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ORIGINAL PAPER

Educational 360-Degree Videos in Virtual Reality: a Scoping Review of the Emerging Research

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Abstract

360-degree video (or 360° video) is recorded in an omnidirectional form so that viewers can look in any direction while the video plays. Interest in the application of 360° video has been emerging along with the advancement of lower cost technologies and increase in online video content. Little is known about trends in the emerging research for 360° video. A scoping review was conducted through a systematic process to identify trends in peer-reviewed research journal articles. A sample of 12 articles were identified as meeting the research criteria. Findings illuminate the extent and nature of research on educational 360° video along with the benefits and drawbacks for learning. The results show how 360° 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° VR video, but the results were mixed regarding the impact on learning.

Keywords 360-degree video · Immersive · Literature review · Virtual reality · VR

360-degree video (or 360° video) is recorded with omnidirectional or multi-camera systems that capture all directions at the same time. Videos are stitched together with software to produce a full spherical field of view. During playback users can interact with the video through a mouse click or by panning and tilting a mobile device to look in any direction within the video recording. Ambisonics may also be included for a full-sphere surround sound experience. 360° videos can be viewed without special equipment other than a computer, smartphone, or tablet. Alternatively, they can be viewed through a head mounted display (HMD) to add a virtual reality (VR) experience (Kavanagh et al. 2016).

360° video is often referred to as VR, or used interchangeably as both provide immersion viewing experience. The differences between 360° video and VR being the former is generated with real-world footage while the latter is generated by using computer software. Also, 360° video allows left-right and top-bottom viewing within an enclosed spherical space limited by the filmmakers' views, while VR allows interaction with the objects in simulated digital worlds (e.g., picking up an object or opening a door) (Ward 2017). In this paper, we referred to 360° video and VR interchangeably in terms of the immersion experiences that both can bring to its users and learners through HMDs.

In recent years, support for 360° video has been progressively integrated into popular social media and video sharing sites, starting with YouTube and Facebook in 2015, and later Vimeo in 2017. This has contributed to improved ease of use for 360° video playback in addition to ubiquitous access to a growing collection of online 360° video content (see Saba 2015; Vimeo Staff 2017; YouTube Creator Blog 2015).

The field of educational 360° video is emerging alongside the advancement of affordable VR technologies, such as Google Cardboard (Google n.d.), that reduce the barrier of cost (Berg et al. 2016; Brown and Green 2016). It is now feasible for educators to try 360° video, or its virtual reality counterpart 360° VR video, when examining the merits of innovative pedagogical practice in the context of real-world classrooms. For example, Ardisara and Fung (2018) integrated 360° video in undergraduate chemistry laboratory education to demonstrate techniques and complex laboratory equipment. The full field of view was deemed valuable for

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increasing access to detail, but there were also challenges with disorientation when people felt lost when looking around in the video. In another example, 360° video was coupled with Google Cardboard to develop an immersive empathy-building experience that included several scenarios about bullying in schools (Berg et al. 2016). This study describes technical, design, and implementation details along with suggestions about script writing, recording, and collaborative development of an immersive learning application.

The research on educational 360° video is not well understood at the present time. Kilinç et al. (2017) conducted a review of research on video in distance education and recommended further research on 360° video as an emerging area of study. The purpose of this study is to examine the extent and nature of research pertaining to the educational use of 360° video, and explore the benefits and drawbacks of 360° video for learning, through a scoping review approach on refereed articles (Arksey and O'Malley 2005; Levac et al. 2010). The information from this review will illuminate the state of educational 360° video research to inform further study and educational practice.

Methods

A scoping review approach was applied in this review of the research literature about educational 360° video (Arksey and O'Malley 2005; Levac et al. 2010). Scoping reviews, or scoping studies as they are sometimes called, have been conducted in multiple sectors including health, social sciences, business, agriculture, software engineering, and education (Pham et al. 2014). The purpose and defining attributes of scoping review methodology vary across the literature, but they often involve review of the extent, range, and nature of research activity for a topic that is complex or has not been comprehensively reviewed previously, mapping of key concepts for a research area, examination of the types of evidence available, or identification of gaps in the research literature (Arksey and O'Malley 2005; Levac et al. 2010; Pham et al. 2014).

