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A Descriptive Study of EFL Teachers' Perception toward E-learning Platforms during the Covid-19 Pandemic

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Abstract: The study critically examines the features of three e-learning platforms: Blackboard (BB), Google Classroom, and Zoom. It provides an in-depth analysis of the digital learning platform's effectiveness in a pandemic like the COVID-19. It synthesizes the strengths and limitations of the selected e-learning platforms for English language teaching. The study focuses on authentic e-learning platforms' potential to encourage English as a Foreign Language (EFL) teachers and learners to take the challenge of adapting to a transforming world that could engage them in e-learning innovation. The research was conducted in the first period of quarantine during the COVID-19 pandemic in Saudi Arabia. An electronic survey of 36 items was conducted to identify three different countries' 101 EFL teachers' perceptions about the performance of these platforms. The survey comprised three questionnaires for each e-learning platform with six parts, namely, accessibility and usability, efficiency and convenience, communication and interaction, teacher's attitude, teacher's satisfaction, and e-learning experience during the COVID-19 pandemic. The data was analysed using Minitab 16 Statistical software. The internal consistency of the survey was measured through the values of Cronbach's Alpha. Other statistical measures such as mean, standard deviation, and agreeable rate (AR) were used to portray the efficacy of each application. The results of the survey indicate that Google Classroom (Ave. AR = 72.92%, Ave. Mean = 3.887) is the most effective e-learning platform, followed by BB (Ave. AR = 68.09%, Ave. Mean = 3.694), and lastly Zoom (Ave. AR = 61.85%, Ave. Mean = 3.544), according to the participants. Furthermore, the findings indicate that free E-learning platforms like Google Classroom could be more beneficial for developing countries, whereas BB Learning Management System (LMS) works best for the developed countries. The research findings should be of interest to the language learners and help teachers and policymakers design e-learning environments to make the learning process feasible in and out of an international global crisis.

Keywords: E-learning platforms, Blackboard, Google Classroom, Zoom Classroom, COVID-19

1. Introduction

It is interesting to explore the opportunities arising from advances in multimedia, web-learning, and other cutting-edge digital revolution technologies available in almost all areas of life which offer potential advantages to people in the workplace, academics, and home. At the beginning of the 21st century, e-learning has been adopted as a supplementary tool in educational systems because the role of digital literacy in education has been acknowledged (Halawi & Mccarthy, 2008). However, a complete transition to e-learning as a primary educational tool for interacting and communicating with students was entirely a different case. It was an unpredicted rapid change through the transformation from the physical domain of conventional teaching to the digital world that was expected due to technology before the COVID-19 pandemic; no one had ever imagined it to be so frustrating. The worst consequences of the COVID-19 pandemic have been observed worldwide in the form of complete lockdown for months in 2020, which deeply affected the education sector like all other areas of life. As a result, academia needed to adapt online education with a high level of technical competence to meet the significant challenges of e-learning.

The study's rationale is that emerging technologies have radically transformed the learning scenario (Sayemet al., 2017). The traditional teaching system seems unsuccessful in producing the desired learning outcomes for teaching the English language. Therefore, a detailed digital learning outlook can help the language learning process flow and utilize advanced technologies as teaching tools. Secondly, during the global crisis of the COVID-19 pandemic, there has been a dire need for innovative teaching methodologies to keep the learning process on track without unnecessary delays. The present study argues that digital learning should have an updated system to lodge into the educational field. It cannot take place randomly by using some simple websites online. Thirdly, the research focuses on the potential benefits and possible drawbacks of three popular e-learning platforms: Blackboard (BB), Google Classroom, and Zoom, examining the context, the learning environment, activities that can be significant for the teachers, learners, and contribute to reshaping the future education system. Finally, this study strongly appeals to the researchers to explore the unfamiliar aspects of the digital world for language learning.

