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Videoconferencing Technologies in Higher Education Settings: A Systematic Literature Review Based on the PACT Framework

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Abstract

The advantages of using videoconferencing in education has been reported by several studies, and further emphasized during the covid-19 pandemic where all universities had to shift to online learning. However, despite this attention, it is found that scant studies tried to analyze and understand videoconferencing tools in education based on a given framework or theory. This results in an incomplete picture of how such tools might reshape education. To address this research gap, this study conducts a systematic review to analyze videoconferencing tools in education based on the People, Activities, Context, Technologies (PACT) framework. The obtained results revealed that videoconferencing tools are mostly used in medical education with undergraduate students. Additionally, most of the targeted stakeholders are students, calling for more research to also target other stakeholders, such as administrators, teachers, etc. Finally, Zoom is the most used videoconferencing tool in education. The findings of this study can provide a roadmap on the future research directions to consider for a better adoption of videoconferencing in education.

Keywords: Video conference, university, online learning, PACT framework, communication technology

1. Introduction

1.1 Videoconferencing in Education

The majority of today's higher education students are members of Generation Z, colloquially called "Zoomers", are digital natives born between the mid-1990s and early 2010s. The term "Zoomers" did not originate from the video chat service Zoom. Rather, it is a creative adaptation of the term 'boomers,' intended to characterize the rapid and dynamic upbringing of Generation Z. This designation reflects the swift integration of technology and cultural changes during their formative years. They spend their entire lives surrounded by and using computers, video games, digital music players, video cams, cell phones, and all the other toys and tools of the digital age (Ceylan & Elitok Kesici, 2017). These technological advances inspired educators and researchers to investigate the advantages of using videoconferencing technology for teaching and learning (Anderson & Northcote, 2018). Video conferencing tools are defined as real-time audio and video means of communication between individuals from geographically different places (Mader & Ming, 2015). The affordance of videoconferencing in learning and teaching has been acknowledged, where during videoconferencing, learners have opportunities to receive authentic input, produce output, and receive prompt feedback (Yu, 2022). The use of videoconferencing has been further emphasized by the covid-19 pandemic, where all schools and universities switched to technology and online teaching in response to the pandemic and closure of schools and universities (Affouneh & Salha, 2021; Huang et al., 2020), in order to sustain education in crises (Tlili et al., 2023).

The use of the videoconferencing tools helps both teachers and students in their work, teaching and learning, which allows them to interact and learn (Sutterlin, 2018). The necessity to use Videoconference media in organizing meetings or briefings when working from home brings several opportunities and challenges (Parasian & Yuliati, 2020) at the same time.

1.2 Research Gap and Study Objectives

Twelve studies identified (Uerz et al., 2018) that technological competences are not enough for teacher educators to be able to use technology for pedagogical and educational purposes. Moreover, age and gender significantly impact the prediction of the level of pedagogical digital competence among teaching staff, whereas the educational stage in which they teach shows no effect (Guillén-Gámez et al., 2021). Therefore, for an

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effective and efficient use of digital technologies, which include videoconferencing systems just like in this present study, pedagogical and educational purposes need to be emphasized for both the generation Z and their educators in higher education. While different systematic reviews were conducted on the use of videoconferencing in education, they were focusing on a specific educational field or not framed within any model or theory, leading to incomplete results, or understanding of the effects of using videoconferencing in education. For instance, Rush et al. (2018) conducted a systematic review of videoconferencing systems compared to telephone in health care delivery, while Chipps et al. (2012) studied the effectiveness of videoconferencing on medical education through a systematic review. There is a need for reviewing both the technological aspects from interaction design or broader user experience perspective and the higher education pedagogical aspects. Thus, to contribute with both technological and pedagogical purposes of use in education, this present study reviews empirical studies on videoconferencing in higher education by applying the PACT framework (Benyon, 2019). PACT is an established framework in the fields of interaction design, user experience, and service design and innovation as a tool for supporting scoping studies.