The Arksey and O'Malley (2005) framework was followed in the present scoping review since it is well known and has a logical flow of stages that include (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.

Stage One: Research Questions

The research questions emerged after several months of preliminary immersion in the topic, which included reviewing 360° video examples and reading literature from a variety of sources including peer-reviewed journals, conference proceedings, practitioner magazines, and websites. According to Levac et al. (2010) the research questions for a scoping review tend to be "broad in nature as the focus is on summarizing breadth of evidence" (p. 3), yet they go on to recommend combining broad questions with "a clearly articulated scope of inquiry" (p. 3). The following three research questions capture the broad scope of 360° videos but constrain the scope to educational applications.

1. What is the extent, range, and nature of the research activity pertaining to 360° video in education?
2. How are 360° videos being used in education?
3. What are the benefits and drawbacks of 360° video for learning?

Stages Two and Three: Study Identification and Selection

Study identification and selection was conducted by following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines for scoping reviews (Tricco et al. 2018). The PRISMA flowchart showing the process of study identification and selection is illustrated in Fig. 1 with counts of articles at each step. Several academic literature databases were searched to obtain primary research articles related to the educational applications of 360° video. These include Academic Search Premier, Education Research Complete, ERIC (Education Resource Information Center) and the Web of Science Core Collection: Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index and Emerging Sources Citation Index. The database search was conducted on February 24, 2019 using the search phrase "360 video* or VR video* not game*" with filters set to retrieve peer-reviewed journal articles. Citation references were exported from the databases and imported into the online version of EndNote (Clarivate Analytics n.d.) where they were stored for screening and selection.

Research articles were selected for inclusion based on the criteria that they were published in peer-reviewed journals, available in full-text English, and were research studies that emphasized an educational application of 360° video with or without the addition of a virtual reality component. Article screening progressed through two phases. First, article titles and abstracts were reviewed. Articles were excluded during title and abstract review if it was obvious that they did not meet the inclusion criteria (e.g., not a study, not education related). The remaining references were selected for full-text review, where the full-text copy of each article was obtained

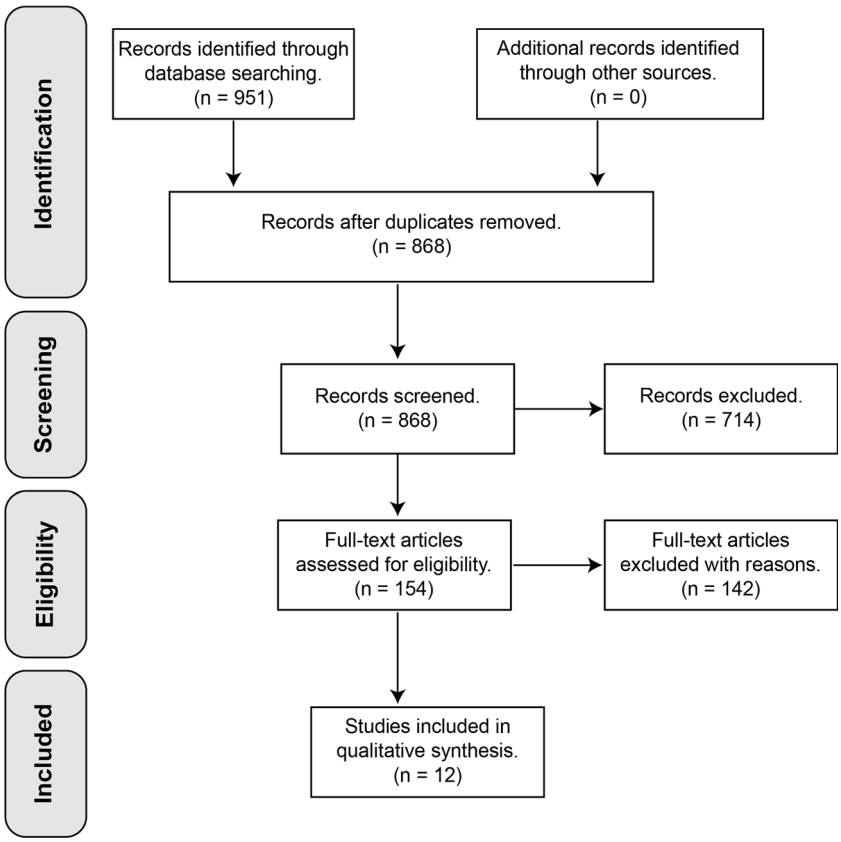

Fig. 1 PRISMA Flowchart for Study Identification and Selection (Tricco et al. 2018)

and reviewed. The articles that met the inclusion criteria were selected to be part of this scoping review.