2. Literature Review

2.1 E-learning Platforms

Today e-learning plays a vital role in education as an extraordinary teaching approach (Squillante, Wise & Hartey, 2014). It has successfully integrated classroom-based courses with online and hybrid technology. According to BB (2020), virtual classrooms are in use with a rapid increase of 9000% every year. Distant education, accessibility to educational services, resources, materials, and flexibility in time and space are the significant characteristics of e-learning (Rahayu, 2020; Sayem et al., 2017), which have proved to be extremely valuable during the pandemic since all face to face learning had to come to a sudden halt. Learners experience "personalization and positive motivation" on e-learning platforms (Northey et al., 2015. pp. 172). E-learning platforms provide exceptional ease and liberty to users (Halawi & Mccarthy, 2008). Students can understand the importance of the education process in academic settings, and they eagerly participate in the tasks, learning activities, and home assignments (Uziak, et al , 2018). Students' motivation and willingness come from innovative and flexible information delivery (Al Rawashdeh et al., , 2021). In the present situation of COVID-19, e-learning seems to be a perfect way to learn how to manage their time and save energy and resources in the learning process. BB, Google Classroom, and Zoom are synchronous Learning Management Systems (LMS) for e-learning which are being used by most educational institutions worldwide during the COVID-19 pandemic to avail all the benefits mentioned above.

2.2 Blackboard (BB)

BB Learning System is offered in the academic suite of Blackboard Inc (Bradford et al. 2007; Cader & McGovern, 2003). It is a paid e-learning platform launched as a commercial LMS and focuses on a higher education level with a refined presentation of unique features (Bradford et al., 2007; Martin, 2008; Squillante, Wise & Hartey, 2014). BB is used worldwide by many colleges and universities with potential benefits (Beatty, 2010). It is considered a flexible and easily accessible educational platform (Uziak et al., 2018; Beatty,2010), and users can access BB at any place via the world wide web (WWW). Among the most distinctive features of BB are efficient functionality, usability, standardization, security, student-teacher interaction, and class management.

Collaboration and communication are regarded as the best LMS features embedded in BB (Bradford et al., 2007; Uziak et al., 2018; Chen, Dobinson & Kent, 2020). Since the teacher-student interaction during the pandemic has been of utmost importance, BB provides access for the teachers to communicate with students by asynchronous and synchronous platforms. Students can notice announcements on BB, which can be posted with downloadable supplementary materials and attachments. Another feature is emailing within the BB system added and stored on each student's profile with different formats. Blackboard Collaborate Ultra (BCU) allows face-to-face classroom interaction, which creates a sense of physical presence on campus. This feature has proven to be very effective in instilling the feeling of being in a classroom, both for the learners and the teachers. Teachers can give virtual classes on BCU by creating their live sessions with convenience (Chen, Dobinson & Kent, 2020). A large audience can be managed and up to 250+ students to join a session on BB. However, the drawback is that it is hard to maintain student motivation during the lessons. Teachers cannot fully engage the students and they participate passively (Rogers, 2011).

Standardization (Beatty, 2010) and user security (Squillante, Wise, & Hartey, 2014) are significant features with a hierarchical organization followed rigidly for class management. Teachers can create or upload their course materials like lectures, assignments on BB with different formats. The PP slides, hyperlinks, audio/visual aids, and instructional materials are easily accessible (Bradford et al., 2007). It is easy to monitor students' progress and participation in online classes. A distinctive feature of BB is assessment. Online exams, tests, and quizzes have become necessary to assess students during the pandemic and can be designed easily with a timed schedule in BB (Beatty, 2010). After submitting, students can get immediate feedback with or without graded material that can be automated or faculty-initiated on their projects, homework, and quizzes (Bradford et al., 2007; Martin, 2008).