2. Method

2.1 Study Selection

To identify the needed studies for the current systematic literature review, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed (Page et al., 2021). PRISMA provides a standard peer-accepted methodology that uses a guideline checklist, which was followed in this paper. Specifically, two electronic databases, namely DOAJ and ERIC, which are open and accessible in the field of educational technology were searched using the following search strings.

- Education: School, learning, university and teaching.
- Videoconferencing: Virtual conference, hybrid, online conference, Zoom, Teams, Google Meet/Hangout, WebEx, Adobe Connect, and Skype.
- Online application: Software, platform and system.
- Portable: Mobile and remote.
- Engagement: Interaction, communication and discussion.
- Learning Experience Design: Learning environment and flipped (classroom).

Additionally, the search period was set starting from 2017. The range of this study is close to Crompton and Burke (2020)'s recommendation, who recommended covering the last five years to see how technologies and pedagogies evolved. The final search was conducted on October 1, 2023 and led to 39 potential studies. After removing duplications, 34 potential studies were identified and went through the inclusion/exclusion criteria. A study was excluded if it: (1) was not in English; (2) did not use a videoconferencing system for teaching and learning; or (3) the educational setting was not in higher education. After the inclusion/exclusion filtering, 11 studies were analyzed, where the distribution of these studies by publication year is as follows: 2017 (n = 1), 2019 (n = 1), 2020 (n = 3), 2021 (n = 2), 2022 (n = 3) and 2023 (n = 1). Figure 1 presents the flow diagram of the study selection process.

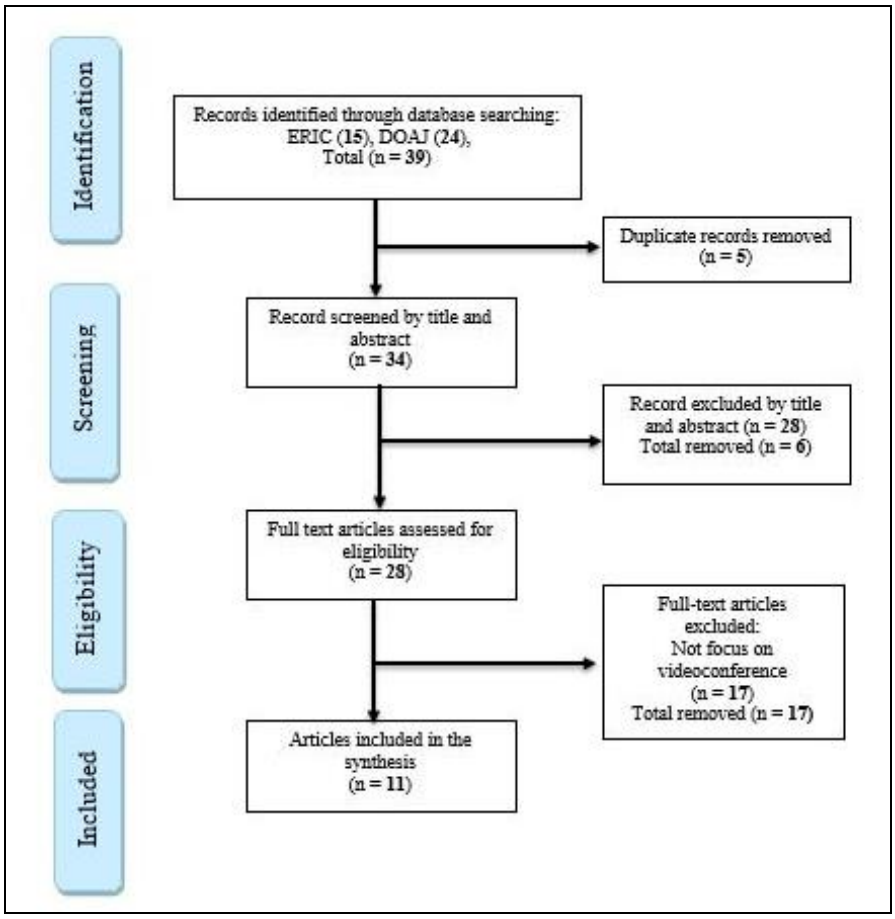

Figure 1. PRISMA flowchart of study selection process

2.2 Method for Analysis

The papers were coded based on the PACT framework (People, Activities, Context, and Technologies). A PACT analysis means that identification of the different activities that people conduct in different contexts using different technologies. Moreover, People use technology to undertake activities in contexts, while technology is used to enhance a wide range of people undertaking various activities in different contexts. If the technology is changed, then the nature of the activities will also change (Benyon, 2019). Additionally, using the PACT framework facilitates the process for data interpretation and understanding. Weekly meetings were held during the coding process, where any disagreements were solved through discussions.