Stage 4: Charting the Data

Charting the data refers to strategies used to extract information from the articles during analysis. The set of articles selected for this review were analyzed through a qualitative approach. The articles were imported into NVivo 12 for Mac (QSR International n.d.) where they underwent three rounds of coding following strategies described by Saldana (2016). Structural coding was applied during the first round while reading the papers to gain a sense of them as a collective whole. Sections common to research articles such as purpose, method, participants, intervention, and key findings, were coded on each article. During the second round of reading and coding, descriptive coding was applied to generate an index of subtopics under each broad structural code and mark information that was pertinent to the research questions. Finally, pattern coding was applied to merge codes that were highly similar and group clusters of related codes. A matrix was constructed in a spreadsheet to organize thematic information extracted from the coded articles in a tabular form for comparison across the studies (Miles et al. 2020).

Stage 5: Summarize and Report Findings

Themes identified when charting the data were collated and summarized following recommendations from qualitative synthesis and scoping review methods literature (Arksey and O'Malley 2005; Levac et al. 2010; Sandelowski and Barroso 2007). Findings from the scoping review were written to offer both a "descriptive numerical summary and a thematic analysis" (Levac et al. 2010, p. 6) of key information from across the sample of research studies. Themes and summaries of corresponding studies are organized by research question to discuss findings that are pertinent to each question.

Findings and Discussion

Extent, Range, and Nature of the Research Activity

The research literature on educational 360° video was sparse at the time of this review with only 12 articles identified as having met the inclusion criteria. All of these articles are listed in the references section where they are marked with an asterisk. The studies originated from nine different countries with publication years spanning from 2017 through early 2019 as shown in Fig. 2. The short and recent publication timespan suggests the possibility of an emerging area of scholarship

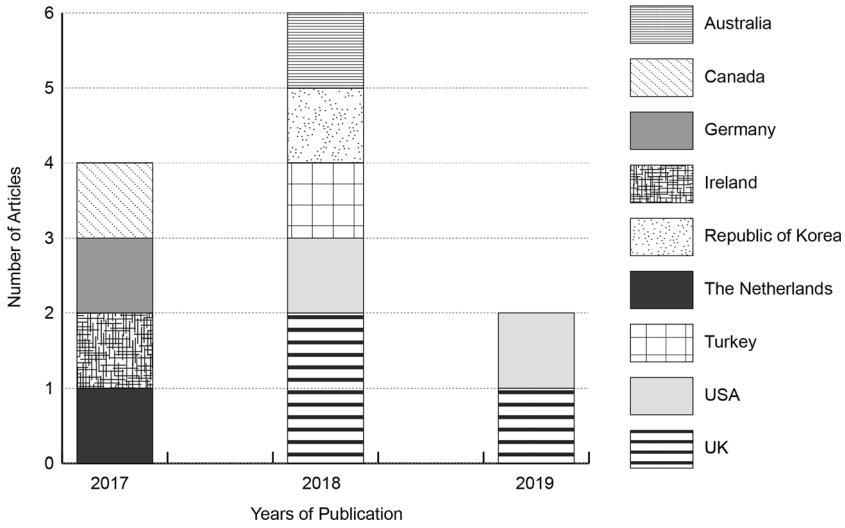

Fig. 2 Chart of Publication Timespan and Countries of Origin

since no restrictions were placed on publication year when sampling the literature. Studies published in 2019 represent only those articles that were in the databases at the time of sampling and should be considered an incomplete record of research activity for the year.

A brief summary of the content area (i.e., academic discipline or subject matter), purpose of each study, research design, participant information, and key findings can be found in Table 1. The information is organized in alphabetical order by content area so that key findings from similar disciplines appear in close proximity for quick comparison. The information in Table 1 reveals that research on the use of educational 360° video was conducted in the context of eight different content areas with the highest level of activity in surgical education where four of the 12 studies were conducted.