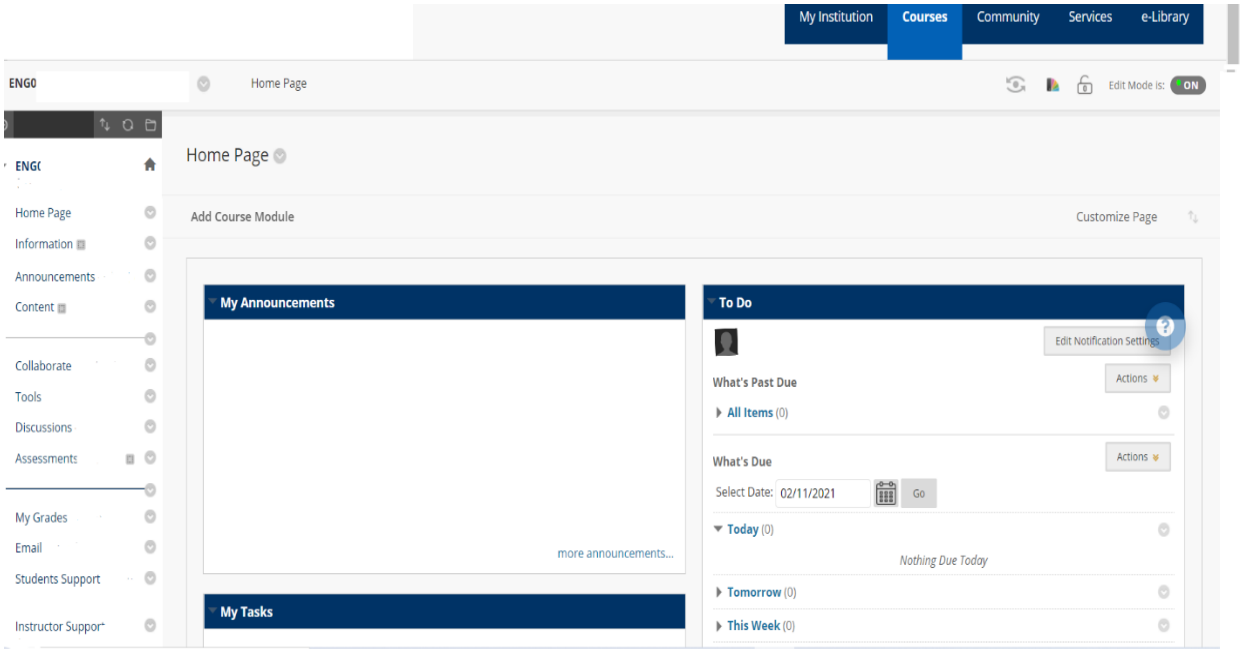

Figure 1: *Blackboard Portal*

However, BB has some limitations. First is the cost, with academic institutions having to pay a hefty amount to use the services. Secondly, BB's complex interface and the inherent technical issues can disappoint the teachers (Lavine, et al.,2012). Finally, the study materials are not available to anyone without enrollment in the class. It means that outsiders cannot take advantage of the resources, which otherwise should be accessible free to all (Beatty, 2010).

2.3 Zoom

Zoom has unique popularity and convenience for EFL teaching and learning features. Zoom is a third-generation synchronous web-based tool launched in 2013 (Sayem et al., 2017; Rahayu,2020)**.** It has gained much attention from teachers and learners in academia during the COVID-19 pandemic. Moreover, Zoom can be easily incorporated in any educational institution at any level as a user-friendly software (Bates, 2005).

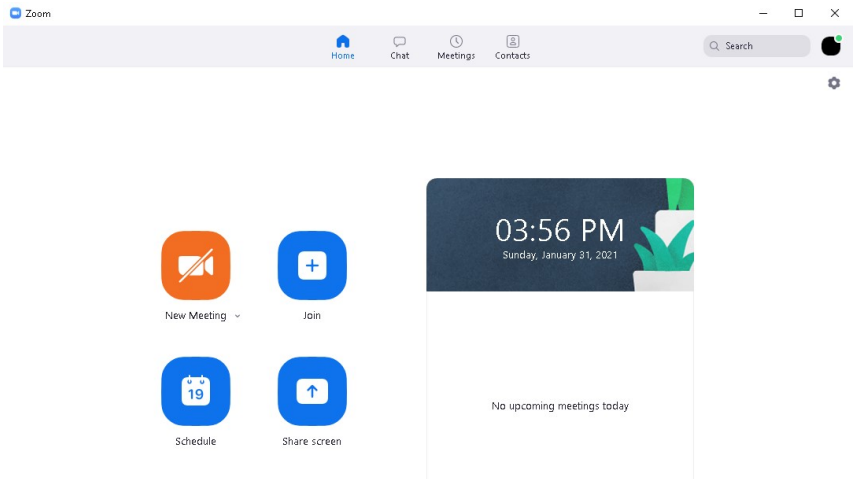

Figure 2: Zoom Portal

Among Zoom's main features, gripping from the language learning point of view, are individual and group collaboration through video conferencing, collaborating and participating in the discussion, file sharing, and data security (Archibald et al., 2019; Dharma, Asmarani & Dewi, 2017). Remote classroom sessions via Zoom through the video-conferencing application offer a great learning opportunity for students worldwide, especially in English learning. Sayem et al., 2017 assert the effectiveness of Zoom as a digital teaching platform for teachers

and students. The results confirm that the Zoom platform can reduce teacher's workload by 25% without compromising teaching material delivery quality. Dharma, Aswarani and Dewi (2017) compared Skype and Zoom as online media applications for teaching Japanese students grammar and conversation. The researchers concluded that Zoom is a better e-learning platform to teach effectively, and learners can interact easily.