3. Results and Discussions

Eight papers had didactical design context as they used frameworks to develop and implement the educational and the training materials, and interventions. Three papers presented multiple perspectives of teachers and students over videoconferencing systems, and one paper focused on presenting a case study of using videoconferencing. None of the reviewed papers considered instructional design models, which leads to the presence of using technology in the activities. The videoconferencing systems were used as means of teaching, learning and communication in seven studies, and they were the target and the aim in the rest of the studies. Videoconferencing systems were used by medical staff to treat, facilitate and to evaluate people like patients in faraway places. In organizational contexts, the videoconferencing systems were used to investigate the leadership status in the online environments. To shed light on the PACT components and the interaction among them, each component is discussed in the following sections. The full coding of the papers is presented in Appendix 1.

3.1 People

Table 1 reveals that different samples in higher education settings were targeted when discussing videoconferencing tools in higher education. Based on Table 1, it can be seen that videoconferencing tools have been mostly used with undergraduate students instead of graduate students. This could be attributed maybe that

these students need more engaging tools and methods to keep them motivated while learning. Additionally, it is seen that most of the targeted people in higher education are students and limited studies targeted other stakeholders, such as administrators and teachers. Therefore, future research should do one step further to cover more stakeholders, hence providing a complete picture of how videoconferencing can shape higher education and the perception of different stakeholders towards it. Finally, Table 1 shows that most of the studies investigated videoconferencing tools in higher education with limited sample size, raising concerns about the validity and reliability of the obtained results. Future researchers should pay attention to the research methodology when discussing videoconferencing in higher education so that they can obtain generalizable and reliable findings accordingly.

Table 1. Sample in each study

Study	Sample
MacLeod et al. (2019)	15 undergraduate medical education students, 18 faculty members, administrators, and audiovisual professionals.
Nichols et al. (2022)	139 instructors and students, specifically 3 instructors, 136 undergraduate students (47 females and 89 males)
Stokes et al. (2017)	6 teachers and 191 undergraduate medical students
Khalil & Cowie (2020)	16 doctoral students
Pennella & Bignami (2021)	3 university students (young adults)
Hilyard et al. (2020)	24 adolescents
Kelly et al. (2020)	3 undergraduate students
Oducado et al. (2021)	597 undergraduate nursing students
Blake et al. (2022)	25 university employees, 8 men, 17 women, administrative, professional, and managerial (IT and technical staff).
Griffin et al. (2022)	3 teaching staff working as a team.
Susila et al. (2023)	20 university lectures

3.2 Activities

In this section, activities are discussed from two perspectives; the first perspective is the learning activity, i.e., how videoconferencing tools were used in learning (see Table 2). The second perspective is the research activity conducted in each study to validate the results (see Table 2). Based on Table 2, it is seen that videoconferencing was used in learning activities for different purposes, including socializing, supporting students, discussing a given phenomenon, among others. However, it is found that limited information exists about the best practices of using videoconferencing in education. Specifically, online learning can be synchronous, asynchronous, flipped, flex, station rotation, among others (Ashraf et al., 2021), it is therefore important to investigate in which learning model and format videoconferencing can lead to significant positive learning outcomes. It is suggested that future research directions investigate this line of research. In terms of the research activity, it is found that qualitative research design was mostly followed, including conducting interviews, observations, etc. While qualitative results can help to draw conclusions about a given phenomenon, it is recommended that future research studies conduct mixed methods where qualitative and quantitative data are triangulated to obtain more reliable results that can be generalized.

