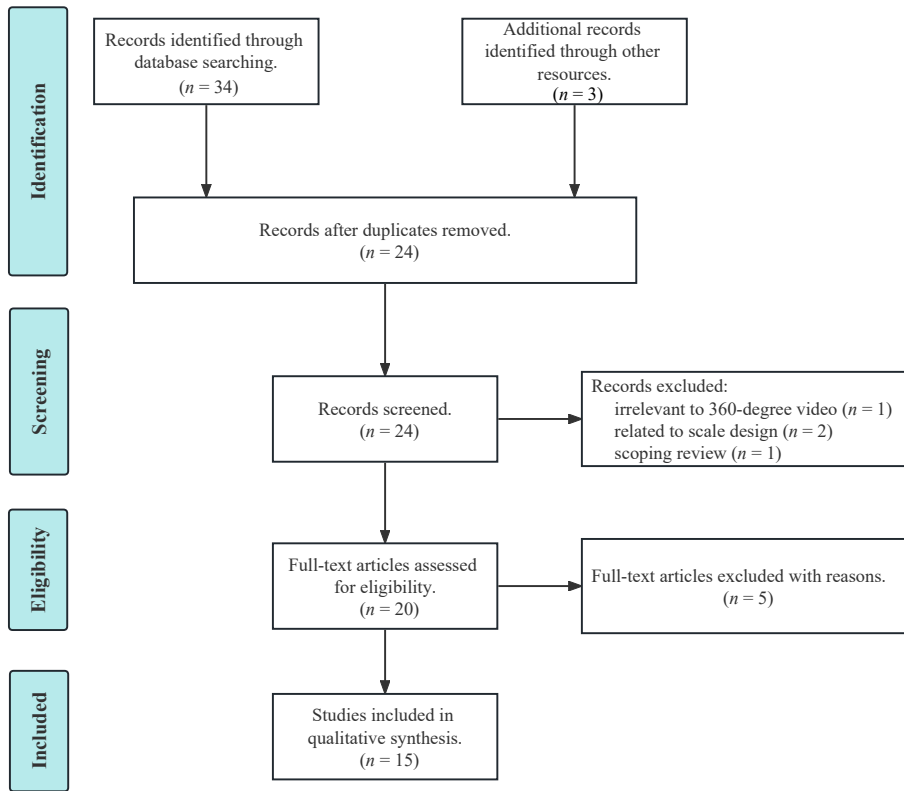


Figure 1.
A PRISMA-based flowchart for study identification and selection (Tricco *et al.*, 2018)

Source(s): Figure by authors

360-degree video scenarios. Roche *et al.* (2021) evaluated the benefits and risks of integrating 360-degree video into teacher education by using SWOT analysis. Moreover, Gold and Windscheid (2020) investigated whether there is a difference in perceived presence, emotions, workload, classroom observations and ratings of teaching quality between a 360-degree classroom video and a traditional classroom video. In summary, the above literature covers many aspects of 360-degree video, but each aspect is not explored in depth due to its broad scope. Therefore, the following studies focused on one particular aspect of 360-degree video.

Another four studies focused on pre-service teachers' noticing. Buchbinder *et al.* (2021) measured pre-service teachers' reflective noticing, including pre-service teachers' notice while watching the 360-degree videos of their teaching and learning from reflecting on the 360-degree videos of their teaching. Kosko *et al.* (2021) studied and compared teachers' perceptions of 360-degree video affordances and their professional noticing of students' mathematics in 360-degree videos. Kosko *et al.* (2021) examined whether 360-degree video technology affected the specificity of mathematics attended by pre-service teachers viewing mathematics instruction reflected in perceptual and embodied noticing. Kosko *et al.* (2019) emphasized teachers' noticing whether there is a difference in the specificity of mathematics noticed by pre-service teachers when watching a standard video, 360-degree video on a laptop, or 360-degree video with a virtual reality headset. Overall, the 360-degree video actively promotes different types of notice from pre-service teachers.

