Emergency remote teaching in higher education: Mapping the first global online semester

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Abstract

Due to the Covid-19 pandemic that spread globally in 2020, higher education courses were subsequently offered in fully remote, online formats. A plethora of primary studies began investigating a range of topics exploring teaching and learning in higher education, particularly during the initial semester. In order to provide an overview and initial understanding of this emerging research field, a systematic mapping review was conducted that collates and describes the characteristics of 282 primary empirical studies. Findings reveal that research has been carried out mostly descriptively and cross-sectionally, focusing predominantly on undergraduate students and their perceptions of teaching and learning during the pandemic. Studies originate from a broad range of countries, are overwhelmingly published open access, and largely focused on the fields of *Health & Welfare* and *Natural Sciences, Mathematics & Statistics*. Educational technology used for emergency remote teaching are most often *synchronous collaborative tools*, used in combination with *text-based tools*. The findings are discussed against pre-pandemic research on educational technology use in higher education teaching and learning, and perspectives for further research are provided.

Keywords

Emergency remote teaching, higher education, systematic mapping review, Covid-19, educational technology

1. Introduction

Globally, the first semester of 2020 marked a turning point within education; the Covid-19 pandemic lead to the unprecedented situation of having to switch to online instruction. Early on considered as *emergency remote teaching—ERT* (Hodges et al., 2020), it has turned – and continues to turn - teaching and learning upside down, with considerable impact on students in all levels of education (Bond, 2020; Marinoni, van't Land & Jensen, 2020).

During the pandemic, most higher education institutions deployed a strategy of ERT, which can be considered as a branch of distance education (Bozkurt et al., 2020; Hodges et al., 2020). The special feature of emergency remote education is that it is an unplanned practice, with no option than to use any kind of offline and/or online resources that may be at hand. Stemming from this situation, researchers from across the globe have started to investigate a broad variety of topics related to teaching and learning during the pandemic, including studies on, for example, how educators' and students' acceptance of digital formats changed in the context of Covid-19, and how this potentially affects higher education in the long-term (Vallaster & Sageder, 2020), experienced instructors' views on online teaching and advice (Rapanta et al., 2020) or the relation between digital readiness and the social-emotional state of students (Händel et al., 2020).

With the emergence of primary research and the accompanying focus on specific courses, institutions and populations, research is needed that provides orientation within this vast field, in an attempt to structure the presently growing body of knowledge. Initial research overviews have begun to emerge, ranging from the commented list of selected studies on Covid-19 and ERT (Bates, 2020), a Padlet to collate information and links to studies (Hochschuldidaktisches Zentrum Sachsen, n.d.), to the open access COVID-19 in Higher Education Literature Database (CHELD V1) (Butler-Henderson et al., 2020). The research presented in this article aligns with these first endeavours of providing an insight into the emerging field of research around ERT. It aims to provide a glimpse into the breadth and depth of higher education studies that have been conducted so far, focusing on teaching and learning in the first semester of 2020 (April-September), by systematically collating information on primary studies.

1.1 Prior reviews of emergency remote research in higher education during the COVID-19 pandemic

A number of descriptive articles have been published that address the institutional processes that higher education institutions around the world implemented, in order to adapt to the pandemic, which provide useful lessons on failures and successes. For example, Bozkurt et al. (2020) analysed both the K-12 and higher educational landscape, covering 31 countries, and identified the main issues of concern in relation to the interruption of education, such as psychological pressure and anxiety, alternative assessment and evaluation methods, as well as surveillance and data privacy concerns. Crawford et al. (2020) also analysed 20 countries' higher education intra-period digital pedagogy responses to COVID-19 and noted three typologies of response, ranging from no response through to social isolation strategies on campus, and rapid curriculum redevelopment for fully online offerings, including the extension of the semester break, campus closures and the move to online teaching. These higher education responses also involved diverse decisions regarding teaching and learning. By conducting a qualitative content analysis of 52 student surveys and 17 instructor surveys at higher education institutions in Germany, Arndt, Ladwig and Knutzen (2020) derived thirteen central topics across the institutions, for example, workload, communication and interaction, prior experience and the impact on courses, and the evaluation of the switch from in-person to online learning.

Apart from descriptive studies, a number of secondary reviews have been conducted. For instance, the previously mentioned open access COVID-19 in Higher Education Literature Database (CHELD V1) (Butler-Henderson et al., 2020) represents a valuable resource to support research into literature on higher education during the pandemic. The thematic literature review by Bhuwandeep and Piyusa Das (2020) identified three trends that emerged with emergency remote education during COVID-19: blended learning, access and availability to e-resources, and stakeholder theory in distance education. The bibliometric analysis by González-Zamar et al. (2021) identified the impact of returning to the classroom with the effects on the cognitive processes, motivations and academic performance of students as the main research trends on the effects of COVID-19 in university classrooms during the summer semester 2020. The discipline of medicine has emerged as the most prolific, with major clusters of collaboration in terms of co-authorship, observed by the type of studies in those cases and most common keywords identified in the included articles (González-Zamar et al., 2021).

Whilst we recognise that previous reviews have begun the process of collating higher education teaching and learning research undertaken during the pandemic (e.g. Butler-Henderson et al, 2020), this review uses a larger number of databases and includes articles written in three languages. Furthermore, this article represents only the first stage of this project, mapping the literature in the early stages of the pandemic. The next stage of this research will see the

ongoing evolution of this work as an open access living review, in the hopes of providing the higher education community with a resource that provides multiple insights into the implications for research, policy and practice.

Research questions

Against this background, the following research questions guide this mapping study:

1. Where, when and by whom has research on teaching and learning in higher education during the COVID-19 pandemic been published?
2. What are the characteristics of, methods used, and topics studied in teaching and learning research in higher education during the COVID-19 pandemic?
3. What technology has been used during emergency remote teaching in higher education?

2. Methodology

In order to provide first insights into the rapidly emerging field of ERT in higher education, a systematic review was pre-registered (Händel et al., 2020) and conducted using explicit and transparent methods (Gough et al., 2012; Zawacki-Richter et al., 2020), and guided by the PRISMA reporting guidelines (Page et al., 2020). This mapping article provides a first overview of the research that has been undertaken during the initial stages of the pandemic, located using pre-defined inclusion/exclusion criteria. This will also be a living systematic review (Elliott et al., 2014), which means that it will be regularly updated with new studies that are published during the pandemic, that meet the inclusion criteria. The living review will be publicly available (see Bond et al., 2021).

2.1 Search strategy and study selection

The initial search was conducted on 24 July 2020, with subsequent searches conducted until the first week of December 2020. As the author team is trilingual, studies that were written in English, Spanish or German were targeted for potential inclusion. The platforms and databases searched for English language studies were Web of Science, Google Scholar, ERIC, PsycINFO, Scopus, ProQuest, EBSCOHost and Microsoft Academic Graph (see Chen, 2020), as well as the COVID-19 living systematic map (EPPI-Centre et al., 2021). For Spanish studies, Dialnet was searched, alongside Web of Science, Latindex, Redalyc and Google Scholar, and the Web of Science. These databases were chosen, as they are considered well-suited to evidence synthesis, with the Web of Science, Scopus and EBSCOHost, for example, being found particularly useful in a recent review (Gusenbauer & Haddaway, 2019). A number of studies were also identified during the life of the review through, for example, special issues being published, studies being published on Twitter, or through the COVID-19 research community on ResearchGate¹. Additionally, empirical studies included in the CHELD V1 database as of September 9, 2020 were included (Butler-Henderson et al., 2020) if they met the inclusion criteria and had not been duplicates of our own search. Searching pre-print servers and grey literature has been recommended when searching for research undertaken during the pandemic (e.g., Tricco et al., 2020), due to peer review duration and the “rapidly changing nature of the research landscape” (Bond, 2020, p. 195).

2.2 Search string

Two search strings were developed, one for each language (see Tables 1 and 2), focusing on formal teaching and learning settings in higher education during the pandemic, and using * for truncations. Given the large amount of medical studies published during the COVID-19

¹<https://www.researchgate.net/community/COVID-19>

pandemic (see EPPI-Centre et al., 2021), medical terms were added as ‘NOT’ terms, such as ‘pathology’, ‘telemedicine’ and ‘inflammation’, in order to further refine the search results, especially in the English search.

Table 1. Search string, English language studies

"emergency remote teaching" OR "student-centred remote teaching" OR "emergency remote education" OR "student-centered remote teaching" OR "COVID-19" OR "COVID19" OR pandemic OR "Corona virus" OR "online pivot"
AND
universit* OR "higher education" OR postgrad* OR undergrad* OR "tertiary education" OR college
NOT
pharmaceutical OR pharmacy OR clinic* OR pathology OR telemedicine OR telehealth OR inflammation OR patient* OR neurolog* OR surgery

Table 2. Search string, Spanish language studies

"enseñanza remota de emergencia" OR "educación remota de emergencia" OR "docencia no presencial de emergencia" OR "docencia virtual" OR "COVID-19" OR "COVID19" OR "coronavirus" OR "pandemia"
AND
"educación superior" OR "estudio* universitario*" OR "programa* universitario*" OR universitari*

2.3 Inclusion/exclusion criteria

The combined strategy of searching electronic databases, websites, social media and organisations, yielded 11,686 items (see Fig. 1), which were imported into EPPI-Reviewer evidence synthesis software (Thomas et al., 2020). Following the automatic removal of 1,740 duplicates, 9,946 items were screened on title and abstract by the four authors, applying the inclusion/exclusion criteria (see Table 3). Studies were included if they were empirical, written in English, German or Spanish, and explored teaching and learning in higher education during the COVID-19 pandemic (after January 2020).

In order to ensure inter-rater reliability between the four reviewers and authors of this study, five rounds of comparison coding were conducted with 492 studies (100, 100, 92, 100 and 100), resulting in substantial agreement (Cohen's $k = 0.795$) (McHugh, 2012). Following this, 9,454 items were screened on title and abstract, resulting in 669 potential includes. During this process, the reviewers adjusted the inclusion criteria to specifically ensure that only studies with students, educators or administrators as the units of analysis would be included.

Given the breadth of studies included for consideration, further rounds of screening to calibrate mutual agreement on the inclusion criteria was undertaken at the screen on full text stage. After retrieving 661 items to screen on full text, seven rounds of calibration and reconciliation were conducted (20, 20, 20, 20, 50, 100, and 140 items), resulting in strong agreement (Cohen's $k = 0.829$), and 282 studies being included for the initial map. Please note, however, that this is a living review, with further studies to be added in the future. Researchers are encouraged to contact the authors, with suggestions of research for possible inclusion. It should also be noted that over 100 studies have already been identified for potential inclusion, since the writing of this article began, and those that match the inclusion criteria will be made available within the living review (Bond et al., 2021).