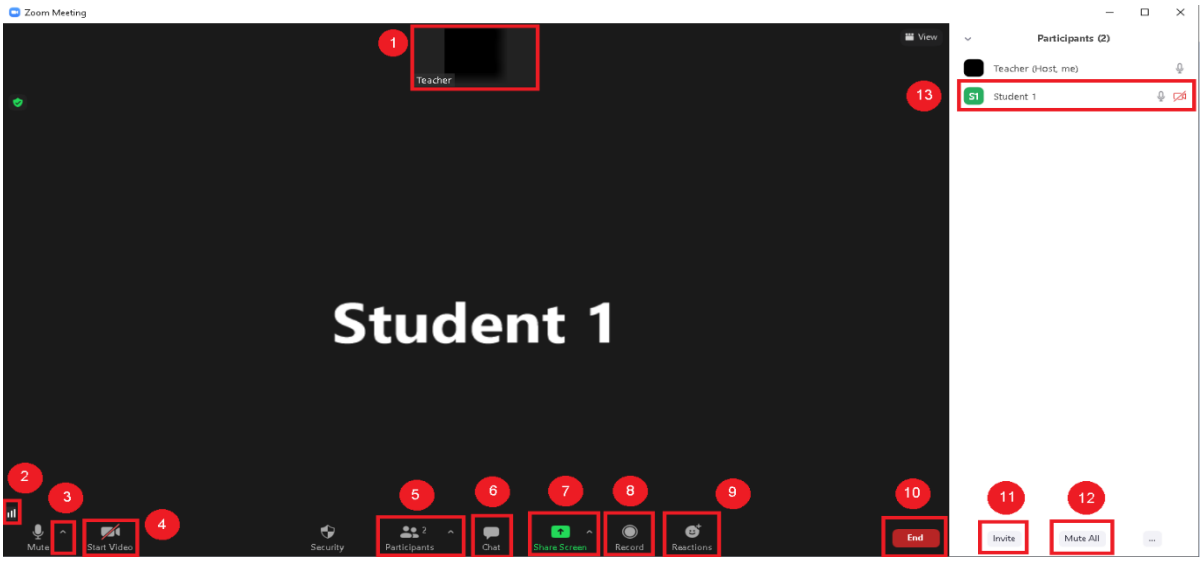

Figure 3: Zoom Interface

Zoom screen annotation encourages EFL teachers to deliver their instructional material more effectively. They can explain a concept or a topic more comprehensively by using essential annotation tools. Both verbal and non-verbal feedbacks are available for the participants. Also, teachers can utilize Zoom breakout room functionality for group work, allowing the host to split the Zoom meeting into 50 breakout rooms with 200 participants in separate sections like physical classes.

Drawbacks of Zoom are reluctance due to distraction (Brainard & Watson, 2020). Users can experience audio and video quality deterioration during lessons, affecting participants interaction, and therefore limit the language learning process. The screen sharing feature is also subject to lag and can disrupt the flow of online presentations. Lastly, sharing files is not possible on mobile devices and can only be done using a PC.

2.4 Google Classroom

Google has introduced a valuable productivity tool, Google Classroom (GC) (Ventayen et al., 2018), with other practical applications. An attractive feature of GC is the cost-free service (Albashtawi & Al Bataineh, 2020; Gupta & Pathania, 2020; Hemrungrote, Jakkaew & Assawaboonmee, 2017), which could prove to be a game-changer for institutions during the high inflation caused by the COVID-19 pandemic. Since the institutions would not have explicitly pay Google to use GC's features, they could save a lot of cost over the period of pandemic. The users do not have to pay for creating their accounts (Ventayen et al., 2018), and teachers and learners can enjoy its benefits for free and save their budgets spent on paper (Gupta & Pathania, 2020). It requires technically less savvy users so that anyone can use it without strict professional training, which is good news for language teachers. GC centralization helps English learners, teachers, and educators to merge their e-learning teaching resources in a single cloud-based location and create the learning tasks within the application (Hemrungrote, Jakkaew & Assawaboonmee, 2017). GC is highly integrated with main Google applications, like G Suite (Albashtawi & Al Bataineh, 2020; Ventayen et al., 2018). Users can save and organize the materials in personalized Google Drive folders and recreate them whenever required. Students can access the assigned tasks anywhere and use the Google Doc application to complete and submit their work. The assignment reception and submission are organized and encourage students to self-directed learning (Hemrungrote, Jakkaew & Assawaboonmee, 2017). The assignment page of GC is an excellent way to keep them updated through Gmail. It highlights the upcoming assignments and tasks and gives reminders for the deadlines (Hemrungrote, Jakkaew and Assawaboonmee, 2017).