Table 2. Conducted research activity in each study

Study	Learning Activity	Research Activity
MacLeod et al. (2019)	Connecting learners in multiple environments outside the traditional classroom or clinical environments.	A description of a series of practical tips for those working in the context of a videoconferenced distributed medical education program. In addition, the authors conducted an ethnographic study from 2013 to 2016 that included a critical analysis of 65 institutional documents, policies, and videos; more than 100 hours of observing videoconferenced distributed medical education classrooms; and 33 interviews with medical students, faculty members, administrators, and audiovisual professionals.
Nichols et al. (2022)	Participation in synchronous online lectures.	Investigation of three life sciences classrooms that utilized synchronous online lectures during the pandemic. Observing each class throughout the semester, quantified participation behaviors, and investigated the role of student gender. Comparing final course grades by gender.
Stokes et al. (2017)	The description of the partnership between two	Evidence-based internal medicine, residency curriculum and twenty-four videoconference teaching sessions were conducted and support the Guyana's Internet Medicine academic half-day and is characterized by

Continued. Table 2

	universities in medicine programs.	mutually beneficial, resident-led videoconference teaching sessions. Twenty-four videoconference teaching sessions were conducted over eight months.
Khalil & Cowie (2020)	Knowing the reflections during videoconferencing meetings.	Building understanding with participants, exchanging nonverbal cues between researcher and participants, considering socio-cultural aspects of the participants and gathering important information of the participants' feelings, thoughts and behaviours.
Pennella & Bignami (2021)	Socializing and communicating in videoconferencing environments.	Conducting free counseling and psychological support service, to frame clinical interventions and to reflect on these interventions through videoconference. Making a clinical case
Hilyard et al. (2020)	Testing the feasibility of a protocol that used in medical and clinical context.	Conducting group therapy and individual videoconference sessions.
Kelly et al. (2020)	Supporting students learning when using online environments.	Videoconference appointment options with learning advisers and librarians, and peer-to-peer virtual guides to online learning
Oducado et al. (2021)	Understanding the reasons that exhaust students in videoconferencing meetings.	The determination of the predictors of videoconference and the effect of videoconference in exhaustion and fatigue among nursing students.
Blake et al. (2022)	Testing the quality and the kinds of leadership services.	Exploring workforce experiences of the rapid implementation of a SARS-CoV-2 asymptomatic testing service (ATS) and to produce four overarching themes regarding workforce experiences: (1) feelings relating to their involvement in the service, (2) perceptions of teamwork, (3) perceptions of Asymptomatic Testing Service leadership, (4) valuing the opportunity for career development.
Griffin et al. (2022)	Exchanging best practices during online learning.	Informing practice while contributing to scholarly knowledge through offering spaces for students and staff to teach and learn Master's (MSc) in Global Challenges for Sustainability locally and remotely. Reviewing working documents, reports on what happened during delivery, including artefacts and general usage statistics, and a group reflection
Susila et al. (2023)	Training teachers on operating Zoom and using it for online learning	Identification and determination of participants, identification of needs, preparation of the equipment needed, giving invitations training participants targets, and training implementation activity.

3.3 Context

When investigating the learning context where videoconferencing tools have been used (see Table 1), it is found that they were used in different educational and work contexts and mainly in medicine education and medical practices (e.g., MacLeod et al., 2019; Stokes et al., 2017; Hilyard et al., 2020 & Oducado et al., 2021). This could be explained with virtual cultures having great benefits for medical students and health education. In the reviewed paper the advantages of using video conferencing have been stressed in order to save time, money and also the lives of many people by providing instance support for emergency cases. The advancements in information and communication technology present an opportunity for cognitive behavioral therapists to service patients or clients in remote areas through videoconferencing (Matsumoto, Hamatani, & Shimizu, 2021). Videoconferencing is proposed as an innovative telerehabilitation approach for stroke survivors (Tarihoran et al., 2023). Videoconferencing systems offer several advantages, particularly improved provider diagnostic accuracy and reduced readmission rates (Rush et al., 2018). However, the use of videoconferencing for nursing and medical education should be encouraged along with guidelines for the use of videoconferencing (Chipps, Brysiewicz, & Mars, 2012).