Fig. 1 Systematic review PRISMA diagram

Table 3. Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Higher education	K-12, further education
Teaching and learning setting (students, educators, administrators)	No teaching and learning setting
English, German or Spanish language	Not in English, German or Spanish
Empirical study	Not empirical or primary research
Studies undertaken during the COVID-19 pandemic	Studies undertaken before the outbreak of COVID-19
Studies published after January 2020	Published before 2020
Students, educators or administrators as unit of analysis	Unit of analysis not students, educators or administrators

2.4 Data extraction

The coding system of Bond (2020) was slightly modified in order to extract data within EPPI-Reviewer (Thomas et al., 2020). Data extraction codes for this initial mapping stage included publication and study characteristics (e.g. publication name, participant focus, study level of students), methodology (e.g. study design, date of data collection), as well as research focus and technology used (research scope and the type of technology used, based on Bower's 2016 typology, see Appendix B). An initial five studies were coded by all four authors, in order to ensure agreement on the coding scheme. A full list of the coding scheme is available from Händel et al. (2020).

2.5 Data synthesis

In order to provide an insight into the heterogeneous articles included within this mapping review, a narrative synthesis was undertaken (Petticrew & Roberts, 2006), including a

tabulation of the included studies' characteristics (see Appendix A). Further tables are also provided throughout the text, or included as appendices, accompanied by a narrative description that summarises the results and frames the recommendations provided.

2.6 Interactive evidence gap map development

So as to provide an open and publicly accessible resource of research undertaken during the pandemic, interactive evidence gap maps were produced for each research question, using the EPPI-Mapper application (Digital Solution Foundry & EPPI-Centre, 2020). Following data extraction in EPPI-Reviewer (Thomas et al., 2020), a JSON report of all included studies was imported into EPPI-Mapper, where display and filter options were chosen². The HTML files of each map were saved, and are available to access and download (Bond et al., 2021). The interactive evidence gap maps provide users with the opportunity to explore cross tabulations of data within the review, beyond that which is provided within this article. Instructions are also provided within the 'About' section of each map, as to how other researchers can contact the author team, to suggest possible studies for inclusion in the living review.

2.7 Computer-assisted content analysis

In order to help answer research question two and provide further insight into the topics explored within publications during the pandemic, the content analysis software Leximancer³ was used. The popularity of computer-assisted content analysis methods has been growing in the past decade, particularly within the field of educational technology (e.g., Bozkurt, 2020; Zawacki-Richter & Latchem, 2018). It has been found to be particularly useful in refining qualitative findings, assisting the identification and understanding of connected themes (Lemon & Hayes, 2020), and is considered both an effective and efficient method of analysing data (Fisk et al., 2012; Krippendorff, 2013).

The title and abstracts of all included English language studies ($n = 262$) were converted into an Excel .csv file and imported into Leximancer. The decision was made to include English language only studies, due to how the software works. Stop words were removed ('conducted', 'due', 'during', 'participants', 'reported', 'results', 'use', 'used', 'using'), and plural phrases were merged (e.g. 'student' and 'students'). The software then automatically identified significant themes and concepts within two sentence blocks, and a concept map was produced (theme size of 50%), with the frequency and connectedness of identified concepts highlighted (Smith & Humphreys, 2006). Key themes were automatically produced in the concept map (e.g. students), due to the frequency and connectedness of the words within the data. The map was then analysed by the authors, involving cross-checking the map with the included studies, to ensure deeper understanding of the themes identified (Harwood et al., 2015).

2.8 Limitations

This mapping article represents a first attempt to systematically locate, categorise and analyse research that has been undertaken in higher education teaching and learning during the COVID-19 pandemic. Four large international databases were searched, as well as further repositories containing grey literature, and although articles written in both English and Spanish were explicitly searched for, and appropriate German language studies included, the search needs to be continuously updated, for example also including databases such as the Germany-based FIS

² For more information about EPPI-Mapper and creating interactive evidence gap maps, see <https://eppi.ioe.ac.uk/cms/Default.aspx?tabid=3790>

³ <https://info.leximancer.com/>

Bildung⁴, which now (as of March 2021) lists many more German language resources than were initially available. Furthermore, numerous journals have announced special issues on the impact of COVID-19 on teaching and learning, due to be published in 2021 (e.g. *Journal of Research on Technology in Education*, *Journal of Engineering Education*), as well as institutional evaluations and surveys (Arndt, Ladwig, & Knutzen, 2020). These now available sources of research will need to be included in future iterations of the search strategy.

The review was conducted by four reviewers and, whilst attempts were made to reduce bias and inconsistency (see section 2.3), the possibility of the human flaw of having overlooked or misinterpreted information cannot be fully discounted. Furthermore, whilst it is important to conduct a quality appraisal of studies included within a systematic review (Harden & Gough, 2012), it was decided to map the available studies at this stage, prior to conducting further synthesis and quality assessment in future iterations of the review. We did, however, code many methodological aspects, and have provided recommendations for future research going forward (see Discussion).

3. Findings

3.1 Publication characteristics

The 256 published journal articles in this review were sourced from 155 unique journals (see Appendix C) from a range of disciplines (e.g., Health Sciences, Social Sciences). The *Journal of Chemical Education* published 36 articles, this being by far the highest number of articles sourced from one outlet. This is likely due to that journal opening a special issue call for papers in April 2020 that was published online in August⁵. The remaining studies were pre-prints ($n = 12$), reports ($n = 9$), conference papers ($n = 4$) and one thesis. The vast majority of studies (88.3%, $n = 249$) are available open access, corresponding to the share of open access publication of K-12 research undertaken during the pandemic (Bond, 2020).

3.1.1 Where, when and by whom were studies published?

The studies in this review were published by 1,019 authors, mostly in teams of two or three (see Table 4), and hailing from 73 different countries (see Fig. 2), which covers a broader range of affiliation countries compared to the K-12 review (Bond, 2020). 10.3% ($n = 29$) included more than 6 authors, which was predominantly the case for studies where the discipline of the first author was either *Health & Welfare* or *Natural Sciences, Mathematics & Statistics*.

In terms of country affiliation, the United States was the most prevalent country (23.4%, $n = 66$), followed somewhat surprisingly by Saudi Arabia (7.4%, $n = 21$), Indonesia (6.4%, $n = 18$), India (6.0%, $n = 17$), Spain (5.7%, $n = 16$) and the United Kingdom (4.6%, $n = 13$). Most of the authors' affiliation countries are located in Europe (27.7%), Asia (27.7%) and North America (25.5%), followed by the Middle East (15.6%), with little representation from South and Central America (5.7%), Africa (5.3%), and Oceania (2.5%); a finding that echoes prior educational technology in higher education research (e.g., Bond, Zawacki-Richter, & Nichols, 2019).

Most of the collaboration between authors were of a domestic only nature (68.8%, $n = 194$), which can also be understood by the type of articles that have been published and are included in this review, as most of them focus on the specific situation for teaching and learning in higher education within their institution and/or country (see e.g., Bozkurt et al., 2020). 17.4% were written by only one author, 10.3% were collaborations between international and

⁴ https://www.fachportal-paedagogik.de/literatur/produkte/fis_bildung/fis_bildung.html

⁵ See <https://pubs.acs.org/doi/10.1021/acs.jchemed.0c00378> for more information

domestic authors (two or more authors from the same country), and only 3.5% were published by international collaborations of authors from two or more completely different countries.

Table 4. Scope of article authorship ($n = 282$)

Number of authors	N studies	N studies [%]
1 author	50	17.7
2 authors	59	20.9
3 authors	56	19.9
4 authors	44	15.6
5 authors	30	10.6
6 authors	14	5.0
More than 6 authors	29	10.3

Fig. 2. Geographical location of authors, created using <https://mapchart.net/world.html>

Similar to the K-12 review (Bond, 2020), there was a first wave of publications that peaked in August 2020 (see Fig. 3). After September 2020, the number of monthly publications decreased. Unfortunately, however, it was not possible to identify the exact month of publication in 2020 for 38 studies. Looking at the discipline of the first author, all of them were represented, but the most frequent was *Health & Welfare* (22.3%, $n = 63$), followed by *Education* (18.1%, $n = 51$) and *Natural Sciences, Mathematics & Statistics* (16%, $n = 45$). For 36 studies (12.8%) it was not possible to identify the discipline of the first author.

3.2 Study characteristics

3.2.1 Geographical characteristics

Comparing both continental and country-level origin of authors and study participants, both correspond clearly and unsurprisingly. Participants mostly hailed from Asia ($n = 78$, 27.7%), North America ($n = 64$, 22.7%) and Europe ($n = 77$, 27.3%), followed by 14.2% studies from the Middle East ($n = 40$), 6.4% from South and Central America ($n = 18$), 6.0% from Africa ($n = 17$), and, finally, 2.1% from Oceania ($n = 6$). 1.1% of studies ($n = 3$) can be considered as

global studies, that is, students or educators from many countries across the globe participated (e.g., Aristovnik et al., 2020).

Fig. 3. Timeline of study publication ($n = 282$)

A total of 79 individual countries are represented in the corpus, exceeding that of author affiliation by six countries. In 20.6% of studies, participants came from the USA ($n = 58$), participants from India are present in 7.4% studies ($n = 21$), followed by 6.4% studies with Indonesian participants ($n = 18$), 6.0% with Spanish ($n = 17$) and 5.7% with Saudi Arabian participants ($n = 16$). The UK follows with 4.6% studies ($n = 13$) and China with 3.2% studies ($n = 9$). However, it needs to be noted that 25 studies published in the *Journal of Chemical Education* all sourced their participants from the USA, causing this number to be dominant in comparison with other countries.

3.2.2 Sample focus

Most of the studies (68.1%, $n = 192$) focused solely on the experiences and perspectives of higher education students (see Appendix D), especially undergraduates (46.1%, $n = 130$). Only 36 studies focused just on teachers/instructors (12.8%), although there were studies that triangulated data between student and educators (12.1%, $n = 34$; e.g. Abdulrahim & Mabrouk, 2020), teachers and department managers ($n = 4$; e.g. Ahmed, 2020), or teachers and support staff ($n = 2$; e.g. Littlejohn, 2020). Other combinations were rare (e.g., IT experts and developers, students, teachers and policy makers, $n = 1$) or non-existent (librarians with no other groups, $n = 2$). However, numerous studies included more than one group of participants, with the combination of students and instructors/teachers being the most frequent.

The studies were also categorised according to their sample size. While 25.2% of the studies can be considered large, with more than 400 participants, including a number of institutional (e.g., Alturise, 2020) and international (e.g., Aristovnik et al., 2020; Elumalai et al., 2020) surveys, but particularly comprised of national surveys (e.g., Wang, Zhang, & Ye, 2020), 16.3% of studies in the review had sample sizes of up to 25 participants (see Appendix E). This

is in stark comparison to studies of K-12 teaching and learning during the pandemic, with 34% of studies focusing on 25 or fewer respondents (Bond, 2020).

3.2.3 Discipline and education setting

In order to allocate participants' study discipline to fields of study, the ISCED classification (UNESCO, 2015) was used. In instances where participating students and instructors stemmed from a number of fields of study, all disciplines were marked (see Table 6), and it should be noted that each study could include more than one discipline (see Appendix F). The most researched disciplines were *Health & Welfare* (27.3%), followed by *Natural Sciences, Mathematics & Statistics* (24.1%) and *Education* (16%). For 23.4% of the studies, the discipline of participants was unclear.

