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A Scoping Review of Videoconferencing Systems in Higher Education: Learning Paradigms, Opportunities, and Challenges

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Abstract

Videoconferencing as a learning tool has been widely used among educators and learners in order to induce effective communication between learners and teachers or learners and their peers, especially when face-to-face means are not possible. Different types of videoconferencing platforms or systems have emerged for use in today's higher education institutions. Previous research has focused on examining the potential of three different forms of videoconferencing systems: desktop videoconferencing (DVC), interactive videoconferencing (IVC), and Web videoconferencing (WVC). In this study, a review of the literature was conducted to increase the current knowledge regarding the use of these videoconferencing systems. A classification of the videoconferencing paradigms from the constructivism and cognitivism perspectives was provided. The summary of the results for these videoconferencing systems revealed specific learning opportunities, outcomes, and challenges for both learners and instructors. The results suggest that current policy and teaching strategies are not ready to provide an accessible and comprehensive learning experience in DVC and IVC. Relative to previously conducted studies regarding the use of videoconferencing in higher education, this study offers a broader consideration of relevant challenges that emerge when using certain videoconferencing systems in both learning and teaching situations.

Keywords: computer-mediated communication, distance education, telelearning, improving classroom teaching, lifelong learning

Introduction

The current movement toward creating a comprehensive learning experience via the Internet by most higher education institutions, in both developing and developed countries, appears to be increasing the use of advanced Information and Communication Technology (ICT) in higher education (Al-Samarraie & Saeed, 2018). This movement requires engaging students in a learning space that is compatible with their abilities and surrounding context. In addition, the cognitive nature of a learning task typically demands an effective medium for creating and sharing ideas among group members. Creating a comprehensive learning experience online also requires continuous updating of technology to ensure its integrity for use in delivering instruction. From this, video communications technologies have been used to enable more authentic learner–learner interaction in virtual environments (Reaburn & McDonald, 2017; Smyth, 2011). In higher education, videoconferencing, whether it is accessed via the Web or desktop, is considered one of the most commonly used tools for facilitating learners' self-directed use of technology in a synchronous mode (Fischer, Collier-Meek, Bloomfield, Erchul, & Gresham, 2017; Reese & Chapman, 2017).

Previous studies on the effectiveness of videoconferencing in education have reported that various environmental (e.g., hardware, station, etc.) and individual (e.g., attitude, knowledge, etc.) dimensions influence the learning experience of students (Ghazal, Al-Samarraie, & Aldowah, 2018; Malinovski, Vasileva-Stojanovska, Trajkovik, & Caporali, 2010). Lawson, Comber, Gage, and Cullum-Hanshaw (2010) suggest that individuals' learning experiences can be changed by using different modes or forms of communication within and across different learning environments. In his research, Coventry (1995) demonstrates how videoconferencing can be put into a learning framework by taking a learner-centered rather than technology-centered approach, while also highlighting that institutions must have a clear understanding of videoconferencing capabilities before committing to the use of videoconferencing technology. Thus, the effective use of teleconferencing services can be associated with the technological readiness of an organization (Coventry, 1995). Pitcher, Davidson, and Napier (2000), on the other hand, address the need for exploiting opportunities offered by different videoconferencing systems to facilitate learners' interaction and collaboration. This requires careful modification of the conventional lecturing in order to meet the videoconferencing standards and needs (Pitcher, Davidson, & Napier, 2000). Thus, it is evident that video and audio conferencing are considered as more "complex" communication channels than face-to-face communication (Allen, Bourhis, Burrell, & Mabry, 2002), where learning outcomes expected from using certain types of videoconferencing systems may vary from one context to another based on the available ICT resources (Sife, Lwoga, & Sanga, 2007).

With the use of 'cutting-edge' teleconferencing tools in different educational environments, there is still a notable lack of research to demonstrate the current use of videoconferencing in the higher education of developing and developed countries. Furthermore, previous studies have not sufficiently addressed the specific opportunities and challenges related to the use of different types of videoconferencing systems to the policy makers of higher education, which may promote current efforts for the delivery of effective distance learning experiences. According to Lawson et al. (2010), the impact of videoconferencing on how learners learn and interact may serve certain educational objectives, and therefore videoconferencing must be adapted in certain learning circumstances. Based on these observations, the research study at hand reviewed the existing literature concerning the use of desktop videoconferencing (DVC), interactive videoconferencing (IVC), and Web videoconferencing (WVC) to identify how their use may contribute to the learning of students, as well as to identify the specific

challenges associated with DVC, IVC, and WVC. In addition, a classification of the videoconferencing paradigms from the constructivist and cognitivist perspectives was formulated.