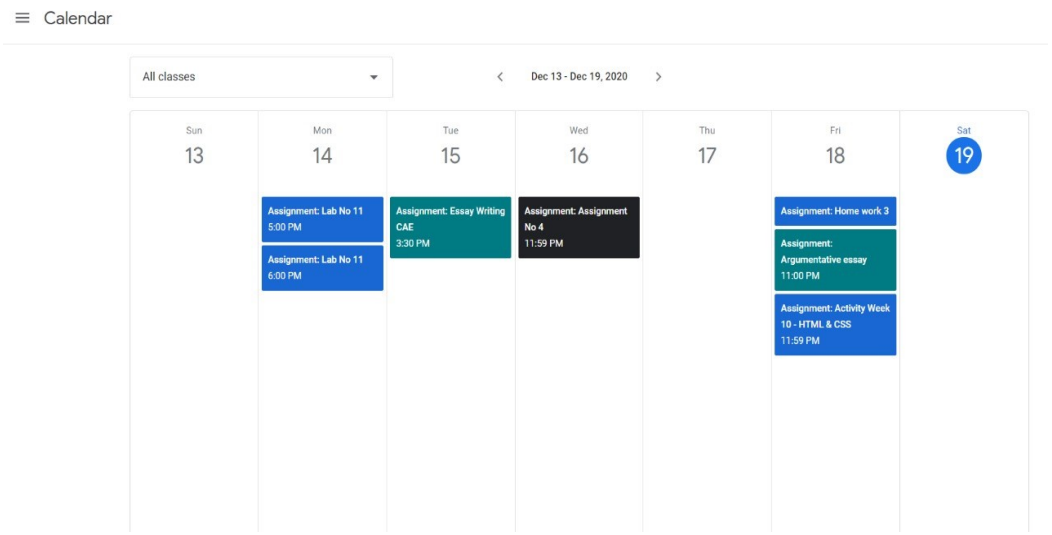

Figure 4: Google Classroom Portal

GC provides constructive feedback, which EFL teachers can use to respond conveniently and promptly. Students can get immediate feedback on their written work with the teacher's support, which motivates students to correct and write better to improve their English language skills. In addition, EFL teachers can upload audio and videos as supplementary teaching material with shareable links. Also, students can work collaboratively and share their tasks with the group members.

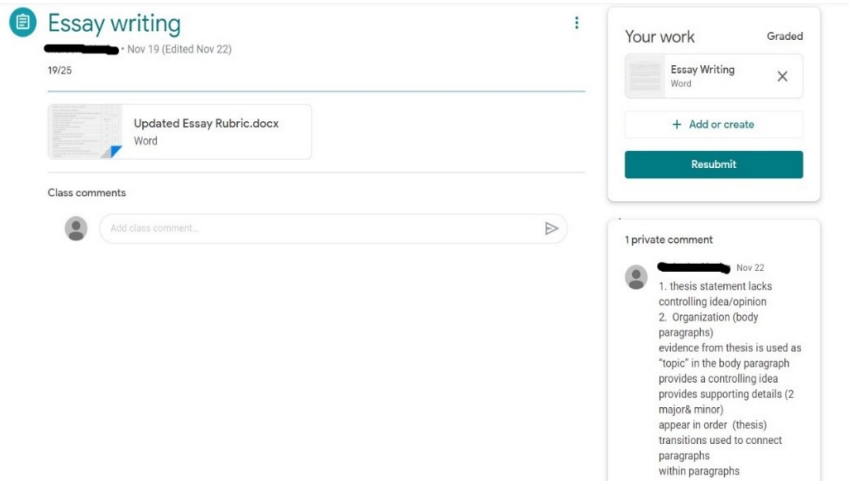

Figure 5: Assignment Submission & Teacher's feedback on Google Classroom

GC has a few drawbacks that slow down the learning process, mostly related to the technical part. Less configuration is a big issue, annoying teachers and students alike. Account management is not ideal with fewer advanced management and integrated options. Also, the classroom capabilities are restricted due to the G Suite. Sometimes users face problems sharing and editing the materials, which is a big obstacle for language learners.