Table 6. Researched disciplines in the corpus ($n = 282$)

Discipline of Participants	<i>N</i> Studies	<i>N</i> Studies [%]
Health & Welfare	77	27.3
Natural Science, Maths & Statistics	68	24.1
Unclear	66	23.4
Education	45	16.0
Arts & Humanities	40	14.2
Engineering, Manufacturing & Construction	30	10.6
Business, Administration & Law	26	9.2
Social Sciences, Journalism & Information	26	9.2
ICT	16	5.7
Other	2	0.7
Agriculture, Forestry, Fisheries and Veterinary	2	0.7

In 40.8% of studies ($n = 115$), research was conducted with participants who were not sourced from a specific course, discipline or department, but generally investigated perceptions of teaching and learning in Summer 2020, followed by studies within a specific department (21.6%, $n = 61$). Course-specific research accounts for 26.6% ($n = 75$) of the studies, and 6.4% of the studies were conducted within a discipline or a specific study program (5%).

3.2.4 Methodological characteristics

To provide an overview of the methodological characteristics of the studies, information was extracted about their approach, study design, data collection methods, when the studies had been performed (date of data collection), and the type of data analysis performed. It should first be noted, however, that 18.8% of studies did not appear to formulate any aims, research questions, or hypotheses. Furthermore, mirroring prior educational technology research (e.g., Hew et al., 2019), only 10.6% ($n = 30$) of studies in this sample used a theoretical framework, with the most used the Technology Acceptance Model (Davis, 1989), such as the Indonesian study by Sukendro et al. (2020), which used an expanded model to explore Indonesian students' use of educational technology during the pandemic. Hence it could be said that, not only was the research focused on emergency remote teaching and learning, but also the design and conduct of the research itself could be considered as "emergency remote research" (Bond, 2020, p. 202).

3.2.4.1 Approach and study design

The majority of studies were coded as quantitative research ($n = 151$, 53.6%), 16.3% of studies ($n = 46$) used a qualitative approach, and 30.1% ($n = 85$) were coded as mixed methods studies. The vast majority were cross-sectional studies (92.2%, $n = 260$) and thereby provide an overview on the situation under consideration. In contrast, the studies with a longitudinal study design (5.3%, $n = 15$), have the potential to display developments and to investigate reciprocal

effects (e.g. Knudson, 2020; Wang & East, 2020). For example, some studies had data available from previous study terms and could track students' development (e.g., Klegeris, 2020). In addition, 2.5% of studies used (quasi-)experimental designs to detect group differences regarding specific interventions (e.g. Gonzalez et al., 2020; Sáiz-Manzanares et al., 2020).

Sample sizes seemed to be equally distributed among the different study designs; i.e., there were different sample sizes across cross-sectional, longitudinal or (quasi-)experimental research, indicating that large (institutional) surveys with more power, as well as small cross-sectional studies, were conducted.

3.2.4.2 Data collection and analysis

The current review encompasses studies published between January 2020 and October 2020 (see Fig. 4). Most of those studies that reported when data were collected, had done so between March 2020 and June 2020, that is at the very beginning of the shift to online teaching and learning. However, more than half of the studies included in the review (55.7%, $n = 157$) did not include information as to when their data were collected. Given the variable spread of COVID-19 throughout the world, it is important to frame study results within this kind of contextual information (Bond, 2020).

Due to the situation of ERT, many students could not be on-campus, and could only participate in studies via online measures. Accordingly, it is not surprising that the majority of studies (83%, $n = 234$) used online surveys for their research (see Appendix G), followed by interviews (14.5%) and students grades (7.4%). The most often combined methods of data collection were surveys and interviews (8.5%, $n = 24$), such as the study of Indian educators and postgraduate students by Mishra, Gupta and Shree (2020), followed by surveys and student grades (7.4%, $n = 21$), such as the study of Canadian undergraduate Chemistry students by Rodríguez Núñez and Leeuwener (2020).

Fig. 4. Data collection timeline

Four in every five studies ($n = 227$) reported using descriptive statistics to analyse their data (see Appendix H), while a smaller proportion of studies reported correlational or inferential

statistics. This indicates that many studies can be considered as descriptive studies on the status quo of emergency remote teaching and learning. A small proportion of studies aimed to develop new measures and were explicitly concerned with psychometric analyses (e.g., Dwidienawati et al., 2020). 30.5% of studies employed qualitative data analyses, with a broad range of analysis approaches (e.g., content analysis, auto-narrative analysis), however 8.2% did not explicitly mention in their report, how they undertook their analysis.

3.2.5 Terminology used about research on teaching and learning during the pandemic

The terminology used to describe ERT throughout the studies varied greatly, with 71 individual terms used (see Appendix I). Across the study corpus, ‘online learning’ was the most frequently used term (20.6%, see Table 7), with ‘emergency remote teaching’ being used relatively less often (5.3%), which was surprising given its popularity amongst the educational technology community (e.g., Hodges et al., 2020; Bozkurt et al., 2020). However, the terms coded refer to terms and concepts that are well-established in the literature, with some studies opting to use multiple terms.

Table 7. Top 10 used terms for online learning during the pandemic

Terminology used	<i>N</i> Studies	<i>N</i> Studies [%]
Online learning	58	20.6
e-Learning	52	18.4
Distance learning	50	17.7
Online teaching	33	11.7
Online education	18	6.4
not specified	17	6.0
Internet Web-Based Learning	16	5.7
Emergency remote teaching	15	5.3
Remote learning	15	5.3
Computer-Based Learning	8	2.8
Distance education	8	2.8

Some studies also coined terms such as emergency remote online learning (e.g. Jeffery & Bauer, 2020), digital higher education (Littlejohn, 2020), home learning (Schmölz, Geppert, & Barberi, 2020) or multimedia-based learning (Scruggs et al., 2020). Others referred directly to specific forms of online learning and teaching, mostly when using terms related to assessment; examples include e-assessment (Sharadgah & Sa’di, 2020) or remote E-exams (Elsalem et al., 2020). As the terminology was derived from either the wording in the title, abstract, keywords or research questions, it needs to be noted that, for example, the *Journal of Chemical Education* used predefined keywords such as Internet Web-Based Learning and Distance Learning, which is presumably one reason why these terms were found with such frequency.

3.2.6 Study focus

The studies that were published in the first semester of the pandemic were predominantly focused on student perceptions of emergency remote education and online learning (see Table 8), followed by the impact of the shift to ERT and teacher perceptions of online learning during the pandemic. Surprisingly little research focused on student (4.6%) and educator well-being (1.1%), or on teacher professional development (1.1%). Only two studies focused specifically on students with special education needs and disabilities (SEND), with Alsadoon and Turkestani (2020) reporting on the experiences of teachers of hearing-impaired students, and Bartz (2020) exploring the experiences of students with disabilities and mental disorders at German universities.

This has not yet been peer-reviewed

Area of focus	<i>N</i> Studies	<i>N</i> Studies [%]
Student perceptions of online learning	171	60.6
Impact of shift to online learning	84	29.8
Teacher perceptions of online learning	54	19.1
Students' technical equipment	38	13.5
Course redesign	31	11.0

In order to gain further insight into the breadth of topics explored within the review corpus, a concept map was produced using content analysis software Leximancer (see Fig. 5). The thematic summary reveals that *students* has the most direct mentions with 1343 (100% relative count), followed by *pandemic* (52% connectivity), *e-learning* (7%), *classes* (7%), *social* (7%) and *data* (6%). The map confirms the findings of the topic analysis, indicating that higher education research has heavily focused on the experiences of students during the pandemic (see *experience-students-study-learning-activities*), and particularly that of undergraduate and medical students (see *undergraduate-online-learning-activities* and *students-learning-online-medical*). The map further reveals that research has sought to explore the quality of online teaching and learning (*quality-e-learning-system-institutions-education-challenges*), as well as how students could be supported through digital technology during the pandemic (see *students-social-support-digital*). Interestingly, the map indicates a focus on assessment (see *students-learning-online-teaching-assessment*), although the topic analysis only found 10% of studies with assessment as a research focus; a potential area for further exploration.

Fig. 5. Concept map of study titles and abstracts ($n = 282$)

3.3 Technology use for emergency remote teaching

Based on Bower's (2016) typology, we identified and coded 12 tool categories across the studies (see Appendix B). We additionally incorporated LMS and the devices used, due to their relevance and presence in some of these publications. 14.2% of the studies ($n = 40$) included the exploration of the type of devices used by the participants for teaching and learning, such as handheld device and internet access (e.g., Adnan & Anwar, 2020). However, in 20.6% of the studies ($n = 58$) no specific technology, tools or devices were specified, often using a phrase such as 'online learning' to refer to all forms of technology used.

The most often mentioned type of tools were *synchronous collaboration tools*, especially video conferencing systems (e.g. Zoom, Teams, Google Meet, etc.) (51.8%, see Appendix I). Since many universities had to move from presence teaching to online teaching rapidly, many adopted video conference to replace the presence teaching traditional sessions. LMS were also popular in these publications (41.5%), which is in line with the use of the main institutional systems that the majority of universities already had and used to some extent (e.g. to upload materials). Other typologies of tools with important presence were *text-based tools* (especially text-based communication such as email or instant messaging, 31.9%) and *multimodal production tools* (34.8%), particularly the use of teachers' pre-recorded videos.

Interestingly, the specific use of *assessment tools* was only 22.3%, which was lower than that found in a review of 242 pre-pandemic higher education studies (Bond et al., 2020), at 26.8%. Given the need to switch to online forms of assessment during the pandemic, this low number was quite surprising. Studies that did explicitly discuss the use of online assessment tools mentioned student concerns around not completing tests in time and online quizzes being inflexible with answers (Dietrich et al., 2020), internet connections dropping out during tests and affecting completion (Means & Neisler, 2020), the use of 'just in time' quizzes delivered to students' mobile devices (Chen, Jiao, & Hu, 2021), and educator concerns over using online proctoring services (Cutri, Mena, & Whiting, 2020).

In order to provide further insight into the types of technology used during the pandemic, a tool co-occurrence was conducted (see Fig. 6). *Synchronous collaboration tools* was most often used with other technology types, being combined with *text-based tools* in 86% of all possible cases, with *multimodal production tools* in 81% of all possible cases, and with *social networking tools* in 77% of all possible cases. The increased use of video conferencing and pre-recorded videos during the pandemic becomes even further apparent, when the combination of tools are considered in comparison to pre-pandemic research. There was a much higher use of *synchronous collaboration tools* in combination with *text-based tools* in this review (86%), in comparison with 69% in a review of pre-pandemic higher education studies (Bond et al., 2020). Likewise, the combination of *synchronous collaboration tools* and *multimodal production tools* (81%), as well as the combination of *synchronous collaboration tools* and LMS (68%) was strikingly higher than that found in the review by Bond et al. (2020), with 56% and 38% respectively.