Educational Uses of 360° Videos

Immersiveness surfaced as an important concept in the educational 360° video studies sampled for this scoping review. The results of a word frequency query run in NVivo 12 for Mac (QSR International n.d.) revealed that some variant of the word "immersive," appeared in the collective sample of 12 articles a total of 364 times. Furthermore, every one of the studies combined 360° video with some type of immersive virtual reality (VR) experience involving the use of head mounted displays (HMDs) to view the videos. This indicates that the role of VR and the concept of immersiveness have been closely linked to the educational use of 360° video.

Immersiveness has been described as "the subjective impression that one is participating in a complex, realistic experience" (Dede 2009, p. 66). Immersive media environments, such as 3D virtual worlds or games, are intriguing because of their potential to enhance learning through promotion of multiple perspectives, situated experiences, or transfer of knowledge (Dede 2009; Dede et al. 2017). Yet, consideration of immersiveness when designing, developing, or implementing effective educational 360° video has only recently started to emerge in the research literature. The sample of studies in this scoping review offer insights into immersiveness with 360° video through three general approaches that include: (1) comparison of technologies that support various degrees of immersion and the impact on learning, (2) effectiveness of immersive instructional approaches using 360° VR video applications, and (3) merits of immersive 360° VR video as part of an interactive learning system.

Degrees of Immersiveness Four of the studies involved a comparison of educational 360° VR video technologies with 2D video to examine the effectiveness of immersive versus traditional video technologies. One additional study included comparisons among four devices offering varying degrees of immersiveness. Through these studies the role of shutting out the world through sensory immersiveness (Dede et al. 2017) was explored to uncover how learning might be affected when a VR element is introduced. For example, Lee, Sergueeva, Catangui, and Kandaurova (2017) compared the experiences of a group of business education students who watched a 360° travel video about Nepal using Google Cardboard (VR condition) with another group who watched the same video without the HMD (flat screen condition). Participants completed a survey after the viewing experience that measured their perception of the novelty, reliability, understandability, enjoyment, and interest related to the content of the video. Results indicated that participants in the VR group rated their enjoyment and interest significantly higher than the flat screen group. However, there was no significant difference for content items pertaining to novelty, reliability, and understandability. Because of this, the researchers questioned the benefits of VR for content delivery, while noting that learner engagement and interest may be enhanced.