3.4 Technology

In terms of technology, Figure 2 shows that Zoom (e.g., Nichols et al., 2022; Oducado et al., 2021; Susila et al., 2023) was the most used videoconferencing tool, followed by Microsoft Teams (Griffin et al., 2022) and Blackboard (e.g., Kelly et al., 2022). Several studies highlighted the advantages of such tools, including saving time, improving learners' engagement, and increasing learner and teacher self-confidence.

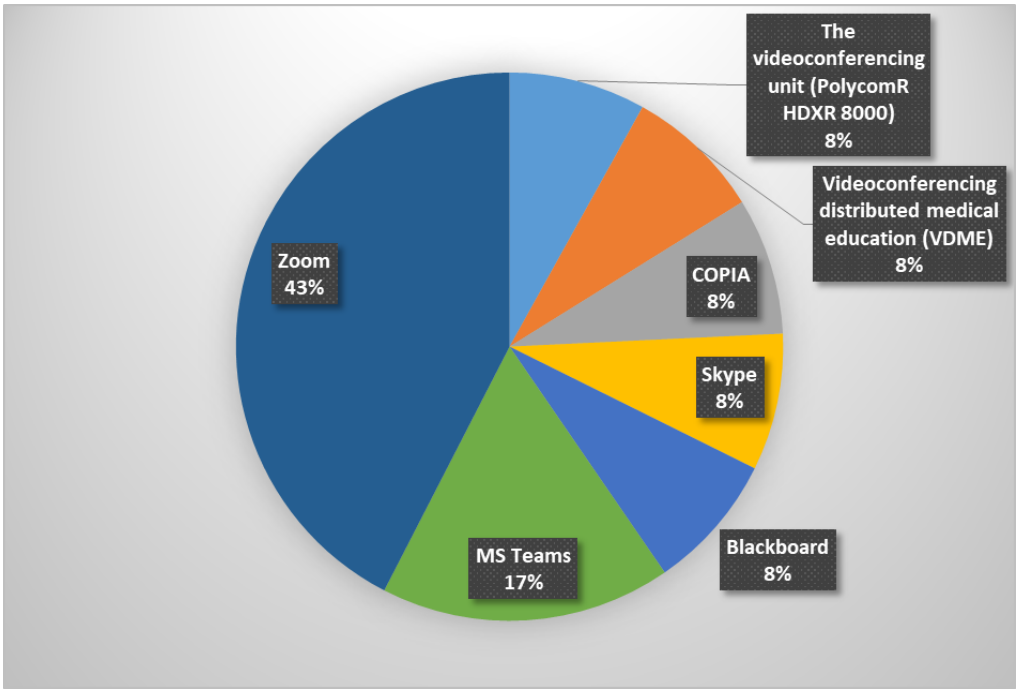

Figure 2. Distribution of videoconferencing tools

Siddiqui and Ahmad (2022) compared Google Meet, Microsoft Teams, and Zoom, as teaching and learning tools due to systems requirements, teaching and learning features, and security features and the study showed that Zoom was a better option for educational purposes. Leporini, Buzzi and Hersh (2023) investigated the accessibility and usability of the desktop and mobile versions of Zoom, Google Meet, and MS Teams and they concluded that Zoom was preferred to Google Meet and MS Teams. Cavus and Sekyere-Asiedu (2021) further conducted a comparative research method to compare nine features of the different videoconferencing tools which are maximum participants, meeting recording duration, security, chat/screen sharing, meeting duration, archive meeting, trial version, account creation to use and mobility. Table 3 relies on these nine criteria to conduct a comparative study of the videoconferencing tools identified in the 11 reviewed studies. Particularly, it is seen that, in addition to the paid license, these tools offer a free license, however with limited functionalities that might hinder the learning process. Therefore, universities from under developing countries might face the challenge of adopting such videoconferencing tools due to the limited financial funds. Therefore, future research directions should investigate open source tools and technologies, as these tools can help to ensure educational inclusivity and adaptation based on the needs of students, teachers and even universities (Zhang et al., 2020).