4. Discussion and Conclusion

This review mapped 282 studies conducted during the first ten months of the COVID-19 pandemic in 2020. The results from this mapping study are revealing in the sense that they allow a glimpse into a field of research that has been emerging over a period of only twelve months, but that continues to grow in parallel with the ongoing pandemic. Whilst the overall topic of emergency remote teaching is driven by the current COVID-19 situation, several results from this review are in line with pre-pandemic research in the field of educational technology.

	Sum all	Sum Quanti	Sum Mixed	Sum Quali	LMS	MPT	TBT	AT	SNT	KO&S	VW	MOOCs	WCT	DAT	ML	GAMES
SCT	146	72	47	27	0.68	0.81	0.86	0.70	0.77	0.72	0.60	0.33	0.60	0.50	1	1
LMS	117	52	43	22		0.62	0.64	0.57	0.65	0.61	0.26	0.33	0.60	1	1	1
MPT	98	45	36	17			0.60	0.59	0.57	0.61	0.47	0.33	0.60	1	1	1
TBT	90	37	33	20				0.48	0.48	0.67	0.40	0.33	0.40	0.50	0.50	0
AT	63	33	26	4					0.20	0.33	0.33	0	0.40	1	0	1
SNT	40	21	15	4						0.33	0.06	0	0.60	0	1	0
KO&S	18	11	4	3							0.13	0.17	0.40	0	0.50	0
VW	15	6	9	0								0.17	0.20	0	0	0
MOOCs	6	1	2	3									0	0	0	0
WCT	5	2	3	0										0	0.50	0
DAT	2	1	0	1											0	0
ML	2	0	2	0												0
Games	1	0	1	0												

Fig. 6. Co-occurrence of tools across the sample ($n = 282$).

Note: Quanti = Quantitative, Quali = Qualitative, SCT = synchronous collaboration tools, LMS = learning management system, MPT = multimodal production tools, TBT = text-based tools, AT = assessment tools, SNT = social networking tools, KO&S = knowledge organisation & sharing tools, VW = virtual worlds, WCT = website creation tools, DAT = data analysis tools, ML = mobile learning

The pandemic struck higher education unexpectedly, with swift decisions and actions enforced (ERT; Hodges et al., 2020). Ensuing research, as collated per this review, indicates that the scope of studies overwhelmingly resides in the *perceptions* of students of the switch to online teaching and learning - although perhaps not of all students, with a noticeable lack of consideration of vulnerable populations such as international and SEND students as part of the general student body found across the studies - and, to a lesser extent, on the perceptions of educators. That is, the opinions, experiences and perceptions of stakeholders were evaluated and considered, particularly through the use of surveys, but less so actual learning behaviour, grade differences or changes in study performance of students. This is not surprising, as this kind of research is easier to conduct – especially in the given circumstances – and is still informative of how students lived through the opening months of the pandemic. This finding is also in line with the fact that the majority of studies were carried out cross-sectionally, and employed descriptive statistics rather than more complex analyses. Thus, while teaching and learning were organised in a pragmatic manner, research was as well. This was particularly highlighted by the fact that only 10.6% of studies were grounded by theoretical frameworks, which is comparatively low in comparison with previous pre-pandemic research (Bond et al., 2020) and the wider field of educational technology (Hew et al., 2019; Castañeda & Selwyn, 2018). As more time passes, it will be interesting to look out for changes in research currently being conducted. It is to be expected that after online learning and teaching has become more established within institutions, more profound and elaborate studies will follow.

The global geographical distribution of authors and participants' country affiliations likewise mirrors previous findings (e.g., Bond, Zawacki-Richter, & Nichols, 2019), with a noticeable lack of research coming from African and Oceanic countries. However, this should be

considered within the specific context of the pandemic, given the variable numbers of infections in those locations in 2020, as well as the varying national responses to COVID-19 and measures employed to fight the spread of the pandemic. Although the pandemic struck globally, academic collaboration in research occurred mostly with domestic colleagues and in teams working with two or three authors. It can be assumed that researchers had – in their double-function as teacher and researcher – relatively easy access to students at their respective institution. In contrast, the conditions, semester timing and other factors, certainly varied from country to country (Bozkurt et al., 2020), and doing international comparative research might have been harder to realise.

As found in K-12 research conducted during the early stages of the pandemic (Bond, 2020), approximately one third of research omitted important study design information. This ranged from information about student participants' study levels, to the discipline/ subjects under investigation, whether 'first year' or 'introductory' referred to undergraduate or postgraduate students, to information about the exact technology being employed within courses. The concept of online or digital learning can vary an extraordinary amount between contexts and studies, and in order for readers to understand and consider whether a study is applicable to their own situation, full study design details must be provided (Slavin, 2008; Bond et al., 2020).

The large number of studies published open access, mirrors the relevance of initiatives such as the Open Covid Pledge for Research in Education (<https://www.alt.ac.uk/about-alt/what-we-do/open-covid-pledge-education>), in spite of the forecast analysis on general overall research on COVID-19 literature being more restrictive (Torres-Salinas, Robinson-Garcia & Castillo-Valdivieso, 2020). With the broad range of publication outlets, ranging from educational technology to discipline-specific journals, as well as pre-print and academic repositories, it is again evident how forceful COVID-19 has impacted higher education and the actors involved.

It can be surmised that the educational technology most often employed - *synchronous collaboration tools*, and especially video conferencing – is because of the fact that teachers and students had the urge to re-create communication and interaction situations that are found during in-person lessons on campus (Giovannella, 2021), with a high potential of simulating face-to-face communication. With video conferencing being around for thirty years (Bonk, 2020), it has certainly experienced a surge in interest and broad application, entailing other questions related to its use (Bedenlier et al., 2020; Castelli & Sarvary, 2021). The use of video conferencing and the reliance on synchronous courses/meetings as part of online teaching and learning does, however, also indicate that at the outset of the first semester, larger numbers of teachers can be assumed to have not yet had extensive experience in providing other formats of online learning that make more use of the temporal flexibility inherent to online formats. What is also evident in the reviewed studies, is that another educational technology tool that was used frequently - the learning management system – whilst not surprising, is interesting in the sense that it is potentially used more often for teaching and learning purposes, and not solely as a file repository (Brady & O'Reilly, 2020). Only a small number of studies referred to having employed more advanced educational technology, such as virtual worlds, simulations, e-portfolios or similar, as well as a smaller than expected focus on online and alternative methods of assessment. Given the circumstances, this is perhaps not surprising, and also aligns with pre-pandemic use of educational technology (e.g., Bond et al., 2020). This does beg the question, however, of whether the expectations of COVID-19 as a catalyst for educational change have been - or will be - realised (Zhao, 2020), and that there is a further need for greater research into how the digital transformation of higher education should be developed (García-Peñalvo, 2021).

The next stage of this research is to conduct a further iteration of the search strategy and data extraction, in order to bring the review up to date. Researchers are warmly invited to contact the review team with suggestions of studies for inclusion, as a publicly available database will be created using EPPI-Reviewer (see Bond et al., 2021), which will be searchable and filterable, and contain several interactive evidence gap maps, which researchers, policy makers and educators can explore, download and use to inform policy and practice. More extensive data extraction will also occur, in order to synthesise results and gain deeper knowledge of which technology worked well and why.

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Authors' contributions

All authors contributed to the design and conceptualisation of the review, as well as screening, extracting and analysing the data. The first author managed the use of EPPI-Reviewer and EPPI-Mapper, including importing items, exporting reports and creating interactive EGMs, produced the concept map and analysis, and co-wrote all article sections. The second, third and fourth authors all co-wrote the literature review, method, results, discussion and conclusion sections. All authors read and approved the final manuscript.

Availability of data and materials

The datasets generated and analysed during the current study are available on [ResearchGate](#), as well as on the [Open Science Framework](#).

Competing interests

Two of the authors of this review have two studies included within the corpus. However, these were checked by the other authors and were found to meet the study inclusion criteria.

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⁶ Please note that studies included within the review corpus are listed with an asterisk *

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Appendix A – Tabulated list of included studies ($n = 282$)

Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Abbasi et al.	Asia	Pakistan	S	382	UG	H&W	D
Abdulrahim & Mabrouk	Middle East	Saudi Arabia	S, T	250	UG, PG	A&H, NSM, H&W, Eng	N/S
Aboagye, Yawson & Appiah	Africa	Ghana	S	141	N/S	N/S	N/S
Aboagye	Africa	Ghana	T	63	-	Edu	LMS
Adnan & Anwar	Asia	Pakistan	S	126	UG, PG	N/S	D
Agoestiyowati	Asia	Indonesia	S	5	N/S	N/S	SCT, TBT
Aqormedah et al.	Africa	Ghana	S	467	UG	N/S	LMS
Ahmed et al.	Global	Global	T, DM	79	-	H&W	N/S
Akande et al.	Africa	Nigeria	S	850	N/S	N/S	SNT
Al-Marroof et al.	Middle East	UAE	S	450	UG, PG	A&H, B, ICT	SCT
Al-Nofaie	Middle East	Saudi Arabia	S	25	UG	A&H	LMS, SCT, TBT, MPT, AT
Al-Okaily et al.	Middle East	Jordan	S	587	UG	Edu, A&H, NSM, Eng, B, ICT	N/S
Al-Tammemi, Akour & Alfalah	Middle East	Jordan	S	701	UG, PG	N/S	N/S
Al-Taweel et al.	Middle East	Iraq	S	832	UG	H&W	MPT, SNT, LMS
Aleksandra et al.	Europe	Serbia	S	129	UG	Edu	LMS
Allam et al.	Asia	Malaysia	S	631	UG	A&H	D
Almaiah, Al-Khasawneh & Althunibat	Middle East	Saudi Arabia, Jordan	S, T, SS, PM	67	N/S	N/S	N/S
Almuragab	Middle East	UAE	S	133	UG, PG	Eng, B, ICT	D
Alqahtani & Raikhan	Middle East	Saudi Arabia	SS	69	-	Edu, A&H, NSM, H&W, Eng, B, SS	N/S
Alqudah et al.	Middle East	Jordan	T	22	-	H&W	SCT, TBT, MPT, SNT, LMS
Alqurshi	Middle East	Saudi Arabia	S, T	777	UG	H&W	AT
Alsadoon & Turkestani	Middle East	Saudi Arabia	T	11	-	N/S	SCT, TBT, LMS
Alshehri et al.	Middle East	Saudi Arabia	T	122	-	A&H, B, ICT	SCT, LMS
Altinay et al.	Europe	Cyprus	T, DM	15	-	N/S	N/S
Alturise	Middle East	Saudi Arabia	S, T	661	N/S	N/S	LMS
Alvarez	Asia	Philippines	S	5	UG	N/S	LMS, D
Amaya, Cantú & Marreros	S & C America	Mexico	T	87	-	N/S	N/S
Amin & Sundari	Asia	Indonesia	S	140	UG	A&H	SNT
Amir et al.	Asia	Indonesia	S	301	UG	H&W	SCT, MPT, LMS
Anggraeni & Pentury	Asia	Indonesia	S	84	UG	A&H	SCT, TBT, LMS
Anwar, Khan & Sultan	Asia	Pakistan	S	450	N/S	Edu, A&H, NSM, SS	N/S
Anzovino et al.	North America	United States	S	1,095	UG	NSM	MPT, AT, LMS
Area-Moreira et al.	Europe	Spain	S	51	UG	Edu	N/S
Aristovnik et al.	Global	Global	S	30,383	UG, PG	A&H, NSM, SS	SCT, TBT, MPT, D
Armstrong-Mensah et al.	North America	United States	S	184	UG, PG	H&W	TBT, MPT, AT, D
Arroyo-Vázquez & Gómez-Hernández	Europe	Spain	SS	14	-	SS	SCT
Aucejo et al.	North America	United States	S	1,446	UG	N/S	N/S
Azis & Fatimah	Asia	Indonesia	S	65	UG, PG	B	LMS
Azlan et al.	Asia	Malaysia	S	11	PG	H&W	KOT, SCT, TBT, MPT, AT, LMS
Baber	Asia	India, South Korea	S	100	UG	N/S	N/S
Baloran	Asia	Philippines	S	530	N/S	N/S	N/S
Barkanian	Middle East	Lebanon	S, T	170	N/S	N/S	D
Barova & Mileva	Europe	Bulgaria	S	116	UG	H&W	SCT
Barra et al.	Europe	Spain	S	85	UG	Eng	AT
Barrera et al.	S & C America	Colombia	S, T, SS	2,432	N/S	Edu, Eng, B, SS, ICT, Other	N/S