Videoconferencing: An Illustration of Different Types

Videoconference technology is a communication medium that allows connected users to share visual and audio facilities in real time. It also allows registered users to transmit files, slides, static images, and text through the platform being used (such as desktop and Web) (Krutka & Carano, 2016). As the bandwidth availability, networks, and the speed of computers have dramatically increased in developed countries and most developing countries, using videoconferencing has become more feasible and realistic for professional organizations, school districts, and universities. However, even with a high-speed network, using certain videoconferencing systems may imply different experiences in accordance to the usage purpose and environmental conditions.

According to Campbell (2006), interaction between students-to-students and students-to-instructors in videoconferencing environments have opened new opportunities for advancing the delivery of traditional pedagogies. Many instructors use videoconferencing services to promote problem solving development and competency among students and themselves (Lawson, Comber, Gage, & Cullum-Hanshaw, 2010). However, synchronous videoconferencing systems may not necessarily deliver the required set of learning outcomes and an enhanced pedagogy to users, which poses new challenges to higher education (Lewis, O'Rourke, & Dooly, 2016).

For the purpose of the study at hand, we argue that students' exposure to different types of videoconferencing systems may offer different learning experiences and outcomes. Our review of the literature led to the identification of three types of videoconferencing systems (DVC, IVC, and WVC). Figure 1 shows a visual illustration of videoconferencing in its three forms.

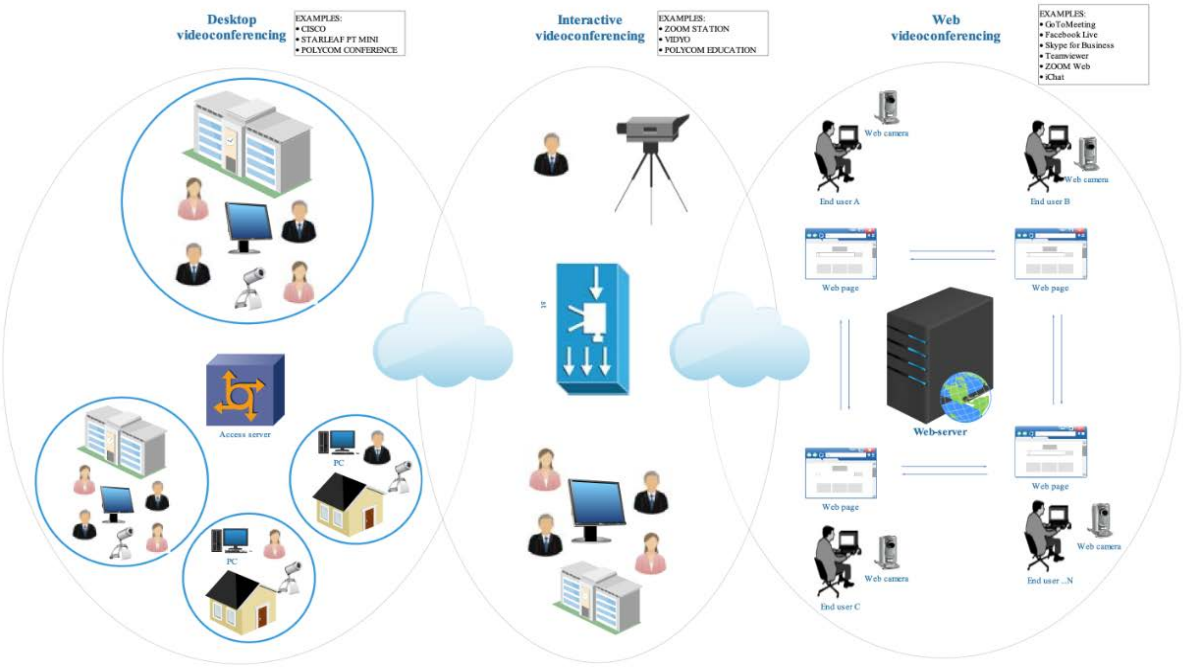

Figure 1. An illustration of different videoconferencing types.

As depicted in Figure 1, DVC (e.g., CISCO, STARLEAF PT MINI, and POLYCOM conference) is a type of videoconferencing which offers a group of people multiple channels of communication to discuss and learn about relevant issues and to solve certain learning problems. DVC supports multiple modes of interaction including: many-to-many, one-to-many, many-to-one, and one-to-one. It also provides a unique advantage to university members by allowing individuals to access and engage in active discussion via specially configured computers (provided by the university) and systems that can be installed and used on their own computers.

Also depicted in Figure 1, IVC (e.g., ZOOM STATION, VIDYO, and POLYCOM EDUCATION) is a type of videoconferencing that requires fixed environmental settings and advanced configuration to maintain the interaction between instructor and students. This type of service supports one-to-many interaction where instructors deliver their courses to the students in real time. It is suitable for conducting classes and trainings in distant locations. Meetings supported by IVC are usually aided by multimedia elements to facilitate the learning and teaching of the subject.