Table 3. A comparison of the used videoconferencing tools

Features / Platforms	**Google Meet**	**Microsoft Teams**	**Go to Meetings**	**Cisco Webex Meetings**	**Zoom Meetings**	**Click Meetings**	**Big Blue Button**
Maximum participants	100	300	250	100	100	25	100
Meeting recording duration	Limited	Limited	40 min	24 hours	30 min	30 min	unlimited
Security	✓	✓	✓	✓	✓	✓	✓
Chat/screen sharing	✓/✓	✓/✓	✓/✓	✓/✓	✓/✓	✓/✓	✓/✓
Meeting duration	60min	24 hours	40min	50 min	40min	40min	60min
Archive meeting	✓	✓	✓	✓	✓	✓	✓

Continued. Table 3

Trial version	Unlimited	6 months	14days trial	7 days trial	unlimited one-on-one meetings	30 days trial	7 days
Account creation to us	Not required	Not required	Not required	Not required	Not required	Not required	Not required
Mobility	Yes	Yes	Yes	Yes	Yes	Yes	Yes

On the other hand, students, teachers and users have faced several challenges while using videoconferencing tools, such as the feelings of loneliness and isolation since social interaction is very rare online and needs more efforts to be significantly visible (Massner, 2022). Some students and members of the staff mentioned that using videoconferencing was not a personal choice and, therefore, increased the resistance to using it and find it challenging (Riedl, 2022). Others suffered from technology fatigue (Hilty et al., 2023) while the rest concentrated on the lack of infrastructure readiness (Singh et al., 2021). Mukan and Lavrysh (2020) indicated several challenges faced by teachers when they used videoconferencing systems such as class management, educational materials transformation for the online mode, working with different abilities among students, and assessment.

4. Conclusions, Limitations and Future Directions

Videoconferencing systems are being investigated rapidly as they are the main platforms of online learning and teaching. Research on videoconferencing systems showed different gaps in their functionalities and the ways they were used. Particularly, Zoom is still dominant among these videoconferencing systems. The art of instructional design is still far away from the effective use of VC systems calling for more research in this regard. In light of this research, PACT model did not fit properly in the process of online learning. PACT could be one of several frames that should be studied and presented in a wide range of contexts including videoconferencing systems to reveal, for instance, why students with different cultures might perceive videoconferencing systems differently, especially in terms of using particular functionalities (e.g., turning on or off webcams while learning) (Salha et al., 2022).

Despite that this study presented solid findings that might help to understand the use of videoconferencing in higher education, it still has some limitations that should be acknowledged. For instance, the findings of this study are limited by the searched databases and keywords. Therefore, future research could complement these finding by covering more electronic databases.

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Appendix 1. Coding of the 11 studies

Authors & Year	Title	PACT			
		People	**Activities**	**Context**	**Technologies**
Directory of Open Access Journals (DOAJ)					
MacLeod, Cameron, Kits, Power & Tummons (2019).	Teaching and Learning with Videoconferencing at Regional Medical Campuses	Medical education students faculty members, administrators, and audiovisual professionals	Everything we hear, we hear through a network of microphones, cables, and speakers. Everything we see, we see through a system of cameras, cables, and screens. Spontaneous adjustments we would make in in-person	This study used ethnography students often avoided asking questions because they were hesitant to have their images projected on screen. The technologies are designed to optimize seeing and hearing-and they do so very efficiently! eye contact to gage attention	Videoconferenced distributed medical education (VDME)
Nichols, Xia, Parco, and Bailey (2022)	Participation and Performance by Gender in Synchronous Online Lectures: Three Unique Case Studies during Emergency Remote Teaching	Instructors and students	Participation in synchronous online lectures during Emergency Remote Teaching. Observation Recording Students interaction	Classroom Observations Protocol for Undergraduate STEM (COPUS)	ZOOM
Stokes, Ruzycki, Jainarine, Isaac and Cole (2017)	The Canada-Guyana medical education partnership: using videoconferencing to supplement post-graduate medical education among internal medicine trainees	Medical residents	Evidence-based internal medicine residency curriculum Twenty-four videoconference teaching sessions were conducted	Survey Questionnaire Focus group videoconference teaching series is a mutually beneficial partnership for Canadian and Guyanese medical residents and fosters international collaboration in medical education.	The videoconferencing unit (PolycomR HDXR 8000)
Susila, Qosim & Sutiono (2023)	Training of Operating Video Conference for Online Learning During Covid-19	University lectures	Using video conference to facilitate instructional process	A survey for need assessment	Zoom