Note: UAE = United Arab Emirates, S & C America = South & Central America, T = Teachers/Instructors, S = Students, DM = Department Managers, SS = Support Staff, PM = Policy makers, UG = Undergraduate, PG = Postgraduate, H&W = Health & Welfare, A&H = Arts & Humanities, NSM = Natural Science, Mathematics & Statistics, Eng = Engineering, Manufacturing & Construction, Edu = Education, B = Business, Administration & Law, N/S = Not specified, SS = Social Sciences, Journalism & Information, LMS = Learning Management System, SNT = Social networking tools, SCT = Synchronous collaboration tools, TBT = Text-based tools, MPT = Multimedia production tools, AT = Assessment tools, KOT = Knowledge organization & sharing tools, D = Devices used

Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Bartz	Europe	Germany	S	45	N/S	N/S	SCT, MPT
Başal & Eryılmaz	Middle East	Turkey	S	92	UG	Edu	TBT, MPT
Batajoo et al.	Asia	Nepal	S	88	UG	H&W	SCT
Baticulon et al.	Asia	Philippines	S	3,670	N/S	H&W	D
Bautista et al.	North America	United States	S	5	UG	H&W	SCT, TBT, MPT
Bawaneh	Middle East	Saudi Arabia	S	116	UG	NSM	N/S
Berkova & Nemec	Europe	Czech Republic	S	41	N/S	NSM	MPT, AT
Besser, Lotem & Zeigler-Hill	Middle East	Israel	T	313	-	N/S	D
Bhargava	Asia	India	T	40	-	H&W	SCT
Blizak et al.	Africa	Algeria	S	380	UG, PG	NSM	SCT, TBT, SNT, LMS
Bogdandy, Tamas & Toth	Europe	Hungary	S	60	N/S	Eng, ICT	N/S
Cameron-Sanderford et al.	North America	United States	T	83	-	N/S	LMS
Cano et al.	Europe, S & C America	Argentina, Spain, Mexico, Colombia, Chile, Portugal	S, T	175	N/S	N/S	SCT, TBT, AT, SNT, LMS
Capone et al.	Europe	Italy	S	1,124	UG, PG	N/S	N/S
Carrascosa et al.	S & C America	Brazil	S	317	N/S	H&W	N/S
Casillas et al.	S & C America	Multiple	T	1,310	-	N/S	N/S
Chen, Jiao & Hu	Asia	China	S	60	UG	A&H	SCT, AT, D
Choi et al.	Europe	United Kingdom	S	440	N/S	H&W	AT
Cigerci	Middle East	Turkey	S	15	UG	Edu	KOS, SCT, MPT, LMS
Cirillo et al.	North America	United States	S, T	14	N/S	Edu	SCT
Co & Chu	Asia	Hong Kong	S	30	UG	H&W	SCT, MPT
Cohen & Davidovitch	Middle East	Israel	S	1,400	UG, PG	N/S	MPT
Craig et al.	North America	United States	S	49	UG	A&H	KOS
Crick, Knight et al.	Europe	United Kingdom	T	1,148	-	Eng	N/S
Crucho et al.	Europe	Portugal	S	60	UG	NSM	SCT, TBT, MPT, AT, VW, LMS
Cuschieri & Calleja Agius	Europe	Malta	S	172	UG	H&W	MPT
Cutri, Mena & Whiting	Europe, North America	United States, Mexico, Russia	T	30	-	Edu	AT
Danjou	Europe	France	S	20	UG	NSM	MPT, SNT, D
Dasheva, Andonov & Doncheva	Europe	Bulgaria	T	92	-	H&W	SCT, TBT, LMS
Dickson-Karn	North America	United States	S	11	UG	NSM	TBT, AT
Dietrich et al.	Europe	France	S, T	103	UG	NSM	SCT, MPT, AT, LMS
Dingwall	North America	United States	S	304	UG	NSM	SCT, TBT, MPT, LMS
Dinh & Nguyen	Asia	Vietnam	S	186	UG	SSci	SCT, TBT, D
Dost et al.	Europe	United Kingdom	S	2,721	UG, PG	H&W	SCT, MPT, AT, G, LMS
Driessen et al.	North America	United States	S	330	UG	NSM	MPT, AT, LMS
Dushkevych et al.	Europe	Ukraine	S	83	N/S	A&H	SCT, TBT, LMS
Dwidienawati et al.	Asia	Indonesia	S	153	UG	N/S	N/S
Edelhauser & Lupu-Dima	Europe	Romania	S	209	UG, PG	NSM, Eng	SCT, AT, SNT, LMS, D
Elledge et al.	Europe	United Kingdom	S	95	PG	H&W	SCT
Ellis, Steadman & Mao	Asia, Europe, N. America, Oceania	Multiple	DM	10	-	Edu	SCT, MOOC
Elsalem et al.	Middle East	Jordan	S	1,019	N/S	H&W	AT
Elumalai et al.	Middle East, Asia	India, Saudi Arabia	S	784	UG, PG	N/S	LMS

Note: UAE = United Arab Emirates, S & C America = South & Central America, N. America = North America, T = Teachers/Instructors, S = Students, DM = Department Managers, A = Administrators, SS = Support Staff, UG = Undergraduate, PG = Postgraduate, H&W = Health & Welfare, A&H = Arts & Humanities, NSM = Natural Science, Mathematics & Statistics, Eng = Engineering, Manufacturing & Construction, Edu = Education, B = Business, Administration & Law, N/S = Not specified, SSci = Social Sciences, Journalism & Information, LMS = Learning Management System, SNT = Social networking tools, SCT = Synchronous collaboration tools, TBT = Text-based tools, MPT = Multimedia production tools, AT = Assessment tools, KOT = Knowledge organization & sharing tools, VW = Virtual Worlds, D = Devices used

Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Eurboonyanun et al.	Asia	Thailand	S	47	UG	H&W	AT
Fatani	Middle East	Saudi Arabia	S	162	UG	H&W	SCT
Fawaz & Samaha	Middle East	Lebanon	S	520	UG	N/S	N/S
Fey, Theus & Ramirez	North America	United States	S	20	UG	NSM	SCT, SNT
Fox, Werth et al.	North America	United States	T	106	-	NSM	VW
Fox, Bryant et al.	North America	United States	T	4,798	-	N/S	MPT, SCT, TBT, AT, LMS
Fung & Lam	Asia	Singapore	S	154	UG	NSM	SCT, MPT, SNT
Gao, Lloyd & Kim	North America	United States	S	16	UG	NSM	VW
Gao & Zhang	Asia	China	T	3	-	A&H	KOS, TBT, LMS, MOOC
Gaur et al.	Asia	India	S	394	UG	H&W	N/S
Gelles et al.	North America	United States	S	11	UG	Eng	SCT, MPT, LMS
Getova, Mileva & Angelova-Igova	Europe	Bulgaria	S	427	N/S	Edu, A&H, NSM, H&W	KOS, SCT, TBT, LMS
Ghounane	Africa	Algeria	S, T	98	PG	A&H	MPT, LMS, SCT, TBT, SNT
Gill, Brito & Quintero	S & C America	Ecuador	S	627	UG	Edu	SCT, TBT, LMS
Gillis & Krull	North America	United States	S	66	UG	SSci	SCT, TBT, MPT, LMS
Gonzalez et al.	Europe	Spain	S	458	N/S	H&W	N/S
González-Calvo et al.	Europe	Spain	S	8	UG	Edu	N/S
Guangul et al.	Middle East	Oman	T	50	-	N/S	AT, LMS, WCT
Guban-Caisado	Asia	Philippines	S	10	N/S	A&H	MPT, LMS, D
Guo	North America	United States	S	20	UG	NSM	SCT, VW
Gupta, Pandey & Anshu	Asia	India	S	243	UG	H&W	SCT, AT
Gupta et al.	Asia	Nepal	S	769	UG	H&W	SCT
Gvampoh et al.	Africa	Ghana	T	24	-	Edu	SCT, TBT, D
Hadar et al.	Middle East	Israel	S, T	78	PG	Edu	N/S
Hadi, Andrian & Hidayat	Asia	Indonesia	S	167	N/S	N/S	TBT, LMS
Händel et al.	Europe	Germany	S	1,826	UG, PG	A&H, NSM, H&W, Eng, B, SSci	D
Händel, Bedenlier et al.	Europe	Germany	S	5,563	UG, PG	A&H, Edu, NSM, H&W, Eng, B	D
Hashim et al.	Asia	Pakistan	S	239	UG	H&W	N/S
Heyang & Martin	Asia, Europe	China, Norway	T	2	-	A&H	SCT
Howitz et al.	North America	United States	S, T	1431	UG	NSM	SCT, TBT, MPT, AT, LMS, D
Howitz, Guaglianone & King	North America	United States	S	260	UG	NSM	SCT, TBT, MPT, AT, LMS, D
Huang	Asia	China	S, T	488	UG	NSM	MPT, VW, LMS, MOOC, D
Hwang	North America	United States	S	117	UG	NSM	AT, SNT, LMS
Ibrahim, Luzinge & Kapanda	Africa	Tanzania	S, T	1,596	UG, PG	H&W	SCT, MPT, LMS, D
Iqbal et al.	Middle East	Saudi Arabia	S	203	UG	H&W	TBT
Irfan et al.	Asia	Indonesia	T	26	-	Edu	SCT, MPT, LMS
Ivanović, Gaiević & Gaić	Europe	Serbia	S	27	UG	H&W	SCT, LMS
Jadhav et al.	Asia	India	S	373	UG, PG	NSM, H&W, Eng	LMS
Jankowski	Africa, Asia, Europe, N. America, Middle East, S & C America	Multiple	T, DM	813	-	N/S	N/S
Jeffery & Bauer	North America	United States	S	208	UG	NSM	SCT, MPT, LMS
Jiménez-Rodríguez & Arroqante	Europe	Spain	S	93	UG	H&W	VW
Johnson, Veletsianos & Seaman	North America	United States	T, DM	897	-	N/S	SCT, TBT, MPT, SNT, LMS
Johnson et al.	North America	United States	S	38	UG	NSM	SCT, TBT, MPT, AT, VW, LMS
Jones, Vidal & Taylor	North America	United States	S	587	UG, PG	H&W	TBT, LMS