Lastly, WVC (e.g., GoToMeeting, Facebook Live, Skype for Business, Teamviewer, and ZOOM Web) is a type of videoconferencing that allows learners and instructors from different places to participate in Web-based discussions (using interaction modes similar to DVC), and is a particularly popular mean for promoting communication between students and their instructors. The key advantage of WVC is that, unlike when using DVC and IVC solutions, students and other faculty members are not fixed to a certain hardware and software requirements.

In the light of these criteria, university students are commonly perceived to use all three of these communication tools for the purpose of engaging in dialogue and problem solving (Freeman, 1998). However, the current literature does not clearly distinguish the impact of each type of videoconferencing on students' learning in a university context. Thus, we conducted a scoping review of the literature to provide necessary information regarding the learning paradigms, opportunities, and challenges of DVC, IVC, and WVC usage in higher education. Table 1 presents a comparison between DVC, IVC, and WVC from different technical, interaction, and organizational perspectives.

Table 1

Comparison Between DVC, IVC, and WVC Systems

Characteristics	DVC	IVC	WVC
• Requires advanced hardware configuration.	x	X	
• Requires advanced software configuration.	x	X	
• Cost effectiveness.			x
• Requires Internet connection.	x	X	x
• Requires account.		X	x
• Allows file sharing.	x		x
• Enables presentation.	x	X	x
• Provides private access.	x	X	
• Provides public access.			x
• Requires permission to access.	x	X	
• Provides advanced multimedia support.			x
• Requires advanced proxy configuration.	x	X	
• Requires training.	x	X	
• Supports one-to-many interaction.	x	X	x
• Supports many-to-many interaction.	x		x
• Supports one-to-one interaction.	x		x

Method

In this work, we paid special attention to the role of DVC, IVC, and WVC systems in promoting students' learning at the university level. The review was guided by the following research questions: "How can certain videoconferencing types be used to support learning paradigms?" and "What are the learning opportunities and challenges related to the use of these systems?" Figure 2 shows the search and selection flow chart of research articles retrieved from different databases such as ACM, ASSIA, Oxford University Press (journals), Science Direct, EBSCO, PsycINFO, SocINDEX, Emerald, and IEEE.