Table 1 A Summary of 360° Video Studies

Study	Content Area	Purpose	Study Design	Participants	Key Findings
Lee, Sergueeva, Catangui, & Kandaurova (2017)	Business	Identify potential benefits of 360° VR video compared to 2D video for content delivery.	Experimental	University Students	Significant difference favoring VR for enjoyment and interest, but no difference for novelty, reliability, or understandability of video content.
Choi, Yoon, Song, & Choi et al. (2018)	Marine Biology	Examine effectiveness of interactive and immersive educational scenarios in a mobile VR application.	User Study	People with Range of VR Experience	The approach was shown to be effective for adding interactivity, enhancing immersion, and promoting active engagement of users.
Rupp et al. (2019)	Psychology (Cognitive)	Examine effect of viewing 360° video using four devices with varying degrees of immersiveness on content knowledge, affect, subject-matter interest and simulator sickness.	Pretest-Posttest	University Students	Highly immersive 360° VR video experiences are associated with positive affect, improved learning outcomes, more subject-matter interest and less motion sickness.
Stupar-Rutenfrans et al. (2017)	Psychology	Examine effectiveness of a mobile 360° VR video training application for reducing public speaking anxiety.	Longitudinal Quasi-Experimental	University Students	Significant decrease in public speaking anxiety after training sessions with the application. Best results for those with higher initial anxiety.
Johnson (2018)	Religious Studies	Explore potential benefits of integrating 360° videos in religious education.	Implementation and Evaluation	University Students	Student survey had overall positive response related to gaining knowledge of religions and promoting feelings of immersiveness, engagement, sense of presence and empathy.
Panchuk, Klusemann, & Hadlow (2018)	Sports	Examine effectiveness of immersive 360° VR video training on decision making skills of basketball players.	Pretest-Posttest	Elite Youth Basketball Players	No significant difference for decision-making performance, but positive perception of the experience by players.
Harrington et al. (2017)	Surgical Education	Develop and evaluate 360° VR video training of operating room surgery as compared to 2D video.	Single-Blinded Randomized Cross-Over Study	University Students	Significantly higher levels of engagement and attentiveness for 360° VR video with positive perception of experience, but no significant difference for retention of information.
Huber et al. (2017)	Surgical Education	Examine effectiveness of immersive VR simulator combined with 360° video of operating room surgery.	Feasibility Study	Members of a Surgical Department	Simulated surgical tasks took longer or had higher error rates in IVR, but exhilaration and sense of presence were experienced.
Pulijala, Ma, Pears, Peebles, & Ayoub (2018)	Surgical Education	Examine effectiveness of immersive VR simulator combined with 360° video of operating room surgery.	Feasibility Study	Expert Surgeons	They system was deemed easy to use and interactivity was an important aspect of the training. Feedback was offered for improvements.
Yoganathan, Finch, Parkin, & Pollard (2018)	Surgical Education	Examine effectiveness of 360° VR video compared to 2D video training for learning surgical knot tying skills.	Randomized Control Study	First-Year Postgraduate Doctors	Significantly better knot-tying scores for 360° VR video as compared to 2D video, but no difference in time to complete task. Results persisted with face-to-face training.
Walshe and Driver (2019)	Teacher Education	Examine potential benefits of 360° VR video to support student teachers' reflection on microteaching activities.	Interpretive Case Study	University Students	A more nuanced understanding of teaching practice was developed when reflecting on teaching through 360° VR video. Self-efficacy towards teaching was promoted.
Dolgunsöz, Yıldırım, & Yıldırım (2018)	Writing	Examine effects of 360° VR video compared to 2D video on retention and writing performance in English language learners.	Sequential Exploratory Mixed Method	University Students	No significant effect of VR video as compared to 2D on recall or writing performance, but long-term retention was slightly better with VR. Positive opinion of VR was reported.

Similarly, Dolgunsöz, Yıldırım, and Yıldırım (2018) compared 360° VR video with traditional 2D video for retention of information and writing performance in the context of English as a foreign language learning. Two VR videos were used in this study as writing prompts. One of the videos was about Chernobyl and the other was about bears and their habitat. Students wrote a paragraph on the topic of each video after viewing either the VR or 2D videos and then wrote again on the topic after one month as a test of long-term retention. Findings from this study showed no significant impact on

recall of information or writing performance for VR video as compared to 2D video, although long-term retention was slightly better in the VR condition. Students liked the VR video experience and expressed positive opinions about the realistic environment, feeling of involvement, and sense of excitement or joy they had when using the technology.

In a study from the field of surgical education, Harrington et al. (2017) studied the use of 360° VR video as compared to 2D video for teaching about operative procedures. The 360° video was recorded in an operating room during an elective laparoscopic cholecystectomy (gallbladder removal) procedure making it possible to view the entire operating room, medical personnel and equipment. This promoted a sense of immersion and presence in the environment. The video was augmented with additional information and imagery during editing. Results of the study indicated significantly higher levels of engagement and attentiveness for 360° VR video as compared to 2D video. Overall, participants perceived the experience as beneficial with 65% reporting a preference for 360° as their learning platform of choice. However, there was no significant difference between video conditions for retention of information as measured on a multiple-choice test containing questions related to the video content.

Not all of the studies comparing 360° VR video and 2D video concluded with marginal results for learning. The study conducted by Yoganathan, Finch, Parkin, and Pollard (2018) found significantly better results for surgical knot tying skills training with 360° VR video as compared to traditional 2D video. Foundation year (first-year postgraduate) doctors received the training to learn how to tie a single-handed reef knot. Assessment of their knot-tying skills revealed significantly better scores for those who received the 360° VR video training although the time needed to complete the task did not differ between video conditions. In addition, the difference in knot-tying performance between video groups persisted in favor of the VR condition when combined with face-to-face training.