Authors and publication year	Categories	Participants	Data collection	Data analysis
Cross <i>et al.</i> (2022)	Mixed method	66 pupils aged 5–9 years; 83 pupils aged 9–12 years; Approx. 200 pre-service teachers	Case study; semi-structured interviews	Coding
Kosko <i>et al.</i> (2021)	Mixed method	33 pre-service teachers (one male and 32 females) enrolled in an early childhood education program (pre-K–3)	Qualitative and quantitative	Constant comparative analysis, nonparametric statistics
Theelen <i>et al.</i> (2019)	Mixed method	141 first year pre-service teachers of a teacher education program in the Netherlands (81female)	Tags; questionnaires; interviews; ICT affordances	A paired samples <i>t</i> -test; a one-way analysis of variance (ANOVA)
Roche and Gal-Petitfaux (2017)	Qualitative	Physical education teacher	Case study; self-interview confrontation	Categories
Gold and Windscheid (2020)	Mixed method	A total of 59 student teachers (10 men, 48 women, 1 not specified)	Questionnaires; classroom observations	Standardized questionnaires, high-inference observation rating scales, half-standardized observation protocols
Kosko <i>et al.</i> (2019)	Mixed method	34 pre-service teachers (one male and 33 females) enrolled in an early childhood education program	Experiment; write predictions; interview	Coding, a chi-square statistic
Theelen <i>et al.</i> (2022)	Mixed method	141 first year Pre-service teachers of a teacher education institute in the Netherlands	Experiment; questionnaires; interviews	A paired samples <i>t</i> -test; a one-way analysis of variance (ANOVA), Ward's method, the hierarchical cluster analysis
Buchbinder <i>et al.</i> (2021)	Mixed method	Nine prospective secondary teachers (eight female)	Pre-service teachers' reflective comments and written reflection reports on the 360-degree videos	Coding; constant comparison method associated with the grounded theory approach
Walshe and Driver (2019)	Mixed method	Four students from a second Year BA Primary Education	Case study; experiment; interview; questionnaire	Case analysis, QDA Miner Lite, naturalistic coding
Kosko <i>et al.</i> (2020)	Qualitative	Mathematics teacher education and physical education teacher education	Literature research	Categories
Kosko <i>et al.</i> (2021)	Mixed method	34 pre-service and Inservice teachers enrolled in mathematics pedagogy courses	Experiment; observation; questionnaire	Coding (with Kappa calculated), Chi-Square statistics

Table 2.
Coding results of the
included studies in this
review

(continued)

Authors and publication year	Categories	Participants	Data collection	Data analysis
Roche et al. (2021)	Qualitative	31 papers about SWOT in using 360-degree video in education and training	Literature research and selecting	SWOT analysis
Ferdig and Kosko (2020)	Mixed method	34 prospective teachers enrolled in an early childhood education program	Experiment; observation; questionnaire; notes	Three Kruskal-Wallis tests, Median scores, Dunn post hoc analysis, average, coding
Theelen et al. (2020)	Mixed method	141 first year pre-service teachers (81 female)	Concept mapping; individual interviews	Social network analysis; quantitative measurements (density, distance and reciprocity calculated in UCINET), a measure of structural complexity, expert map comparisons
Richter et al. (2022)	Mixed method	69 student teachers (42.0% female)	Experiment; online questionnaires; written reflection	Two-way repeated measures ANOVA, partial eta squared, coding, nonparametric tests based on chi-square statistics

Table 2. Source(s): Table by authors

Besides, three studies focused on interpersonal performance with 360-degree videos used in teacher education. [Theelen et al. \(2019\)](#) aimed to improve pre-service teachers' professional interpersonal vision, especially the interpretations of noticed events. [Theelen et al. \(2020\)](#) investigated the development of pre-service teachers' interpersonal knowledge structures and content. Later, [Theelen et al. \(2022\)](#) used authentic learning experiences to train pre-service teachers' interpersonal competence by measuring their professional anxiety, self-efficacy and self-perceived interpersonal behavior. In a word, all three articles demonstrated the positive impacts of 360-degree videos on pre-service teachers' interpersonal skills, demonstrating the feasibility of 360-degree videos in developing interpersonal skills.