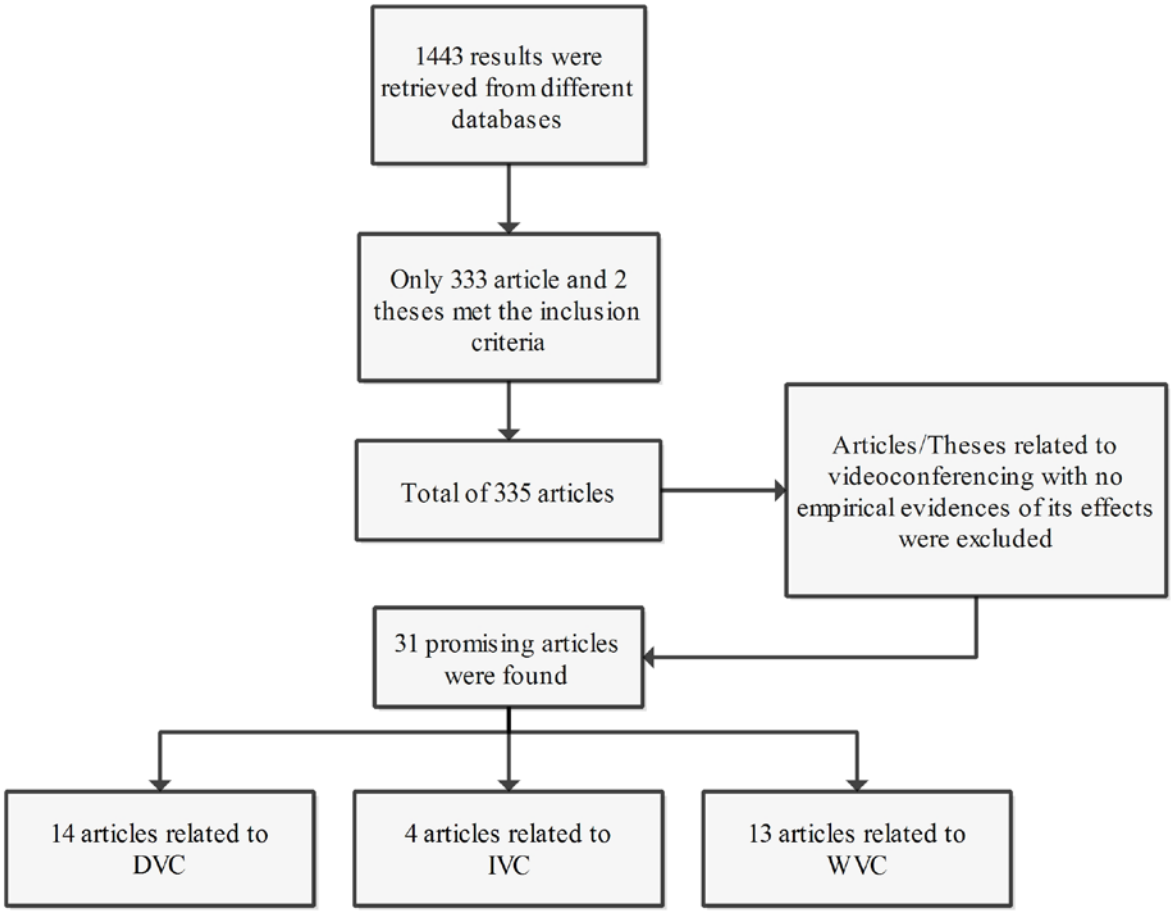

Figure 2. Articles selection flow chart.

The analysis of previous works was based on the recommendations of Srivastava (2007) and followed these steps:

1. Defining unit of analysis: Previous research papers, chapters, and theses on the use of videoconferencing systems in higher education were defined as the unit of analysis in this review. The argument as to why higher education ought to be more concerned with the use of certain videoconferencing systems is mainly to encourage active learner-centered education in hybrid learning environments. This includes the changing learning needs of society and the impact of new technologies on educational policies.

2. Collecting publications: Our literature review focused on English-peer-reviewed journals, since they are the most common resources for information exchange among researchers. Since

videoconferencing in higher education was first officially used 1995, we searched for articles published between the years of 1995 and 2018 and our search included examples of videoconferencing being used in a multitude of learning situations/ circumstances. We used different combinations of keywords to perform the search, such as "videoconferencing in higher education," "desktop videoconferencing in university," "online/Web videoconferencing services," "videoconferencing in distance education/learning," "teleconferencing for learning purposes," "interactive videoconferencing," and "collaborative videoconferencing." We also included more specific terms such as "interactive video communication," "desktop video system," "videoconferencing for distance learning," and "Web video system." A total of 1443 articles were then stored and prepared for further screening and selection. Only empirical studies that investigated the direct impact of the three types of videoconferencing systems on students' learning were included in this review (335 studies). Articles that did not explain the evaluation procedure and use of certain videoconferencing systems were not considered. Other studies that investigated the effect of videoconferencing, supported by other communication or tools such as the Blackboard learning environment, were also not considered. This is because the outcomes that emerged within these studies may not have been purely from the videoconferencing experience itself but instead influenced by the other communication tools used in combination with videoconferencing. We also excluded studies that explored students' general use of videoconferencing in circumstances outside of learning. Out of the 335 articles identified, only 31 articles met the inclusion criteria of the study.

3. Classification context: This review investigated three main schemes: DVC, IVC, and WVC. The 31 articles selected were classified and reviewed according to these schemes.

4. Material evaluation: The overall quality of the 31 studies was assessed by three experienced experts in the educational field, who scored the studies on a scale of 1-3 (low-high) based on: 1) appropriateness of the method, 2) relevance to the context of focus, and 3) credibility and validity. We measured the weight of each study by summing scores of each of the three dimensions. Then, we performed the inter-rater reliability (r) test which resulted in 0.91 agreement between the experts. Ultimately, all the 31 articles were found to fulfil this study's criteria and focus (see Figure 2).

Results

The results of the comparison between different studies on videoconferencing use in higher education are presented in Table 1. Below is a description of these studies according to the type of videoconferencing system used.

Table 2

A Review of Studies About Videoconferencing Use in Higher Education

No	Study	Description	Subjects	Tool
1	Sankar, Ford, and Terase (1997)	Demonstrated the effect of using videoconferencing technology in class.	85 MIS students	DVC
2	Harman and Dorman (1998)	Investigated the potential of videoconferencing as a tool for supporting distance learning.	15 math students	DVC
3	Fillion, Limayem, and Bouchard (1999)	Compared the effect of videoconferencing versus conventional classroom-based approaches on students' perceptions of lecture context.	55 university students	DVC
4	Chisholm, Miller, Spruill, and Cobb (2000)	Examined the effects of videoconferencing on students' academic performance and instructors' teaching evaluations.	26 pharmacy students	IVC
5	Townsend, Demarie, and Hendrickson (2001)	Examined the effect of students' anticipated system utility on videoconferencing satisfaction, and in turn, on their workgroup performance.	64 university students	DVC
6	Reiserer, Ertl, and Mandl (2002)	Investigated the effect of different videoconferencing scenarios on the learning outcomes of peer dyads.	86 university students	DVC
7	MacLaughlin, Supernaw, and Howard (2004)	Compared outcomes of distance education using interactive videoconferencing vs on-site education in pharmacotherapy courses.	78 university students	IVC
8	Wang (2004)	Determined whether videoconferencing can be used as a tool for supporting oral and visual interaction in distance education.	7 university students	WVC
9	Kidd and Stamatakis (2006)	Compared students' performance and satisfaction among medical students when using videoconferencing and live classroom.	38 pharmacy students	IVC
10	Ertl, Fischer, and Mandl (2006)	Explored how to support the collaborative learning activity in videoconferencing.	159 university students	DVC
11	Bertsch, Callas, Rubin, Caputo, and Ricci (2007)	Compared the use of videoconferencing and in-person lectures in preparing medicine students for clinical practice examinations.	52 medical students	IVC
12	Xiao (2007)	Investigated the effects of interaction with native speakers via videoconferencing on learners' language proficiency.	20 language students	WVC
13	Lee (2007)	Studied the potential of videoconferencing in developing second language oral skills.	18 language students	WVC