In a somewhat more complex study, Rupp et al. (2019) asked participants to view a 360° video tour of the International Space Station (ISS) using one of four devices that supported varying degrees of immersion: a smartphone, Google Cardboard, Oculus Rift Development Kit 2 (DK2), or Oculus Consumer Version 1 (CV1). Positive outcomes associated with increased immersiveness, particularly with the DK2 and CV1 conditions, included greater positive affect, better learning of declarative knowledge (i.e., facts, concepts), stronger subject-matter interest and less motion sickness. The results of this study suggest that the educational 360° VR video experience may be improved when using higher quality devices that optimize sensory immersion as compared to lower-cost or less immersive technologies.

Immersive Instructional Approaches Immersive instructional approaches, as opposed to comparisons of technology, was an aspect of all the studies, but took more of a central role in the four studies described next. These studies explored the use of 360° VR videos to promote multiple perspectives, empathy, or a sense of presence (i.e., being there). One example is from the field of religious education where it was argued that inexpensive 360° videos and VR technologies could be used to promote "empathetic understanding and ethnographic analysis of religious place, ritual, and behavior in light of theories of religion" (Johnson 2018, p. 229). In this study, a playlist of 360° VR YouTube videos was created as part of a set of assignments on different religions and included tours, ethnographic, or documentary types of videos. Students were asked to watch the videos using the VR mode of the YouTube app on a smartphone placed inside of a Google Cardboard HMD. Results of an evaluation survey indicated that students valued the experience for helping them deepen their knowledge of religions, for promoting a sense of presence, and for eliciting feelings of empathy toward other religions. Some negative experiences such as discomfort, motion sickness, and difficulty using or obtaining the equipment were encountered, but these problems were described as minimal.

The potential for 360° VR video in sports training was investigated by Panchuk, Klusemann, and Hadlow (2018) who studied its use for improving decision making performance in elite (i.e., advanced) youth basketball players. Gameplay scenarios recorded in 360° video on the basketball court were viewed through HMDs in a series of VR training sessions. The 360° videos promoted a sense of immersion and presence by enabling trainees to view the scene in any direction and observe the movement of the ball, player action on the court, and the progression of gameplay during each scenario. The videos were stopped at key points so that trainees could practice making decisions about appropriate gameplay actions. On-court performance was then assessed to determine transfer of skills from the training. Unfortunately, the results of this study were mixed with non-significant improvements in decision-making skills. Nonetheless, feedback from all players was positive in their perception that the training was beneficial for improving their performance on court.

Walshe and Driver (2019) built on the established tradition of teacher self-reflection on pedagogical practice with their interpretive case study of 360° VR video in teacher education. In this study, education students were individually recorded with 360° video as they practiced teaching a class of children during short microteaching sessions. After this they were interviewed to ask them to reflect on their teaching. Next, they watched their 360° video with HMD, reflected on their teaching, and participated in a think-aloud protocol where they articulated their thoughts and feelings about their pedagogical decisions. The teaching reflection was followed by interviews to learn more about their experiences using 360° VR video for

this purpose. By reflecting on the immersive 360° VR video, where the omnidirectional view permitted observation in any direction, they were able to "develop a more nuanced understanding of what was taking place at different points during the lesson" (Walshe and Driver 2019, p. 101) in addition to developing self-efficacy toward teaching.

The value of using 360° VR video for therapeutic purposes was explored by Stupar-Rutenfrans et al. (2017) who developed and tested a mobile training application to deliver virtual reality exposure therapy (VRET) to people with public speaking anxiety. The Public Speech Trainer (PST) integrated 360° video recordings of audiences of various sizes in a lecture hall. A series of training sessions were accessed from a smartphone app with the use of a VR headset. Findings revealed significant decreases in public speaking anxiety and was most effective for those who started with high anxiety levels. A benefit of this type of immersive VR training is that people can access it with a mobile device at home or in whatever environment is most comfortable.

Interactive and Immersive Learning Systems The remaining studies sampled for this review used 360° video as a component within an interactive learning system. In one of these studies, Choi, Yoon, Song, and Choi et al. (2018) developed a mobile VR learning framework that combined immersive 360° VR media (video and imagery) with interactive enhancements. Three marine biology scenarios in the system enabled exploration and interaction with marine life, virtual fishing on a boat, or examination of different types of fish at various water depths while playing a game. A user study of the application and scenarios was conducted to demonstrate the fidelity of the system, which improved interactivity and immersion using low-cost mobile VR technologies.