Two studies focused on pre-service teachers' reflections. [Richter et al. \(2022\)](#) investigated changes in reflection-related self-efficacy and written reflection processes. [Walsh and Driver \(2019\)](#) explored how 360-degree video can support student-teacher reflection on microteaching activities. In short, 360-degree videos could help pre-service teachers reflect on their teaching process and improve their teaching skills.

Two articles demonstrated the potential and promise of 360-degree videos in teacher education. [Cross et al. \(2022\)](#) explored whether the 360-degree video is appropriate for video observation low-resource context in teacher education in a low-resource context. [Kosko et al. \(2020\)](#) researched how 360-degree video can positively impact pre-service teachers' experiences. In brief, 360-degree video has universal feasibility and applicability in teacher education.

Impacts of 360-degree video on Teacher education (RQ2)

To answer RQ2, this study explores it from the following four dimensions, i.e. enhancing immersion, promoting teacher noticing, assisting teacher reflection and improving interpersonal competence (see [Table 3](#)).

Enhancing immersion. The 360-degree video provided a feeling of presence (Myeung-Sook, 2001) and embodiment (Kilteni *et al.*, 2012), offering users a realistic and authentic situation (Martín-Gutiérrez *et al.*, 2017). The studies demonstrated the immersion mainly in two aspects: the sense of presence and interaction.

The first aspect is about the sense of presence. Pre-service teachers could get an abundant and vivid immersive experience when watching 360-degree videos, enhancing the viewer's sense of presence and they could get a more realistic sense of presence even when viewing 360-degree videos directly through a computer or mobile phone screens. This sense of presence could connect the content presented in 360-degree video with the viewer's senses and imagination, thus making the viewers more interested and engaged. The enhanced sense of presence allowed pre-service teachers to gain immersive learning experiences and improve pre-service teachers' concentration in watching 360-degree videos. Additionally, there is a greater sense of immersion and disconnection from the 'actual' space and a sense of embodiment as the viewer relocated. As a result, the 360-degree video was suitable for application in complex and realistic situations, especially for teacher education. If 360-degree videos could give pre-service teachers a sense of presence or immersion, they would have the opportunity to gain more effective and richer teaching experiences, some from contexts like their own and some even from contexts very different from their own. In short, these experiences could help expand pre-service teachers' insights and enhance their teaching performances (Buchbinder *et al.*, 2021; Cross *et al.*, 2022; Ferdig and Kosko, 2020; Gold and Windscheid, 2020; Kosko *et al.*, 2020, 2021; Ranieri *et al.*, 2022; Roche *et al.*, 2021; Snelson and Hsu, 2020; Theelen *et al.*, 2020).

The second aspect is about interaction. The interactivity of 360-degree video allowed pre-service teachers to choose perspectives that were not limited to those chosen and fixed by producers of the traditional video clips. In addition, pre-service teachers could freely choose the perspective they needed when observing classroom interactions through 360-degree video and could observe the panoramic view of the classroom instead of being limited to a fixed perspective. Therefore, it is highly appreciated by pre-service teachers. Furthermore, interactive content (such as games, pictures and quizzes) could be added to the 360-degree video to increase immersion (Roche and Gal-Petitfaux, 2017; Roche *et al.*, 2021; Theelen *et al.*, 2019, 2020).

Promoting teacher noticing. Teacher noticing contains three dimensions: (1) identifying what is important or noteworthy in a classroom situation, (2) reasoning about the noticed events and (3) making connections between events and broader principles of teaching and learning that they represent (Van Es and Sherin, 2008). The impacts of 360-degree videos on pre-service teachers' teacher noticing focused on two perspectives, i.e. the learning and teaching of pre-service teachers.