14	Gillies (2008)	Investigated students' views of the perceived effectiveness and value of videoconferencing.	27 university students	WVC
15	Giesbers, Rienties, Gijselaers, Segers, and Tempelaar (2009)	Investigated the effect of videoconferencing on students' expectation and satisfaction to communicate and learn online.	82 university students	WVC
16	Stewart, Harlow, and DeBacco (2011)	Studied the effect of videoconferencing on learners participating in multi-site, graduate-level education classes.	18 university students	WVC
17	Hampel and Stickler (2012)	Investigated the effect of videoconferencing on learners' interaction and communication.	7 university students	DVC
18	Florit, Montaño, and Anes (2012)	Evaluated relative efficacy, in terms of academic performance, of videoconferencing in teaching accounting.	630 accounting students	DVC
19	Britt, Hewish, Rodda, and Eldridge (2012)	Investigated the potential of videoconferencing to deliver interprofessional clinical education.	724 medical students	DVC
20	Fitzsimons and Turner (2013)	Reported the potential of collaborative project-based learning in videoconferencing.	6 university students	DVC
21	Giesbers, Rienties, Tempelaar, and Gijselaers (2013)	Examined the potential of videoconferencing tools in promoting students' performance based on their level of motivation, in an online course.	110 university students	WVC
22	Hortos, Sefcik, Wilson, McDaniel, and Zemper (2013)	Compared the effectiveness of using videoconferencing and attending live lectures on students' academic achievement.	275 medical students	DVC
23	Nilsen, Almås, and Krumsvik (2013)	Compared students' perception about on campus lectures and videoconferencing.	56 teacher education students	WVC
24	Jung (2013)	Investigated how learners can develop their linguistic competence via videoconferencing.	45 linguistic students	DVC
25	Jorgenson, Wilby, and Taylor (2016)	Investigated the potential of videoconferencing to promote cultural competency among students.	110 pharmacy students	DVC
26	Eiland, Garza, Hester, Carroll, and Kelley (2016)	Examined students' learning outcomes when engaging in a team-based session.	35 pharmacy students	DVC
27	Saito and Akiyama (2017)	Examined the impact of videoconferencing on the longitudinal development of second language production.	30 students	WVC
28	MacLeod, Kits, Mann, Tummons, and Wilson (2017)	Investigated how the use of videoconferencing can facilitate students' communication with lecturers.	30 students	WVC

29	Haug (2017)	Compared students' interactions when discussing learning topics via face to face and videoconferencing.	8 students	WVC
30	Kubota (2017)	Explored how videoconferencing can promote students' collaboration at a distance.	12 junior students	WVC
31	Oka and Suardita (2018)	Examined dental students' perceptions of videoconferencing lectures on basic/clinical research.	248 dental students	WVC

Videoconferencing Systems and Learning Paradigms

Understanding how certain technologies can be informed by the existing learning paradigms, such as constructivism and cognitivism, is essential for educational policy makers, as it allows them to enhance students' learning experience through the redesign of existing hybrid instructional models (Mallon, 2013). Therefore, a detailed review of the literature on how videoconferencing systems have been used to fulfill the learning goals of these paradigms is necessary. An illustration of the videoconferencing paradigms from the constructivist and cognitivist perspectives is shown in Figure 3.

The perspective of constructivist approach to knowledge construction and learning, we believe, can be well supported with the use of videoconferencing through a variety of collaborative learning tasks, interaction and reflection, and problem-solving conditions, which can offer the field of distance education alternative student-centered approaches to teaching and learning in hybrid courses. These constructivist activities in DVC and WVC can replace the traditional student-teacher-model of distance instruction, which consists of working with a limited number of classroom environments and tools in order to support the knowledge construction process. In addition, DVC and WVC can support student's interpretation of a learning problem through providing students the opportunity to engage in various learning activities. Instructors can use these videoconferencing systems to accurately assess the actual teamwork process and contribute to the construction of knowledge by interacting with students to help them reflect on their response to the learning task and to the learning environment. The supportive communication provided in DVC can offer some great pedagogical values such as sharing, presentation, and file transfer for learners to create external representations of theoretical concepts, evidence, and personal elaborations.