2.5 Effects of COVID-19 and e-learning

The COVID-19 pandemic has changed education forever. In these perilous times, students have to isolate themselves to halt the spread of the virus, but they need to re-emerge and assemble to continue their education. The current situation seems hard for both teachers and students who have already been devastated in lockdown. Some of the unprecedented challenges for English language teaching are designing the content in a digital context, delivering with ease to naïve audiences, developing digital competence and friendliness to collaborate with the students, and keeping them involved and motivated about using the e-learning platforms (Kolesova, Moskovkin & Popova, 2021).

In response to the COVID-19 pandemic, Saudi Arabia has successfully implemented e-learning in education, as acknowledged by UNICEF. The transition from physical to distance learning was carried out at all levels of

academia, beginning in February 2020. It was primarily to ensure student safety to continue the educational process; therefore, online classes were opened immediately for more than six million students in schools and universities. According to the Arab News, 27 public universities hosted two million virtual courses in higher education, which was considered a great success. Most universities use BB LMS to manage and progress in e-learning and it has proven productive throughout the crisis because teachers and students have readily embraced it. This study's central purpose is to investigate the efficiency of e-learning platforms and their productivity during the COVID-19 pandemic on the education system. More specifically, the integration of e-learning in English language teaching is assessed from EFL university teacher's perspective, which leads the authors to search for answers to the following questions:

1. From EFL teacher's perceptions, can (a) BB, (b) GC, and (c) Zoom technology provide a useful e-learning environment?
2. How efficient are (a) BB, (b) GC, and (c) Zoom as e-learning platforms during the COVID-19 pandemic?

3. Research Methodology

The present study evaluates three e-learning platforms: BB, GC, and Zoom. The data was obtained from a diverse sample (n=101), and university teachers were accessed at home and abroad. The research's principal objective is to assess the teacher's opinions about using three e-learning platforms and their usefulness during the COVID-19 pandemic.

A complete survey consisted of 3 separate questionnaires, one for each application, with 36 items each. Two experienced ESL teachers critically reviewed the survey, and a pilot study was also conducted to identify and rephrase any statements presenting ambiguity to the respondents. The survey was conducted online on Google Forms. Notably, the participants had the choice of filling the questionnaire for any of the three applications. They were required to fill in multiple surveys if they wanted to evaluate more than one application. Each questionnaire was divided into six distinct sections to evaluate aspects of e-learning platforms' effectiveness during the COVID-19 pandemic from the teacher's perspectives. The sections were:

1. Accessibility and Usability
2. Efficiency and Convenience
3. Communication and Interaction
4. Teacher's Attitude
5. Teacher's Satisfaction
6. E-learning Experience during the COVID-19 pandemic

Quantitative data was gathered and analyzed using Minitab 16 Statistical Software. The survey's internal consistency was measured using Cronbach's Alpha, a good measure of data reliability. The mean was used to measure data spread, while Standard Deviation was employed to measure data dispersion. Agreeable Rate (AR) was also calculated by adding the percentage responses of *4: Agree* and *5: Strongly Agree* options of each item, which provided insight during the data analysis.

3.1 Participants

The survey was administered on EFL teachers (male and female) at different universities in Saudi Arabia, Pakistan, and Canada. The rationale for collecting qualitative data from other regions was to examine the performance of e-learning platforms widely. The researchers ensured that the respondents were fully aware of the study's purpose and seriousness. They accepted the requests to fill in the survey willingly with a flexible timeline. The anonymity of the respondents was assured to receive unbiased answers.

All the participants utilize some form of e-earning platform for synchronous or asynchronous teaching, and as they reported, during the pandemic, they were entirely dependent on e-learning platforms. The bar chart (Figure 6) shows that the gender ratio (male: female) was almost equal to 1, with 51 participants being male while 50 were female.