Note: UAE = United Arab Emirates, S & C America = South & Central America, T = Teachers/Instructors, S = Students, DM = Department Managers, A = Administrators, SS = Support Staff, UG = Undergraduate, PG = Postgraduate, H&W = Health & Welfare, A&H = Arts & Humanities, NSM = Natural Science, Mathematics & Statistics, Eng = Engineering, Manufacturing & Construction, Edu = Education, B = Business, Administration & Law, N/S = Not specified, SSci = Social Sciences, Journalism & Information, Ag = Agriculture, Forestry, Fisheries & Veterinary, LMS = Learning Management System, SNT = Social networking tools, SCT = Synchronous collaboration tools, TBT = Text-based tools, MPT = Multimedia production tools, AT = Assessment tools, KOT = Knowledge organization & sharing tools, WCT = Website creation tools, D = Devices used

Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Joshi, Vinay & Bhaskar	Asia	India	T	19	-	N/S	KOS, SCT, TBT, MPT, AT, D, LMS
Kabanova et al.	Europe	Russia	S	100	UG	B	N/S
Kamal et al.	Asia	Malaysia	S	354	N/S	NSM	AT
Kapasia et al.	Asia	India	S	232	UG, PG	A&H, NSM, B	SCT, TBT, MPT, LMS
Karalis & Raikou	Europe	Greece	S	103	UG	Edu	SCT, TBT
Karatat & Tuncer	Middle East	Turkey	S	118	UG	Edu	MPT, LMS
Kedra & Kaltsidis	Europe	Greece	S	75	UG	NSM	SCT, TBT
Khalaf et al.	Middle East	UAE	S, T	94	UG	H&W	SCT, AT, D, LMS
Kidd & Murray	Europe	United Kingdom	T	14	-	Edu	SCT, MPT
Kikut	S & C America	Costa Rica	S	14,918	UG	Edu, A&H, NSM, H&W, Eng, B, SSci	SCT, TBT, MPT, LMS, D
Kim et al.	North America	United States	S	240	N/S	N/S	KOT, TBT, LMS
Kirschner, Mohammed & Weiner	North America	United States	S	273	N/S	Eng	SCT, MPT
Klegeris	North America	Canada	S	89	UG	NSM	KOS, TBT, MPT, SNT, LMS
Klein et al.	Europe	Germany, Austria, Croatia	S	578	UG, PG	NSM	SCT, TBT, MPT, D
Knudson	North America	United States	S	74	N/S	H&W	TBT, MPT, AT, LMS
Kockmann	Europe	Germany	S	112	UG, PG	N/S	N/S
Kolar, Turcinovic & Bojanjac	Europe	Croatia	S	819	N/S	Eng	KOS, SCT, LMS, MPT
Kollalpitva, Partigianoni & Adsmund	North America	United States	S	146	UG	NSM	SCT, TBT
Koretsky	North America	United States	S	163	UG	NSM	SCT, TBT, MPT, AT, VW
Kostikova et al.	Europe	Russia	S, T	N/S	UG, PG	N/S	SCT, MPT, SNT, LMS
Krishnapatria	Asia	Indonesia	S, T	62	N/S	A&H	SCT, SNT, LMS
Kusumawati	Asia	Indonesia	S	214	UG	Eng	KOS, SCT, TBT, MPT, SNT, LMS
La Velle et al.	Europe	United Kingdom	DM	N/S	-	Edu	LMS, SCT, TBT, MPT, AT
Lall & Singh	Asia	India	S	200	N/S	H&W, Eng, B, ICT	SCT, TBT, MPT
Lassoued, Alhendawi & Bashithalshaaer	Africa, Middle East	Iraq, Algeria, Egypt, Palestine	S, T	400	N/S	N/S	N/S
Liberman-Martin & Oqba	North America	United States	S, T	55	UG	NSM	SCT, TBT, AT, LMS
Lima et al.	S & C America	Brazil	S	50	UG	NSM, H&W	KOS, SCT, MPT, AT, SNT
Lin & Gao	Asia	China	S	1,189	UG	N/S	SCT, LMS
Lin & Pryor	Asia	China	S	89	UG	A&H, H&W, Eng, B, SSci, NSM	VW
Littlejohn	Europe	United Kingdom	T, SS	412	-	N/S	SCT, TBT, MPT
Liu et al.	Asia	China	S, T	9,382	UG, PG	N/S	N/S
Longhurst et al.	Europe	United Kingdom, Ireland	DM	14	-	H&W	SCT, VW, LMS
Lundquist, Rice & Widenhorn	North America	United States	S	1,143	UG, PG	N/S	N/S
Lyons et al.	Oceania	Australia	S	297	PG	H&W	N/S
Lytovchenko & Voronina	Europe	Ukraine	S	58	UG	Eng	MOOC
Mahdy	Global	Multiple	S	1,392	UG, PG	Ag	KOS, SCT, TBT, MPT, SNT, ML, LMS, WCT
Marek et al.	Africa, Asia, Europe, Middle East, N. America, S & C America	Multiple	T	418	-	A&H, NSM, B, SSci, ICT, Edu, H&W	SCT, TBT, SNT, LMS
Martínez-Garcés & Garcés-Fuenmayor	S & C America	Colombia	T	52	-	N/S	N/S
McRoy et al.	North America	United States	S, T	17	N/S	H&W	SCT, LMS, KOS
Means & Neisler	North America	United States	S	1,008	UG	N/S	SCT, MPT, AT

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Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Means & Neisler	North America	United States	S	620	UG	NSM	SCT, TBT, MPT, AT, D
Milligan	North America	United States	S	35	UG	NSM	SCT, MPT, AT, LMS
Minghat et al.	Asia	Indonesia, Malaysia	S	136	N/S	N/S	SCT, TBT, AT, LMS
Mishra, Gupta & Shree	Asia	India	S, T	338	PG	N/S	SCT, TBT, MPT, SNT, LMS
Mitra & Basu	Asia	India	S	262	UG, PG	H&W	SCT, MPT
Mladenova, Kalmukov & Valova	Europe	Bulgaria	S, T	310	N/S	ICT	SCT, TBT, SNT
Mohammed et al.	Middle East	Oman	S, T	N/S	N/S	N/S	SCT, MPT, SNT, ML, LMS
Molina & Tomás	S & C America	Argentina	S	96	PG	N/S	N/S
Mondal & Mondal	Asia	India	S	100	UG	H&W	SCT, AT, D
Monday et al.	North America	United States	S	89	UG	H&W	SCT, TBT, AT, LMS
Mondol & Mohiuddin	Asia	Bangladesh	S, T	80	UG	N/S	N/S
Moo	S & C America	Mexico	S	96	UG	Edu	N/S
Morales Vaccarezza	S & C America	Chile	S, T	7	UG	H&W	N/S
Mouchantaf	Middle East	Lebanon	T, SS	50	-	A&H	SCT, LMS
Mpungose	Africa	South Africa	S	26	N/S	Edu	TBT, MPT, LMS
Mukhtar et al.	Asia	Pakistan	S, T	24	UG	H&W	SCT, MPT, SNT, LMS
Murphy, Eduljee & Croteau	North America	United States	S	148	UG	Edu, H&W, B, SSsci	SCT, LMS
Muthler	North America	United States	S	10	UG	NSM, Eng	N/S
Nassr et al.	Asia	Malaysia	S	284	UG	ICT	SCT, MPT, SNT
Nenko, Kybalna & Snisarenko	Europe	Ukraine	S	540	N/S	N/S	KOS, SCT, TBT, SNT, D
Ng et al.	Asia	Hong Kong	T	1	-	ICT	LMS
Nickerson & Shea	North America	United States	S	63	UG	NSM	SCT, AT, TBT, MPT
O'Brien et al.	Europe	United Kingdom, Greece, Portugal, Ireland, Finland	T	12	-	Edu	N/S
Octaberlina & Muslimin	Asia	Indonesia	S	25	UG	Edu	LMS
Ogrutan & Aciu	Europe	Romania	S	26	UG	SSci	SCT, AT, LMS
Ohara & Ishimura	Asia	Japan	S, SS	5	UG	A&H	SCT
Olesov et al.	Europe	Russia	S	195	PG	N/S	LMS
Olmos-Gómez	Europe	Spain	S	441	UG	Edu	N/S
Olszewska	Europe	Poland	S	734	UG, PG	N/S	LMS
Omodan	Africa	South Africa	S, T, DM, SS	15	N/S	N/S	N/S
Pal & Vanijia	Asia	India	S	1,595	N/S	NSM, Eng, B	SCT
Papouli, Chatzifotou & Tsairidis	Europe	Greece	S	550	UG, PG	SSci	MOOC
Pather et al.	Oceania	Australia, NZ	T	18	-	H&W	SCT, TBT, MPT, AT
Perets et al.	North America	United States	S, T, SS	15	UG	NSM	SCT, TBT, AT, LMS
Pérez-Jorge et al.	Europe	Spain	S	193	UG, PG	Edu	SCT, TBT
Pérez-López et al.	Europe	Spain	S, DM	548	UG, PG	Edu, A&H, NSM, H&W, Eng, B, SSsci	SCT, MPT, SNT, LMS, WCT, D
Petillion & McNeil	North America	Canada	S	64	UG	NSM	SCT, MPT, AT
Puliak et al.	Europe	Croatia	S	2,520	UG	H&W	SCT, MPT, D
Purwanto et al.	Asia	Indonesia	S	6	N/S	Edu, A&H, Eng, B, SSsci	N/S
Quezada Castro et al.	S & C America	Peru	T	97	-	N/S	N/S
Radu et al.	Europe	Romania	S	135	UG, PG	H&W, Eng	SCT, MPT, AT, SNT, LMS
Rafi, Varghese & Kuttichira	Asia	India	S	364	UG	H&W	KOS, MPT
Rahali et al.	Africa	Morocco	S	123	UG, PG	N/S	SCT, SNT
Rahiem	Asia	Indonesia	S	80	UG	SSci	SCT, TBT, MPT, SNT, LMS
Rajab, Gazal & Alkattan	Middle East	Saudi Arabia	S, T	208	UG, PG	H&W	N/S
Ramachandran & Rodriguez	North America	United States	S	480	UG	NSM	SCT, TBT, MPT, AT, D, LMS