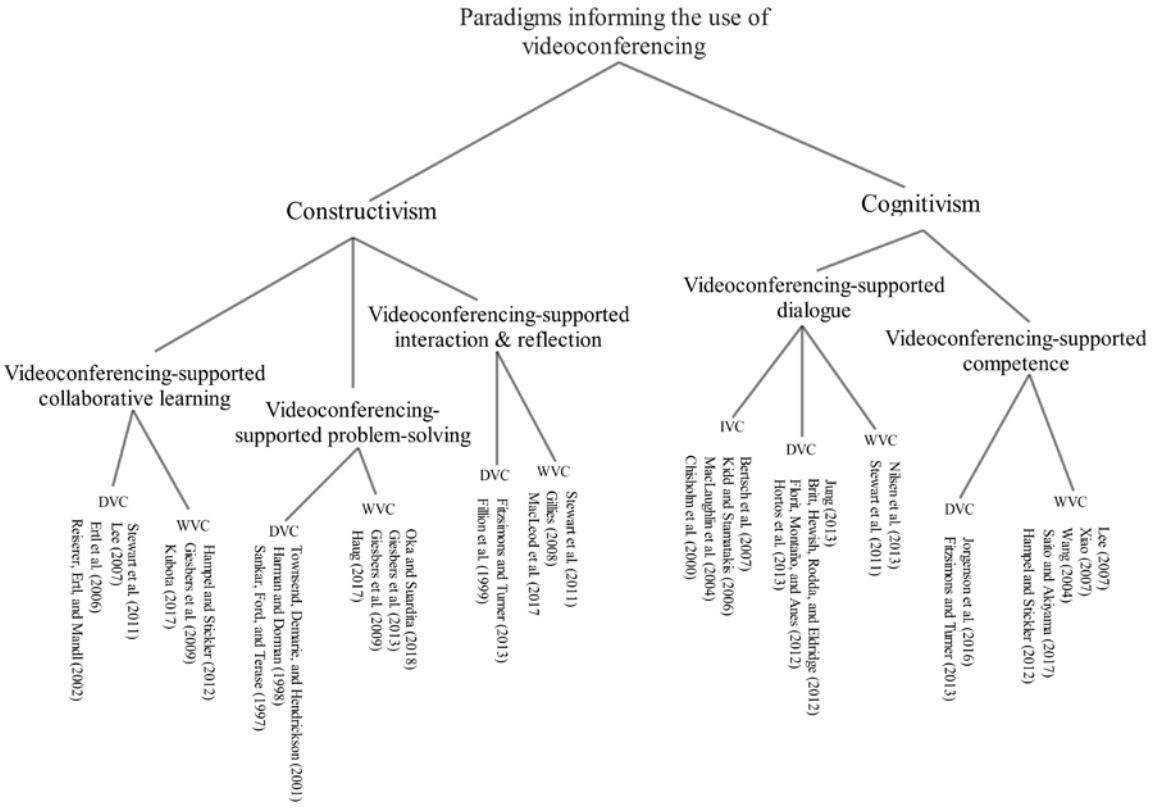

Figure 3. Videoconferencing paradigms.

From the cognitivist perspective, DVC, IVC, and WVC can be used to facilitate individuals' acquisition of information and knowledge from others by providing additional dialogue activities as a means of developing dialogue skills. This includes facilitating the development of the encoding process of learning materials that might facilitate later transfer. These systems can also be used to provide the means for students to transfer knowledge in the most efficient, effective manner possible by providing the necessary feedback to resolve ambiguities. The provision of additional dialogue activities for information recall demonstrates the potential value of interaction in these videoconferencing systems as well as improve information encoding and retrieval. IVC can be used to support effortless elaboration on a subject and the development of lesson content using the students' responses (MacLaughlin, Supernaw, & Howard, 2004), which could both increase the recall of information and make the information more meaningful. Both DVC and WVC can provide authentic learning opportunities that take place when a student communicates with the instructor online, thus promoting the acquisition of knowledge. DVC and WVC may also allow and encourage students to make connections with previously learned material by facilitating the recall of prerequisite skills and use of relevant resources.

Opportunities and Challenges of DVC, IVC, and WVC

Based on the review of previous studies (see Table 2), the major learning opportunities that emerged from the use of DVC, IVC, and WVC are discussed below. Major challenges regarding the use of these systems are also addressed to help educational decision makers understand the different technical, individual, and organizational factors that may impact learning through videoconferencing.