Dimension	Number	References
Immersion	14	Buchbinder <i>et al.</i> (2021), Cross <i>et al.</i> (2022), Ferdig and Kosko (2020), Gold and Windscheid (2020), Kosko <i>et al.</i> (2020, 2021), Ranieri <i>et al.</i> (2022), Roche and Gal-Petitfaux (2017), Roche <i>et al.</i> (2021), Snelson and Hsu (2020)
Noticing	9	Buchbinder <i>et al.</i> (2021), Cross <i>et al.</i> (2022), Ferdig and Kosko (2020), Kosko <i>et al.</i> (2020, 2021), Roche <i>et al.</i> (2021), Walshe and Driver (2019)
Reflection	4	Buchbinder <i>et al.</i> (2021), Ferdig and Kosko (2020), Kosko <i>et al.</i> (2020), Walshe and Driver (2019)
Interpersonal competence	4	Cross <i>et al.</i> (2022), Theelen <i>et al.</i> (2019, 2020, 2022)

Source(s): Table by authors

Table 3.
Dimensions of the impacts of 360-degree video on teacher education

For the learning of pre-service teachers, findings suggested that 360-degree video increased pre-service teachers' professional vision when incorporated into theoretical knowledge acquisition and could accelerate their noticing. The findings showed that pre-service teachers could notice more student movements in the same scenario using 360-degree video observation than standard video. By using 360-degree video, pre-service teachers could "move" in the video, allowing them to "understand the context of the classroom" and improving their performances to observe the individual students in their class. Moreover, viewing 360-degree video broadened their horizons, allowing them to observe more students at the same time and the classroom through multiple perspectives (Buchbinder *et al.*, 2021; Cross *et al.*, 2022; Ferdig and Kosko, 2020; Kosko *et al.*, 2020, 2021; Roche *et al.*, 2021).

For the teaching of pre-service teachers, the impact of 360-degree video on pre-service teachers' noticing was also reflected from the teachers' perspective. On the one hand, the pre-service teachers observed elements of teaching that were relevant to their teaching, and we could credit the 360-degree video technology's advantages and special options for observation for this. On the other hand, the "situatedness" of the 360-degree video would enable student teachers to develop a sense of body awareness, facilitating their reflection on teaching practice, improving their ability to pay attention to teaching practice and informing their professional responses. (Buchbinder *et al.*, 2021; Walshe and Driver, 2019)

Assisting teacher reflection. Ibrahim-Didi (2015) suggested that reflection was a "dynamic process that is embodied at the level of the biophysical through perception"; Teachers "examine the consequences of their instructional decisions on their situated practice to enhance those practices" through the self-critical, exploratory process of reflection (Tripp and Rich, 2012). Much of what teacher education called a reflective approach was grounded in the works of Dewey (1933) who provided one of the earliest definitions of reflective teaching as an active, persistent and careful consideration of a belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it ends (Dewey, 1933; Tripp and Rich, 2012).

From the included studies, it was found that using 360-degree media to reflect on one's teaching was a useful approach. Researchers suggested that compared with simple memory recall, 360-degree video could assist pre-service teachers in reflecting in more detailed ways upon their emotions, thinking and engagement in the classroom; it also supported prospective teachers' self-efficacy. Thus, using 360-degree videos heightened pre-service teachers' bodily consciousness in the time and space of the microteaching, helping them actively construct new meanings and improving their reflective awareness. As a result, 360-degree videos have been widely used in authentic teaching. By watching 360-degree videos, pre-service teachers can review their teaching, be in its space and time and be there in an embodied sense. Related research has verified the feasibility and efficiency of 360-degree videos applied to teacher education and affords them unique opportunities for reflection and noticing (Buchbinder *et al.*, 2021; Ferdig and Kosko, 2020; Kosko *et al.*, 2020; Walshe and Driver, 2019).

Improving interpersonal competence. The interpersonal competence of pre-service teachers is mainly in the area of classroom management, which can be conceptualized in terms of the teacher-student relationship, pre-service teachers manage their classrooms through all the actions they undertake to create a positive learning environment via teacher-student relationships (Stough and Montague, 2014; Wubbels *et al.*, 2014). Besides, Theelen *et al.* (2020) defined pre-service teachers' interpersonal knowledge as their knowledge to develop and sustain healthy relationships with students and a classroom environment supporting these teacher-student relationships.