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Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Ranga	North America	United States	S	29	UG	NSM	SCT, TBT, MPT, LMS
Rapanta et al.	Europe, N. America, Oceania	Spain, Australia, Canada, Switzerland	T	4	-	Edu	SCT, TBT, MPT, DAT, AT, LMS
Ravaei et al.	Europe	Spain	S	84	UG	H&W	VW
Raza et al.	Asia	Pakistan	S	516	UG, PG	N/S	LMS
Reyes-Chua et al.	Asia	Philippines	T	15	-	Edu, A&H, NSM, B, SSci, ICT	SCT, TBT, MPT, LMS
Reynders & Ruder	North America	United States	S, T	127	UG	NSM	SCT, AT, SNT
Rizun & Strzelecki	Europe	Poland	S	1,692	UG, PG	N/S	N/S
Rodríguez Núñez & Leeuwner	North America	Canada	S	1,672	UG	NSM	SCT, TBT, MPT, AT, LMS
Rodríguez-Rodríguez et al.	Europe	Spain	S	306	UG	NSM	SCT, AT
Roig-Vila et al.	Europe	Spain	S	52	UG	Edu	SCT, TBT, SNT, LMS, MPT
Roy et al.	Asia	India	S	182	UG	H&W	SCT
Rupnow et al.	North America	United States	T	6	-	NSM	SCT, TBT, MPT, LMS
Sáiz-Manzanares et al.	Europe	Spain	S	109	UG	H&W	MPT, DAT, AT, LMS
Sales et al.	Europe	Spain	T	20	-	SSci	N/S
Sariu	Europe	United Kingdom	S	44	UG	NSM	SCT, TBT, MPT, AT, LMS
Sarmiento-Espinoza et al.	S & C America	Ecuador	S	338	N/S	N/S	LMS
Sarwar et al.	Asia	Pakistan	S	1,207	UG	H&W	TBT, SNT, LMS, D
Savarese et al.	Europe	Italy	S	266	N/S	N/S	N/S
Savcheva & Domuschieva-Rogleva	Europe	Bulgaria	T	67	-	Edu	SCT, TBT, LMS
Schlenz et al.	Europe	Germany	S, T	277	N/S	H&W	SCT, TBT, MPT
Schmölz, Geppert & Barberi	Europe	Austria	S	412	N/S	Edu	N/S
Scruggs et al.	North America	United States	S	43	UG	NSM	SCT, VW
Scull et al.	Oceania	Australia	T	4	-	Edu	SCT, TBT, LMS
Sepulveda-Escobar & Morrison	S & C America	Chile	S	27	UG	Edu	WCT
Sharadgah & Sa'di	Middle East	Saudi Arabia	T	96	-	N/S	AT, LMS
Shetty et al.	Asia	India	S	170	UG	H&W	D
Shim & Lee	Asia	South Korea	S	393	UG	Edu, A&H, NSM, Eng, B, SSci	D
Shivam & Wagoner	North America	United States	S	43	UG	NSM	SCT, TBT, MPT, VW
Silva et al.	S & C America	Brazil	S	142	UG	H&W	SCT, MPT, D, LMS
Simon et al.	North America	United States	S	41	UG	A&H, B	TBT, MPT, AT, LMS
Sindiani et al.	Middle East	Jordan	S	2,212	UG	H&W	SCT, TBT, MPT
Singal et al.	Asia	India	S	80	UG	H&W	D
Singh, Sharma & Paliwal	Asia	India	S	324	UG, PG	N/S	N/S
Singhi et al.	North America	United States	S	30	PG	H&W	SCT, D
Smoyer, O'Brien & Rodriguez-Keyes	North America	United States	S	122	UG	SSci	SCT
Sobaih, Hasanein & Abu Elnasr	Africa	Egypt	S, T	613	UG	N/S	SNT
Sokhulu	Africa	South Africa	S	5	PG	Edu, SSci	SCT, TBT, D
Soria et al.	North America	United States	S	7,233	UG	N/S	N/S
Srivastava et al.	Asia	India	S	55	PG	H&W	SCT, TBT
Stukalo & Simakhova	Europe	Ukraine	DM	397	-	N/S	LMS
Sukendro et al.	Asia	Indonesia	S	974	N/S	H&W	N/S
Sunasee	North America	United States	S	28	UG	NSM	SCT, LMS
Swartwood	North America	United States	S	37	N/S	A&H	SCT, MPT
Syahrin & Salih	Middle East	Oman	S	32	UG	A&H	LMS
Syauqi, Munadi & Triyono	Asia	Indonesia	S	56	N/S	Eng	N/S
Tang et al.	Asia	China	S	11,088	UG	Eng	SCT, TBT, MPT

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Author	Continent	Country	Participants	# Participants	Study level	Discipline	Technology used
Tartavulea et al.	Europe	Multiple	S, T	362	N/S	N/S	KOS, SCT, AT, TBT
Terenko & Ogienko	Europe	Ukraine	S, T, SS	125	UG	A&H, NSM	SCT, TBT, MPT, AT, LMS
Tigaa & Sonawane	Asia, North America	India, United States	S	150	UG	NSM	SCT, TBT, MPT, SNT, LMS
Tsekea & Chigwada	Africa	Zimbabwe	SS	34	-	SSci	SCT, MPT, SNT, LMS
Tung Son et al.	Asia	Vietnam	S	2,400	N/S	B, ICT	AT, LMS, SCT
Utama et al.	Asia	Indonesia	S	189	UG	H&W	SCT, TBT, MPT, LMS
Utomo et al.	Asia	Indonesia	S	256	N/S	A&H, SSci	SCT, TBT, SNT, LMS
Villanueva et al.	North America	United States	S, T	124	UG	NSM	SCT, MPT, AT
Vlasova et al.	Europe	Russia	S, T	30 T + ? S	UG, PG	Edu	KOS, SCT, TBT, MPT, AT, SNT, VW, WCT
Wang, Zhang & Ye	Asia	China	S, T	8,740	UG	H&W	SCT, TBT, MPT, MOOC
Wang & East	Oceania	New Zealand	S, T	163	UG	A&H	SCT, MPT, AT, LMS, D
Watermeyer et al.	Europe	United Kingdom	T	1148	-	Edu, A&H, NSM, H&W, Eng, B, ICT, Ag	N/S
Wiltse et al.	North America	United States	S	230	N/S	N/S	SCT, TBT, MPT, LMS
Ye et al.	Europe	Sweden	S	43	UG	NSM	SNT, MPT, AT
Youssef et al.	North America	United States	S	68	UG	N/S	KOS, SCT, TBT, MPT, AT, VW
Zeeshan, Chaudhry & Khan	Asia	Pakistan	T	16	-	N/S	SCT, TBT, LMS, SNT
Zia	Middle East	Saudi Arabia	S	716	UG, PG	B	N/S
Ziegler et al.	Europe	Germany	S	1,690	UG, PG	A&H, H&W, Eng, B, SSci	N/S
Zulkefli, Hashim & Syahrin	Middle East	Oman	S	22	N/S	ICT	LMS

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Appendix B – Educational technology tool typology based on Bower (2016)

Text-based tools	Multimodal production tools	Website creation tools	Knowledge organisation and sharing	Data analysis tools
Discussion forums Collaborative writing tools Readings Newsletter Text RSS Interactive textbook Annotation tools Email Chat Instant messaging Wikis	Animations Tutorials Recorded lectures Videos Podcast/Vodcast Screencast Authoring tools Voice recorder	Blogs ePortfolios	Cloud storage Bookmarking Diary tool in Moodle	Learning analytics dashboard
Digital Storytelling tools	Assessment tools	Social networking tools	Synchronous collaboration tools	Mobile learning
Storyboards	eAssessment Quizzes ARS Open badges	Social platforms Microblogging	Audio-Video conferencing	Apps mLearning
Virtual worlds	Learning software	LMS	Devices used	Games
Virtual lab Simulations Virtual worlds	Language learning software Presentation software	Learning management systems	Tablets Hardware Interactive whiteboards	Games

Appendix C - List of publications (n = 155)

Journal Name	f	Journal Name	f
Journal of Chemical Education	36	Acta Inform Med.	1
Sustainability	9	Advances In Physiology Education	1
BMC Medical Education	6	African Educational Research Journal	1
European Journal of Teacher Education	6	African Identities	1
Pedagogy	6	Amfiteatru Economic	1
Revista Românească pentru Educație Multidimensională	6	Arabian Journal of Business and Research Article Management Review	1
Education Sciences	4	Australasian Psychiatry	1
International Journal of Environmental Research and Public Health	4	BMJ Open	1
Anatomical Sciences Education	3	British Journal of Oral and Maxillofacial Surgery	1
Annals Of Medicine And Surgery	3	Chemie Ingenieur Technik	1
Arab World English Journal	3	Creative Education	1
Asian Journal of Distance Education	3	Data in Brief	1
Children And Youth Services Review	3	Digital Library Perspectives	1
Journal of Education for Teaching	3	Digital Promise Global	1
Journal of Information Technology Education: Research	3	Educación y Humanismo	1
Propósitos y Representaciones	3	Education and Information Technologies	1
Bangladesh Journal of Medical Science	2	Educational Assessment, Evaluation and Accountability	1
Campus Virtuales	2	ELT in Focus	1
Cureus	2	European Journal Of Dentistry	1
Ecology and Evolution	2	European Journal of Education Studies	1
European Journal of Dental Education	2	Frontiers In Education	1
Frontiers in Psychology	2	Frontiers in Public Health	1
Healthcare	2	Frontiers in Veterinary Science	1
IEEE	2	Gomal University Journal of Research	1
Interactive Learning Environments	2	Heliyon	1
Interactive Technology and Smart Education	2	Higher Education	1
International Journal of Academic Research in Business & Social Sciences	2	Humanities and Social Sciences Communications	1
International Journal of Advanced Computer Science and Applications	2	Humanities & Social Sciences Reviews	1
International Journal of Advanced Trends in Computer Science Engineering	2	Indian J Otolaryngol Head Neck Surgery	1
International Journal of Distance Education Technologies	2	Indian Journal of Medical Sciences	1
Journal of Critical Reviews	2	Indian Journal Of Surgery	1
Journal of Interprofessional Care	2	Infinity	1
Pakistan Journal of Medical Sciences	2	Information and Learning Sciences	1
Profesional de la información	2	Ingénierie des Systèmes d'Information	1
Revista Conrado	2	Innovative Infrastructure Solutions	1
RIED. Revista Iberoamericana de Educación a Distancia	2	International and Multidisciplinary Journal of Social Sciences	1
Social Education Research	2	International Education & Research Journal	1
Social Work Education	2	International Journal of Advanced Research in Engineering and Technology	1
Studies in Self-Access Learning Journal	2	International Journal of Chinese Language Teaching	1
TEM Journal	2	International Journal of Community Medicine and Public Health	1
Academic Radiology	1	International Journal of Current Research and Review	1
Access: Contemporary Issues in Education	1	International Journal of Educational Research Open	1
Journal Name	f	Journal Name	f