Desktop videoconferencing (DVC). Our review of the literature revealed that the majority of previous studies used DVC mainly to promote knowledge development and attitude-related outcomes. For example, Fillion, Limayem, and Bouchard (1999) stated that DVC sessions can be used to increase students' motivation and satisfaction of the course. In the context of linguistics, Lee (2007) found that speakers' linguistic variations were mostly affected by their degree of interactivity in the DVC session. Jung (2013) reported that the constant use of DVC has the potential to develop students' language competence by promoting participation in cross-cultural communication. In their research, Fitzsimons and Turner (2013) suggest that DVC can promote students' participation in collaborative project-based learning by engaging students in the process of problem-solving and allowing them to effectively apply theory to practice. DVC has been recognized as a system which can provide the means for students to generate a wider range of voices, as well as to allow them to record meetings and ask questions freely (Nilsen, Almås, & Krumsvik, 2013). DVC can also be used to facilitate progressive development in cultural competency among students coming from different backgrounds (Jorgenson, Wilby, & Taylor, 2016).

However, some challenges of DVC were also reported in the literature. For example, Hampel and Stickler (2012) suggest that in DVC, interaction is often limited due to only one person usually being allowed to speak at a time, which may thus impact turn-taking and back channeling, as well as lead to interruptions. Hortos, Sefcik, Wilson, McDaniel, and Zemper (2013) stated that the main challenges of using this DVC in learning include difficulties related to the design of meeting rooms and lack of built-in microphones. They found that students who learned in DVC settings performed no differently than those who attended live lectures (Hortos, Sefcik, Wilson, McDaniel, & Zemper, 2013). In addition, Ertl, Fischer, and Mandl (2006) observed no effect of DVC on learners' outcomes in collaborative learning settings, as students found it difficult to make use of the relevant support strategies for expressing themselves freely during the discussion. Meanwhile, students' contribution to the discussion or

problem-solving session was improperly distributed among themselves (Ertl, Fischer, & Mandl, 2006). In light of these observations, it can be deduced that DVC effectiveness for higher education teaching and learning still need be further explored.

Interactive videoconferencing (IVC). Previous studies (Chisholm, Miller, Spruill, & Cobb, 2000; MacLaughlin et al., 2004) have used IVC to promote students' academic performance. These studies claimed that using IVC can provide students with a close-up viewing and direct interaction with the instructor, as compared to the Web and desktop types (Chisholm et al., 2000; MacLaughlin et al., 2004). However, some studies perceived IVC to be inconvenient for learning complex knowledge. For example, Kidd and Stamatakis (2006) claimed that students' performance and satisfaction with IVC were lower than that of those who learned in a classroom setting. Considering various behavioral and environmental elements, Bertsch, Callas, Rubin, Caputo, and Ricci (2007) showed no significant differences in students' achievement when participating and interacting in IVC sessions compared to regular classroom lectures. It appears that the use of this type of videoconferencing system is less preferred than attending the usual classroom.

This can be attributed to the various challenges that IVC may impose on students' learning, which include creating uncertainty and fear among learners that, as a result, may induce misunderstandings among group members. MacLaughlin, Supernaw, and Howard (2004) added that instructors in the IVC session are required to constantly modify their teaching techniques, which may prove distracting for students and thus decrease the effectiveness of IVC. Furthermore, it is difficult for students and instructors to conduct regular scheduled recitation-type sessions with this type of communication (Kidd & Stamatakis, 2006). Other problems related to technical setup and bandwidth stability can also affect the quality of communication (both audio and visual) in IVC and thus negatively impact teaching and learning.

Web videoconferencing (WVC). WVC, as compared to DVC and IVC, appears to provide a more promising learning environment for students to freely collaborate and communicate effectively through different interaction channels. Most previous studies (e.g., Basiel & Howarth, 2011; Hatzipanagos, Basiel, & Fillery-Travis, 2010) considered this type of communication to be relevant to students' learning of various topics. As articulated by Gillies (2008), WVC allows students to participate in live interaction with the tutor and share relevant questions as well as exchange arguments in peer-to-peer discussions. In the WVC session, students are more likely to be motivated, because they can simultaneously collaborate with other members using audiovisual communication tools in an activity stream (Gillies, 2008). Although the use of WVC may often lead students to interrupt each other, this type of communication can still play a major role in enhancing learning effectiveness and efficiency through the facilitation of dynamic collaborative effort among group members (Stewart, Harlow, & DeBacco, 2011). Previous studies have also noted the potential of WVC to serve as an assessment tool for directing students' communication, which, may increase their sense of autonomy, competency, and relatedness, and thus help them to persist in their engagement (Giesbers, Rienties, Tempelaar, & Gijselaers, 2013). WVC can also be used to facilitate the exchange of ideas during a collaborative effort with regards to geographical placement of team members (Basiliko & Gupta, 2015).

Despite these opportunities, several issues were also noted when using WVC in the university context, such as time delay, background noises, and other technical hitches that may influence learners' interaction (Gillies, 2008). Students may face difficulties in maintaining their concentration when the focus is on another site and where the speaker is not visible on the screen (Lee, 2007). Giesbers,

Rienties, Gijselaers, Segers, and Tempelaar (2009) criticized the use of WVC due to compatibility issues found when students attempt to configure their machines. Still, the majority of previous studies are still dominated by the effectiveness of the WVC system to provide exceptional support for students to establish communication and social presence in collaborative learning sessions. A summary of the major learning outcomes reported in the reviewed studies describing the use of DVC, IVC and WVC is presented in Table 3.