Classroom simulations with 360-degree videos and theoretical knowledge could strengthen pre-service teachers' interpersonal performance. Theoretically, 360-degree

videos have positive effects in terms of pre-service teachers' noticing of relevant classroom events as well as theory-based terminology. These events are also part of the interpersonal competencies of pre-service teachers. In practice, using 360-degree videos in the classroom can improve pre-service teachers' engagement with students and their relationships. A crucial ability for classroom management in general and a key component of pre-service teachers' interpersonal competency is interpreting and noticing what happens in a classroom. Some studies also found that pre-service teachers' well-being was positively associated with positive teacher-student relationships and higher self-efficacy (Cross *et al.*, 2022; Theelen *et al.*, 2019, 2020, 2022).

Benefits and drawbacks of 360-degree video for teacher education (RQ3)

Benefits. Besides the four positive impacts of the 360-degree video for teacher education mentioned above, 360-degree video could also empower teacher education and educational research in the following aspects (see Table 4):

Firstly, the observers could freely choose the viewing angle by using 360-degree video. For example, there were no restrictions on how the classroom is framed, and pre-service teachers can get the chance to view 360-degree videos from various perspectives to examine actual classroom settings (Cross *et al.*, 2022; Theelen *et al.*, 2022).

The next benefit relates to developing teaching skills: 360-degree videos develop pre-service teachers' professional knowledge, perceptual capacity (i.e. the capacity to hear students on your perceptual left in your left ear and students on your perceptual right in your right ear), smell, touch and so on (Kosko *et al.*, 2020, 2021). Moreover, creativity could prepare pre-service teachers for a career by effectively and flexibly using digital technologies.

Then, 360-degree video could increase pre-service teachers' job satisfaction; it also played a role in reducing anxiety and improving self-efficacy (Roche *et al.*, 2021; Walshe and Driver, 2019).

Drawbacks. Although 360-degree videos had many advantages for teacher education, their disadvantages cannot be ignored, including the downsides of the 360-degree video itself and the negative aspects on the users (see Table 5).

For the 360-degree video itself, when using the 360-degree video, the rapid space switching between actual space and the recording spaces and the significance of the refreshed layers when re-watching the same video artifact, make the feeling of space existence complicated and it was not enough to demonstrate fine details (Cross *et al.*, 2022). It is worth noting that 360-degree video cannot be moved anywhere in the classroom, and this immersive experience cannot capture every aspect of a classroom (Kosko *et al.*, 2021). At the same time, the cost of purchasing this type of equipment is high, which may lead to giving up using this technology (Kosko *et al.*, 2020).

Aspect	References
Free choices in the viewing angles	Cross <i>et al.</i> (2022), Ferdig and Kosko (2020), Kosko <i>et al.</i> (2020), Roche and Gal-Petitfaux (2017), Roche <i>et al.</i> (2021), Theelen <i>et al.</i> (2019, 2020, 2022)
Teaching skills	Buchbinder <i>et al.</i> (2021), Kosko <i>et al.</i> (2021), Richter <i>et al.</i> (2022), Roche <i>et al.</i> (2021), Theelen <i>et al.</i> (2019), Walshe and Driver (2019)
Job satisfaction	Buchbinder <i>et al.</i> (2021), Roche <i>et al.</i> (2021), Theelen <i>et al.</i> (2022), Walshe and Driver (2019)

Source(s): Table by authors

Table 4.
Primary benefits of
360-degree videos in
teacher education
based on the included
studies

Regarding the negative aspects of 360-degree videos on users, the complication is the theme. Viewing 360-degree videos is more complicated than viewing a 2D video as there is a necessary aspect of understanding. It also showed that 360-degree videos could be distracting or disabling (Roche *et al.*, 2021). Then, pre-service teachers encountered technical hindrances due to issues with an online platform (YouTube), mobile phones lacking a gyroscope and poor audio and video quality (Theelen *et al.*, 2019). When using 360-degree video, pre-service teachers and technicians require professional guidance, local training and technical support (Cross *et al.*, 2022). Finally, users may experience unpleasant, vertigo-like, or motion sickness-like sensations while watching 360-degree videos with a VR headset, which could cause them to give up the technology (Theelen *et al.*, 2019).