Education Resources Information Center(ERIC)					
Khalil & Cowie (2020)	A research note: Video conferencing interviews	Doctoral students	Interviews. Building understanding with participants, exchanging nonverbal cues between researcher and participants, considering socio-cultural aspects of the participants	Socio-cultural aspects e.g., cell phone, tablet, computer electricity, computer, internet, camera, microphones)	Zoom
Pennella & Bignami (2021)	I didn't think you were listening. Some Reflections on Online Setting and Patient Proxy in the Remote Clinical Relationship	Italian university students and young adults	Counseling and psychological support service Exploratory interviews	Even when a comparison between offline and online therapy MJCP|9, 3, 2021 Reflections on Remote Clinical Relationship 13 settings is made, the goal cannot be to identify a winner between the two but to favour a thought process upon the features and specificities of these instruments and how they support and guide the clinical practice.	Skype
Hilyard, Kingsley, Sommerfield, Taylor, Bear & Gibson (2020)	Feasibility of a Randomized Controlled Trial of Paediatric Interdisciplinary Pain Management Using Home-Based Telehealth	Adolescents	Interviews qualitative analysis	Deliver health services SCOPIA provided an encrypted video link between the hospital and the participant's home, community or school environment	SCOPIA
Kelly, Johnston, and Matthews, (2020)	Online Self-Access Learning Support During the COVID-19 Pandemic: An Australian University Case Study	Students in Australian universities	Reflections. Self-access resources and videos for preparing to learn online, videoconference appointment options with learning advisers and librarians, and peer-to-peer virtual guides to online learning.	Peer-to-Peer Virtual Guides to Online Learning Online Self-Access Learning Support While the Peer Learning Coordinator observed that more students used the Microsoft Teams chat (62%) than made phone calls, the significant proportion of students calling (38%) indicates the need for multiple modes to support students effectively in a digital environment.	Blackboard, Microsoft Teams and Zoom
Oducado, Fajardo, Parreño-Lachica,	Predictors of Videoconference Fatigue: Results from Undergraduate Nursing	Nursing students	Cross-sectional online survey. The determination the predictors of	Nursing students experienced high levels of videoconference fatigue	Zoom

Maniago, Villanueva, Dequilla, Montaño & Robite (2021)	Students in the Philippines		videoconference	Gender, self-reported academic performance, Internet connection stability, attitude toward videoconferencing, frequency, and duration of videoconferences predicted videoconference fatigue. Zoom fatigue is real in the context of the educational enterprise. And while videoconferencing tools have made schooling possible in the midst of a pandemic, it has come without a challenge that may have undesirable consequences specifically among nursing students	
Blake, Somerset, Mahmood Mahmood Corner, Ball and Denning (2022)	Workforce Experiences of a Rapidly Established SARS-CoV-2 Asymptomatic Testing Service in a Higher Education Setting: A Qualitative Study	University employees and students.	Qualitative semi-structured videoconference interviews Exploring workforce experiences of the rapid implementation of a SARS-CoV-2 asymptomatic testing service (ATS)	Self-confidence and a sense of value and belonging. This has implications for staff wellbeing, work engagement, and the creation of workplaces across the sector that are well-prepared to respond to future pandemics and other disruptive events.	NA-- one-to-one, semi-structured, telephone or video-conferencing interviews
Griffin, Gallagher, Vigano, Mousa, Van Vugt, Lodder, and Byrne (2022)	Best Practices for Sustainable Inter-Institutional Hybrid Learning at CHARM European University	Students and teaching staff	Participatory Action Research Hybrid Classroom Design Informing practice while contributing to scholarly knowledge	Action research	MS teams