Table 3

Learning Outcomes Reported in the Studies Associated With the Use of DVC, IVC, and WVC

Learning outcomes	DVC	IVC	WVC
Knowledge-related outcomes			
Problem-solving skills	*		
Performance	*	*	
Achievement		*	
Understanding	*		*
Knowledge			*
Attitude-related outcomes			
Attitude	*		
Perception	*		
Motivation	*		
Autonomy	*		
Satisfaction	*	*	
Communication-related outcomes			
Interaction	*		*
Sharing			*
Fluency			*
Accuracy			*
Confidence			*
Competence	*		

Discussion and Conclusion

The review of the literature revealed that there tends to be possible differences in learning outcomes when students learn through different videoconferencing systems. The opportunities and challenges of using videoconferencing systems in higher education (see Table 4) are summarized as follows:

1. Learning opportunities offered by DVC include: providing students the opportunity to exchange ideas and resources in a collaborative environment, promoting second language competency and performance. Although most previous studies did not find significant differences between students taking DVC and usual classroom, DVC is still considered to provide some exceptional opportunities for language and medical students. It was also found to advance cultural exchange and understanding among students from different racial/ethnic groups and educational establishments. This is due to its role in promoting socio-cognitive processes and structured interfaces that can help to develop students' sense of enjoyment, critical thinking, and autonomy. Challenges implied by this type of communication are more formidable, as reflected by previous studies. Using DVC in higher education still requires further investigation, especially regarding certain environmental effects on students' ability to establish the common

sense to solve learning problems and transfer the necessary support strategies throughout the learning session. In addition, the common challenges associated with students' interaction in DVC are derived from the difficulty in handling linguistic variations, turn-taking, interruptions, and back channeling.

2. The direct interaction with the instructor offered in the IVC environment was found to facilitate students' performance and achievement. Previous studies highlighted the potential of using this technology to help students learn from a close-up viewing with regards to geographical distribution of the instructor. Although IVC enables students to learn from a close-up view, the impact of this close-up view on students' learning was minimal. This can be attributed to the learners' uncertainty and fear to take part in the discussion.

3. WVC offer students and instructors the freedom and flexibility to learn and teach at their own pace. This was mostly reflected by the way in which WVC allows group members to assign roles to one another in their discussions, which is assumed to encourage dynamic cooperative efforts among group members. However, students who are not technology-oriented may be confronted with technical hitches and machine incompatibility. Meanwhile, the constant monitoring of students' progress throughout the session is the key for ensuring a meaningful learning experience in WVC. Such experience would greatly increase students' confidence and interaction to engage in live learning practices, which may enhance their understanding of complex and challenging topics.

This study anticipated that current policy and teaching strategies are not ready to provide an accessible comprehensive learning experience in DVC and IVC. From a policy perspective, this is probably because DVC and IVC are generally considered not cost-effective as they require experience to operate, and well-designed environments in order to establish a meaningful interaction among group members and the instructor. As such, more efforts are needed to determine the key antecedents for creating a comprehensive experience in videoconferencing environments. Future studies may still need to consider examining certain cognitive and behavioral factors when students engage in IVC and DVC sessions, and how they may be associated with the students' learning outcomes and motives for communicating with other group members and instructors. Finally, additional primary research is needed to further justify how certain learning outcomes can be achieved from the use of certain types of videoconferencing systems.

Table 4

Major Learning Opportunities and Challenges of DVC, IVC, and WVC Reported in the Studies

Learning opportunities			Challenges		
DVC	IVC	WVC	DVC	IVC	WVC
• Promote cultural competency. • Generate a wider range of student voices. • Stimulate professional activities and applies theory to practice. • Provide multiple modalities and pedagogical support. • Provide socio-cognitive support and structured interfaces.	• Allow for close-up viewing.	• Provide reliable means to assess individual's role in the discussion. • Promote dynamic collaborative efforts. • Allow students to engage in live interaction with the tutor.	• Availability of the system, ease of use, room location and layout, training issues, cost, and compatibility. • The stability of the Internet connection. • Require pre-knowledge to foster collaborative knowledge construction. • Learners may face difficulties to transfer support strategies of the learning unit. • Turn-taking, interruptions, and back channeling may affect the interactivity. • Difficulties to develop problem solving skills.	• Create uncertainty and fear as it lacks regularly scheduled recitation-type sessions. • Require trained instructors and constant modification of teaching techniques.	• Individual may experience technical hitches and machine incompatibility. • Students may often unintentionally interrupt each other. • Require constant modification of teaching techniques.

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