Discussion

This systematic scoping review aimed to investigate the potential of 360-degree video in teacher education learning and instruction and systematize the main research findings in the field through a comprehensive approach. The main findings of the review can be summarized as follows.

The first important finding in the considered literature is related to the impacts of 360-degree video on pre-service teachers’ learning are mainly reflected in the following aspects: First, Walshe and Driver (2019) contended that the immersive, embodied experience of 360-degree video reflection fosters the development of a more specific comprehension of microteaching practice and improve student teachers’ self-efficacy in the classroom. Also, Theelen *et al.* (2022) pointed out that the 360-degree video-lecture combination would reduce professional anxiety and increase self-efficacy. Besides, the results suggest the powerful potential of 360-degree videos to help pre-service teachers with self-reflection and professional growth (Buchbinder *et al.*, 2021). Additionally, pre-service teachers especially developed their interpersonal knowledge through the theoretical lectures with the use of a VR headset, which positively influenced their theory-based knowledge development and application (Theelen *et al.*, 2020).

The second finding concerns pre-service teachers’ instruction. According to the reviewed literature, pre-service teachers demonstrated increased attention to mathematical strategies in the context of teaching, demonstrating the potential usefulness of 360-degree headsets for perceptual capacity and teacher noticing, which allow pre-service teachers to view 360-degree videos attended to more student actions, and help the pre-service teacher to explore the whole situation and contextual aspect of the teaching situation (Ferdig and Kosko, 2020; Kosko *et al.*, 2021; Roche and Gal-Petitfaux, 2017); In addition, because of the effectiveness of 360-degree video in virtual internships, it universally acknowledged that the use of 360-degree should be continued even when fully face-to-face (Kosko *et al.*, 2020). The above two findings exemplify the possibilities and promise of 360-degree video applications for teacher education.

Table 5.
Primary drawbacks of 360-degree videos in teacher education based on the included studies

General aspect	Specific aspect	References
360-degree video itself	Fail to show fine details	Cross <i>et al.</i> (2022), Kosko <i>et al.</i> (2020), Roche and Gal-Petitfaux (2017)
	Cannot be moved	Kosko <i>et al.</i> (2021)
On the users	High cost	Kosko <i>et al.</i> (2020), Roche <i>et al.</i> (2021)
	Distracting	Roche <i>et al.</i> (2021)
	Technical hindrances	Kosko <i>et al.</i> (2020)
	Require professional guidance	Cross <i>et al.</i> (2022), Roche <i>et al.</i> (2021)
	Discomfort	Kosko <i>et al.</i> (2021), Roche <i>et al.</i> (2021)

Source(s): Table by authors

Although the 360-degree video has its flaws, as an emerging thing, we should still actively embrace 360-degree video and give full play to its positive role in teacher education.

360-degree
videos in
teacher
education

Conclusions

Major findings

This systematic scoping review of 360-degree video examines the main characteristics of the relevant studies in teacher education, including the methods and aims, the impacts of 360-degree video use on teacher education and how some of the benefits and drawbacks are manifested in practice. Our study leads to the following findings.

Firstly, the 15 included studies show that mixed methods have been mostly used to investigate 360-degree video use in teacher education, and the aims cover five aspects (the comprehensible understanding of 360-degree videos, Pre-service teachers' noticing, pre-service teachers' interpersonal performance, pre-service teachers' reflection and the potential and promise of 360-degree videos in teacher education).

Secondly, the results of this review indicate the positive effects of 360-degree video in teacher education, mainly involving enhancing immersion, promoting perceptual capacity, assisting reflection and improving interpersonal competence. Specifically, 360-degree video provides users with a realistic and authentic scenario in teacher education, where pre-service teachers can choose the perspective they need to view through 360-degree video and have the opportunity to gain a more effective and enriched teaching experience. In addition, through 360-degree video, pre-service teachers have an increased ability to focus and reflect on their teaching practice compared to simple memory recall. In practice, using 360-degree video in the classroom enhances pre-service teachers' engagement with their students and improves their relationships.