Two studies in surgical education involved an immersive virtual reality (IVR) training setup that combined 360° operating room (OR) video and interactive practice on a simulator. Huber et al. (2017) integrated the display from an IVR surgical training device with 360° video that was viewed through a HMD. While watching the 360° VR video, participants could simultaneously complete interactive hands-on tasks with the surgical simulator as if they were in the operating room performing the procedure. The medical professionals who participated in the training found the experience exhilarating and experienced a strong sense of presence in the VR operating room. Unfortunately, it took them longer to complete simulated tasks and higher error rates were reported. This finding was attributed to possible distraction while engaged with the immersive VR environment. Pulijala, Ma, Pears, Peebles, and Ayoub (2018) also conducted a study that combined 360° OR video and VR simulation of surgical techniques. The expert surgeons who used and evaluated the training were positive about the potential benefits of this interactive and immersive VR surgical training system.

Benefits and Drawbacks of 360° Video for Learning

The previous section revealed some of the benefits and drawbacks of educational 360° VR video based on individual studies, but a few trends emerge when looking at patterns across the entire group of research articles. One notable trend pertaining to benefits was the positive experience of learning with 360° VR video. Across multiple studies, participants indicated high levels of interest, engagement, enjoyment, or perceptions that the experience was beneficial to them (Dolgunsöz et al. 2018; Harrington et al. 2017; Johnson 2018; Lee et al. 2017; Panchuk et al. 2018; Walshe and Driver 2019). Participants valued the immersive learning experience and sense of presence that contributed to feeling like they were there in the virtual scene.

Despite positive perceptions of educational 360° VR video, findings were mixed about the actual impact on learning. Several studies found no support in favor of 360° VR video as compared to 2D video (Dolgunsöz et al. 2018; Harrington et al. 2017; Lee et al. 2017), although the study by Yoganathan et al. (2018) was an exception. Some studies found non-significant results for learning with immersive educational approaches using 360° VR video (Panchuk et al. 2018; Pulijala et al. 2018), while others reported more promising findings (Stupar-Rutenfrans et al. 2017; Walshe and Driver 2019). In addition to mixed findings on the impact of 360° VR video for learning, some studies reported minor problems with distraction or poor concentration (Huber et al. 2017; Johnson 2018), motion sickness or physical discomfort (Dolgunsöz et al. 2018; Rupp et al. 2019), inadequate video quality (Dolgunsöz et al. 2018; Johnson 2018; Pulijala et al. 2018), or trouble using or obtaining equipment (Johnson 2018).

Conclusions

This scoping review of 360° video research was conducted to examine the extent and nature of the research, how this type of media is used in education, and how some of the benefits and drawbacks are manifesting in practice. Results of this review indicate research activity on this topic is emerging and closely affiliated with VR in education. All the studies identified as part of this review integrated VR in some manner through comparison of VR versus 2D, implementation and evaluation of VR applications with 360° video content, or through feasibility testing of enhanced and interactive 360° VR video systems.

Overall, the research is largely exploratory with mixed findings about learning benefits. Based on the findings from this collection of research studies, there is some indication that learning with 360° VR video might be more appropriate for certain types of learning such as promoting empathy,

reflection, or skill-based knowledge as opposed to factual or conceptual knowledge. The full field of view in 360° VR video supports greater immersion but could lead to distraction that undermines attainment of learning outcomes requiring attention on specific visual items in the video. Future research should explore this further to deepen understanding how, and under what conditions, 360° VR video supports learning. Additional research could delve into the instructional design of educational 360° VR video to identify strategies for directing attention or for using the properties of the media to optimize learning. Accessibility is another area that was not mentioned in any of the studies, but should be considered in future work,

A limitation of this scoping review is that the sample of articles is constrained to the search and selection strategies described in the methods section. Furthermore, it is possible that relevant studies were missed. Future research could expand the search to include additional databases or map the field over time. This scoping review offers a glimpse into an emerging field of research at a specific time and it will likely evolve along with continued interest in educational 360° VR video. The advancement of affordable technologies and the growth of free online 360° video will contribute to increased available for educational use.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This study did not involve human participants or animals.

Informed consent Informed consent was not applicable in this literature review study.

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