International Journal Of Evaluation And Research In Education	1	Research in Dance Education	1
International Journal of Higher Education	1	Retorika. Jurnal Bahasa, Sastra dan Pengajarannya	1
International Journal of Language Education	1	Revista Brasileira de Educacao do Campo	1
International Journal of Learning, Teaching and Educational Research	1	Revista da Associacao Media Brasileira	1
International Journal of Research in Pharmaceutical Sciences	1	Revista de Educación a Distancia	1
International Journal of Social, Political and Economic Research	1	Revista de la Universidad del Zulia	1
International Online Journal of Primary Education	1	Revista Econo	1
International Social Work	1	Revista Ibérica de Sistemas e Tecnologias de Informação	1
Journal of Cancer Education	1	Revista Inclusiones	1
Journal of Clinical and Diagnostic Research	1	Revista Latinoamericana de Estudios Educativos	1
Journal of Dental Education	1	RISE – International Journal of Sociology of Education	1
Journal of Education and e-Learning Research	1	Saudi Pharmaceutical Journal	1
Journal of Education and Learning	1	Sir Syed Journal of Education & Social Research	1
Journal of Educational Computing Research	1	Sports Biomechanics	1
Journal of Educational Technology & Online Learning	1	Student Experience in the Research University (SERU) Consortium	1
Journal of Further and Higher Education	1	Studies in Language and Education	1
Journal of Learning for Development	1	Surgical and Radiologic Anatomy	1
Journal of Loss and Trauma	1	Surgical Practice	1
Journal of Medical Education and Curricular Development	1	Symmetry	1
Journal of Pedagogical Sociology and Psychology	1	Talent Development & Excellence	1
Journal of Public Economics	1	Teaching Sociology	1
Journal of Research in Medical and Dental Science	1	Technium Social Sciences Journal	1
Journal of Research on Technology in Education	1		1
Journal of Surgical Education	1	The International Journal of Information and Learning Technology	1
Journal of Technology and Teacher Education	1	Theory and Practice in Language Studies	1
Journal of the European Honors Council	1	United Kingdom & Ireland Computing Education Research conference	1
Journal of Voice	1	Universal Journal of Educational Research	1
Jurnal Abiwara	1	World Scientific News	1
Medical Education	1		
Medical Education Online	1		
Medienimpulse	1		
National Institute for Learning Outcomes Assessment	1		
Nursing Forum	1		
Online Learning	1		
Orthodontic Journal of Nepal	1		
Pedagogical Research	1		
Physica Medica	1		
Physics Education	1		
Plos One	1		
Polo del Conocimiento	1		
Postdigital Science and Education	1		
Proceedings	1		
Quanun Medika	1		
Rawal Medical Journal	1		

Appendix D. Scope of participant focus

Participant Focus	<i>N</i> Studies	<i>N</i> Studies [%]
Students	233	82.6
Teachers/Instructors	81	28.7
Department Managers	10	3.5
Support Staff	8	2.8
Librarians	2	0.7
IT experts and developers	1	0.4
Policy makers	1	0.4

Crosstabulation of participants ($n = 282$)

Code	Students	Teachers/Instructors	Department Managers	Librarians	IT experts and developers	Policy makers	Support Staff
Students	233	39	2	0	1	1	5
Teachers/Instructors	39	81	5	0	1	1	6
Department Managers	2	5	10	0	0	0	1
Librarians	0	0	0	2	0	0	0
IT experts and developers	1	1	0	0	1	1	0
Policy makers	1	1	0	0	1	1	0
Support Staff	5	6	1	0	0	0	8

Appendix E. Number of participants per study ($n = 282$)

Number of participants	N studies	N studies [%]
1-25	46	16.3
26-50	28	9.9
51-100	49	17.4
101-200	44	15.6
201-300	19	6.7
301-400	21	7.4
More	71	25.2
Not clear	4	1.4

Appendix F. Crosstabulation of disciplines ($n = 282$)

	A&H	BAL	EDU	EMC	H&W	ICT	NSMS	SSJI	Unclear	Other	AFFV
A&H	40	17	12	12	11	7	17	14	0	1	1
BAL	17	26	12	15	11	10	13	13	0	2	1
EDU	12	12	45	9	8	6	11	12	0	1	1
EMC	12	15	9	30	12	6	14	10	0	2	1
H&W	11	11	8	12	77	3	12	9	0	1	1
ICT	7	10	6	6	3	16	5	5	0	1	1
NSMS	17	13	11	14	12	5	68	11	0	1	1
SSJI	14	13	12	10	9	5	11	26	0	2	1
Unclear	0	0	0	0	0	0	0	0	66	0	0
Other	1	2	1	2	1	1	1	2	0	2	0
AFFV	1	1	1	1	1	1	1	1	0	0	2

Note. A&H = Arts & Humanities, BAL = Business, Administration & Law, EDU = Education, EMC = Engineering, Manufacturing & Construction, H&W = Health & Welfare, NSMS = Natural Sciences, Mathematics & Statistics, SSJI = Social Sciences, Journalism & Information, AFFV = Agriculture, Forestry, Fisheries & Veterinary

Appendix G. Data collection methods ($n = 282$)

Data Collection	<i>N</i> Studies	<i>N</i> Studies [%]
(Online) survey	234	83.0
Semi-structured interviews	41	14.5
Student grades	21	7.4
Analytics data	16	5.7
Focus group	10	3.5
Interviews (not specified)	10	3.5
Documents/text	9	3.2
In-depth interviews	3	1.1
Field notes	2	0.7
Discussion board	1	0.4
Observation	1	0.4
Unclear	1	0.4
Expert interviews	1	0.4

Crosstabulation of data collection methods

	Survey	FG	SSI	D/T	Grades	AD	DB	I (U)	FN	IDI	OBS	EI
Survey	234	6	16	4	14	8	1	6	1	2	0	0
FG	6	10	3	1	0	0	0	0	0	0	0	0
SSI	16	3	41	2	2	1	0	0	0	0	0	0
D/T	4	1	2	9	0	1	0	2	0	0	0	0
Grades	14	0	2	0	21	4	0	0	0	0	0	0
AD	8	0	1	1	4	16	0	1	1	0	0	0
DB	1	0	0	0	0	0	1	0	0	0	0	0
I (U)	6	0	0	2	0	1	0	10	1	0	0	0
FN	1	0	0	0	0	1	0	1	2	0	0	0
IDI	2	0	0	0	0	0	0	0	0	3	0	0
OBS	0	0	0	0	0	0	0	0	0	0	1	0
EI	0	0	0	0	0	0	0	0	0	0	0	1

Note. SSI = Semi-structured interviews, AD = Analytics data, FG = Focus group, I (U) = Interviews (not specified), D/T = Documents/Text, IDI = In-depth interviews, FN = Field notes, DB = Discussion board, OBS = Observation, EI = Expert interviews

Appendix H. Data analysis methods ($n = 282$)

Data analysis method	<i>N</i> Studies	<i>N</i> Studies [%]
Descriptive statistics	227	80.5
Qualitative analysis	86	30.5
Inferential statistics	81	28.7
Correlation analysis	32	11.3
Not explicitly mentioned in the article	23	8.2
Psychometric analysis	3	1.1
Cluster analysis	2	0.7
Machine learning algorithms	1	0.4
Analytic Hierarchy Process (AHP); Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)	1	0.4

Crosstabulation of data analysis methods

	QA	DS	IS	CA	CLU	N/M	PA	MLA	AHP
QA	86	47	15	2	2	6	1	0	0
DS	47	227	72	26	2	15	2	0	1
IS	15	72	81	13	2	1	3	1	0
CA	2	26	13	32	0	0	0	0	0
CLU	2	2	2	0	2	0	0	0	0
N/M	6	15	1	0	0	23	0	0	0
PA	1	2	3	0	0	0	3	0	0
MLA	0	0	1	0	0	0	0	1	0
AHP	0	1	0	0	0	0	0	0	1

Note. QA = Qualitative analysis, DS = Descriptive statistics, IS = Inferential statistics, CA = Correlational analysis, CLU = Cluster analysis, N/M = Not explicitly described in the study, PA = Psychometric analysis, MLA = Machine learning algorithms, AHP = Analytic Hierarchy Process

Appendix I. Terminology used to describe teaching and learning during the pandemic ($n = 282$)

Terms used	<i>N</i> Studies	<i>N</i> Studies [%]
Online learning	58	20.6%
e-Learning	52	18.4%
Distance learning	50	17.7%
Online teaching	33	11.7%
Online education	18	6.4%
not specified	17	6.0%
Internet Web-Based Learning	16	5.7%
Emergency remote teaching	15	5.3%
Remote learning	15	5.3%
Computer-Based Learning	8	2.8%
Distance education	8	2.8%
Digital learning	7	2.5%
Online classes	7	2.5%
Self-instruction	7	2.5%
Multimedia-Based Learning	6	2.1%
Blended learning	5	1.8%
Educación virtual	5	1.8%
Online instruction	4	1.4%
Online assessment	3	1.1%
Remote instruction	3	1.1%
Virtual Classes	3	1.1%
Enseñanza virtual	3	1.1%
Digital teaching	2	0.7%
Distance teaching	2	0.7%
Emergency remote online learning	2	0.7%
Online classroom	2	0.7%
Virtual learning	2	0.7%
Enseñanza remota de emergencia	2	0.7%
Enseñanza a distancia	2	0.7%
Docencia virtual	2	0.7%
Remote teaching	2	0.7%
Cloud-based	1	0.4%
Computer-supported collaborative learning	1	0.4%
digital education	1	0.4%
digital higher education	1	0.4%
Digital pedagogy	1	0.4%
Emergency distance education (EDE)	1	0.4%
Emergency distance learning	1	0.4%
Emergency online education	1	0.4%
Emergency remote education	1	0.4%
Emergency remote support	1	0.4%
Emerging Technology	1	0.4%
e-assessment	1	0.4%
e-Teaching	1	0.4%
E-Technology	1	0.4%
Home learning	1	0.4%
information and communications and media technology (ICMT)	1	0.4%
MOOCs	1	0.4%

Terms used	N Studies	N Studies [%]
Net based learning	1	0.4%
online course	1	0.4%
Online delivery	1	0.4%
Online examination	1	0.4%
Online synchronous teaching	1	0.4%
Remote assessment	1	0.4%
Remote classes	1	0.4%
Remote E-exams	1	0.4%
Remote labs	1	0.4%
Virtual education	1	0.4%
Virtual teaching	1	0.4%
Enseñanza online	1	0.4%
Educación a distancia	1	0.4%
Docencia remota de emergencia	1	0.4%
Formación a distancia	1	0.4%
Educación online	1	0.4%
Virtualización de cursos	1	0.4%
Enseñanza semipresencial	1	0.4%
Enseñanza digital	1	0.4%
Educación en línea	1	0.4%
Virtual classrooms	1	0.4%
Self-access learning	1	0.4%
Online-blended learning	1	0.4%

Appendix J. Technology used based on Bower's (2016) typology ($n = 282$)

Data analysis method	N Studies	N Studies [%]
Synchronous collaboration tools	146	51.8
LMS	117	41.8
Multimodal production tools	98	34.8
Text-based tools	90	31.9
Assessment tools	63	22.3
Not specified	58	20.6
Social networking tools	40	14.2
Devices used	40	14.2
Knowledge organisation & sharing tools	18	6.4
Virtual worlds	15	5.3
MOOCs	6	2.1
Website creation tools	5	1.8
Data analytics tools	2	0.7
Mobile learning	2	0.7
Games	1	0.4