Thirdly, the 360-degree video can be useful for teaching and learning in teacher education, demonstrating the advantages like freely choosing the viewing angles, developing teaching skills and increasing pre-service teachers' job satisfaction; meanwhile, its disadvantages cannot be ignored and need to be avoided by users while providing a positive experience, including the downsides of the 360-degree video itself (it was not enough to demonstrate fine details and required high costs) and the negative aspects on the users (distracting or even disabling nature and motion sickness).

Limitations

This study has some limitations to acknowledge. First, some recently published studies on the subjects were partially accessible, which precluded us from adding their findings to this study. Second, the sample of articles is constrained to the search and selection strategies described in the methods section, which increases the possibility that pertinent research may be omitted. Furthermore, this study's summary of the selected research may be inadequate, for example, whether the division of dimensions in the research questions is reasonable and covers all the major aspects. Third, only English-language publications were included in this study. Future researchers can expand on this topic by gathering additional relevant empirical data from publications in other languages.

Implications for future studies

Both researchers and pre-service teachers may benefit from this study's findings. Practically, findings in this study reveal the positive effects of 360-degree video in teacher education. The results may help researchers and pre-service teachers better understand 360-degree video and use it more frequently in teaching. Instructional video technologies have been found to have a nearly medium effect on learning effectiveness in educational practice from a broader

perspective (Lin and Yu, 2023b). As a particular category, future researchers may incorporate diverse technological and pedagogical designs into 360-degree video applications to enhance the effectiveness of such educational technologies. In complement to Lin and Yu's meta-analysis of instructional video technologies from a broad perspective, future researchers can follow the paradigm of this review to examine the effectiveness of particular video technologies in educational practice.

Regarding the research methods, mixed methods have been used most in current studies, followed by qualitative and quantitative. Future studies can follow the mature research paradigm of mixed studies, while extensive efforts should be made to provide more quantitative evidence in evaluating the effects of 360-degree video in teacher education to improve more comprehensive, valid and credible research on this topic. Also, future research can be considered how immersion, perceptual capacity, reflection, interpersonal knowledge and embodied interaction can be associated with this educational technology.

Drawbacks and organizational difficulties are currently some research gaps in the existing publications. Designers and instructors may devote future research and practice to overcome the negative impacts of 360-degree videos and better yield positive outcomes. Future researchers can contribute to addressing these issues by expanding the research to more advanced technological designs and various perspectives (educational policies, pedagogical designs and educational assessment of educational technologies). Besides, with the development of the technological tools for pre-service teachers in the use of 360-degree video, future research is needed for researchers and instructors to better understand how the affordances of this medium can be used in practice and what specialized resources may be required to scaffold interaction with the content in such media.

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Further reading

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Appendix

360-degree videos in teacher education

Study	Method	Participants	Purpose	Key findings
Ferdig and Kosko (2020)	Mixed method	Elementary mathematics Pre-service teacher	Explore 360-degree videos for improving elementary mathematics teacher education	The results of the study show improved immersion, presence and video evaluation from using 360-degree videos. Participants demonstrated increased attention to mathematical strategies in the context of teaching, demonstrating the potential usefulness of 360-degree headsets for perceptual capacity and teacher noticing
Theelen <i>et al.</i> (2019)	Mixed method	Pre-service teachers	Improve pre-service teachers' interpretations of noticed events	360-degree videos can be useful for teacher education to improve pre-service teachers' interpretation of noticed events
Walshe and Driver (2019)	Mixed method	Trainee teacher	Explore how the use of 360-degree video can support student teacher reflection	Results suggest that the immersive, embodied experience of reflecting using 360-degree video develops a more nuanced understanding of microteaching practice, as well as supporting student teachers' self-efficacy toward teaching
Theelen <i>et al.</i> (2022)	Mixed method	141 first year pre-service teachers of a teacher education institute in the Netherlands	Use authentic learning experiences combining theoretical lectures and 360-degree videos watched with virtual reality headsets, to train pre-service teacher's interpersonal competence	The video-lecture combination led to a reduced professional anxiety and increased self-efficacy
Buchbinder <i>et al.</i> (2021)	Mixed method	Pre-service secondary mathematics teachers	Identify the categories of noticing afforded by the 360-degree technologies as well as the instances of pre-service teachers' learning	The results point to the powerful potential of 360-degree videos for supporting pre-service teachers' self-reflection and professional growth
Theelen <i>et al.</i> (2020)	Mixed method	Teacher education program in the Netherlands counting 141 first year pre-service teachers (81 female)	Investigate the development of pre-service teachers' interpersonal knowledge structures and the content of pre-service teachers' interpersonal knowledge after watching 360-degree videos combined with theoretical lectures	pre-service teachers especially developed their interpersonal knowledge through the theoretical lectures, it was shown that the use of a VR-headset positively influenced pre-service teachers' theory-based knowledge development and application

Table A1.
The key elements of the studies
(continued)

Study	Method	Participants	Purpose	Key findings
Kosko <i>et al.</i> (2021)	Mixed method	Mathematics pre-service teachers	Examine whether 360-degree video technology affected the specificity of mathematics attended by pre-service teachers viewing mathematics instruction	Results suggest that viewing 360 videos with a virtual reality headset associate with more explicitly noticed mathematics, while viewing 360-degree videos without a headset was observed to have similar effectiveness as standard video
Kosko <i>et al.</i> (2021)	Mixed method	Both pre-service and in-service mathematics teachers	Examine and compare teachers' perceived affordances of 360-degree video as a representation of practice and their professional noticing of students' mathematics in 360-degree videos	Referencing teacher movement and student tables or groups is associated with a higher focus on student actions and that 360-degree video affords opportunities for teachers to notice students' mathematical thinking
Gold and Windscheid (2020)	Mixed method	Student teachers	Explore whether perceived presence, emotions, workload, classroom observations, and ratings of teaching quality differ when student teachers are shown a 360-degree classroom video and when they are shown a traditional video	The 360-degree video elicited a higher degree of presence. However, there were no significant differences between the two video types with respect to perceived emotions, workload, observer ratings, or noticed events
Kosko <i>et al.</i> (2019)	Mixed method	Elementary mathematics pre-service teachers	Examine whether and how the use of 360-degree video affects pre-service teachers' professional noticing for elementary mathematics	Pre-service teachers viewing 360-degree videos attended to more student actions than their peers viewing standard video
Cross <i>et al.</i> (2022)	Qualitative	Educators in rural India	Indicate the appropriateness or not of the narrative framework in a low-resource context with little prior history of video observation in teacher education	This paper reports a small-scale pilot that explores the practical possibilities of using the technology and the framework in the context of teacher professional development in India, a context not hitherto represented in the literature
Roche and Gal-Petitfaux (2017)	Qualitative	Physical Education Teacher	Describe pre-service teacher activity during workshop: their feelings, concerns, perceptions, emotions, and knowledge used and construct during viewing 360-degree video situations	360-degree video offer to pre-service teachers the opportunity to focus on each student engaged in PE lesson, or to focus on teacher activity 360-degree video help pre-service teacher to explore the whole situation and contextual aspect of the teaching situation

Table A1.

(continued)

Study	Method	Participants	Purpose	Key findings
Kosko et al. (2020)	Qualitative	Mathematics pre-service teachers and physical education pre-service teachers	Make teacher educators learn about the potential and promise for the use of 360-degree video for teaching and teacher education	The use of 360-degree should be continued even when field placements return fully face-to-face
Roche et al. (2021)	Qualitative	Papers that presented information about SWOT in using 360-degree video in education and training	Evaluate all aspects of the benefits and risks of the integration of 360-degree video in teacher education	S: Develop teaching skills . . . W: Immersion is better with HMD . . . O: Easy to use and not expensive . . . T: Need to use high performance HMD . . .
Snelson and Hsu (2020)	Qualitative approach scoping review approach	12 articles on educational 360-degree video	Identify trends in peer-reviewed research journal articles of educational 360-degree videos in virtual reality	The results show how 360-degree video was used in nine different content areas to promote immersive learning through virtual reality. Learners indicated enjoyment with the experience of learning with 360-degree VR video, but the results were mixed regarding the impact on learning

Source(s): Table by authors

Table A1.

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