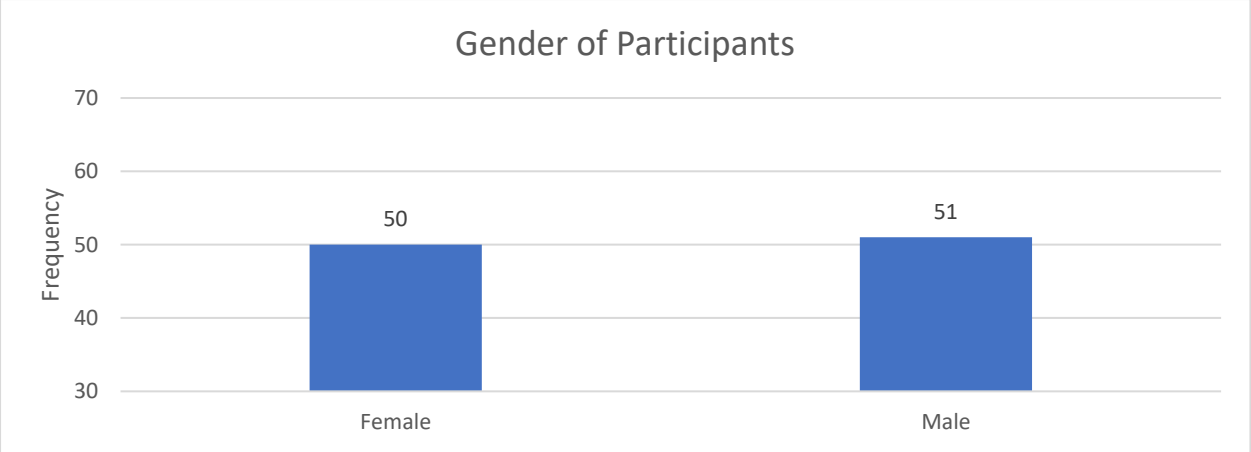

Figure 2: *Gender of Participants*

The bar chart below (Figure 7) shows the data in chart form. 12 teachers had a professional teaching experience of 1-3 years, while 14 had 4-7 years. There were 15 senior teachers with 7-10 years' experience. Most teachers (n = 60) had more than ten years' experience on their records. The professionally experienced teachers can help critically highlight the problems and suggest solutions to these expected or unexpected English language teaching and learning issues.

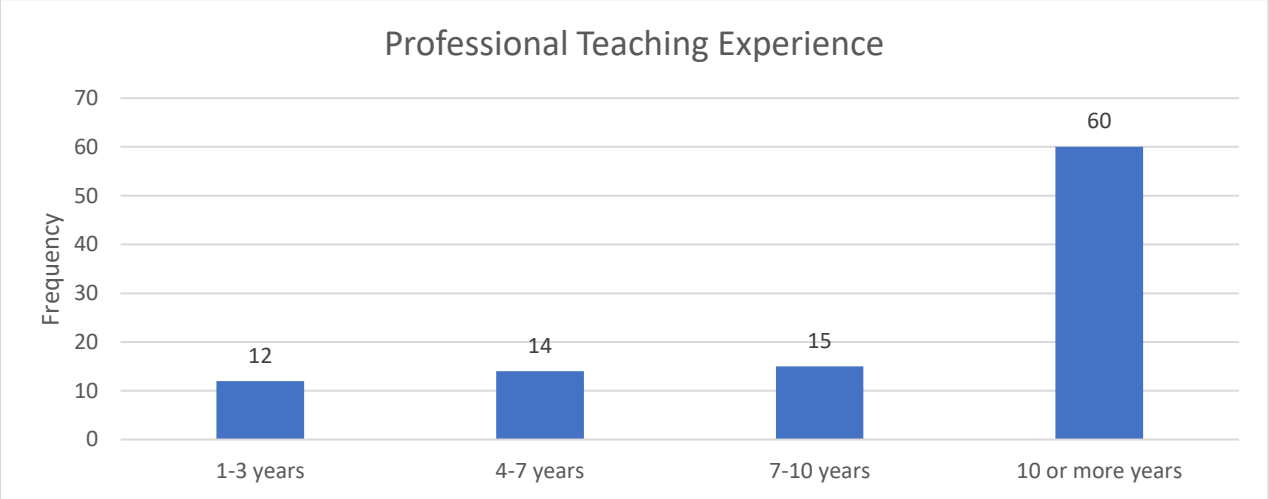

Figure 3: *Professional Teaching Experience*

The bar chart below (Figure 8) shows that most teachers were newly introduced to e-learning platforms with only 1-2 years of utilization experience (n=65), whereas 18 of the participants had been using them for at least 3-4 years. 10 participants had 5-6 years of e-learning platform utilization, and 3 teachers used them for 7-8 years. Only 5 teachers used e-learning platforms for at least 9-10 years. The high difference from using e-learning is because most teachers have not been exposed to the e-learning platform, and they have been using online resources as supplementary material. However, the COVID-19 pandemic shifted the teaching medium to e-learning.

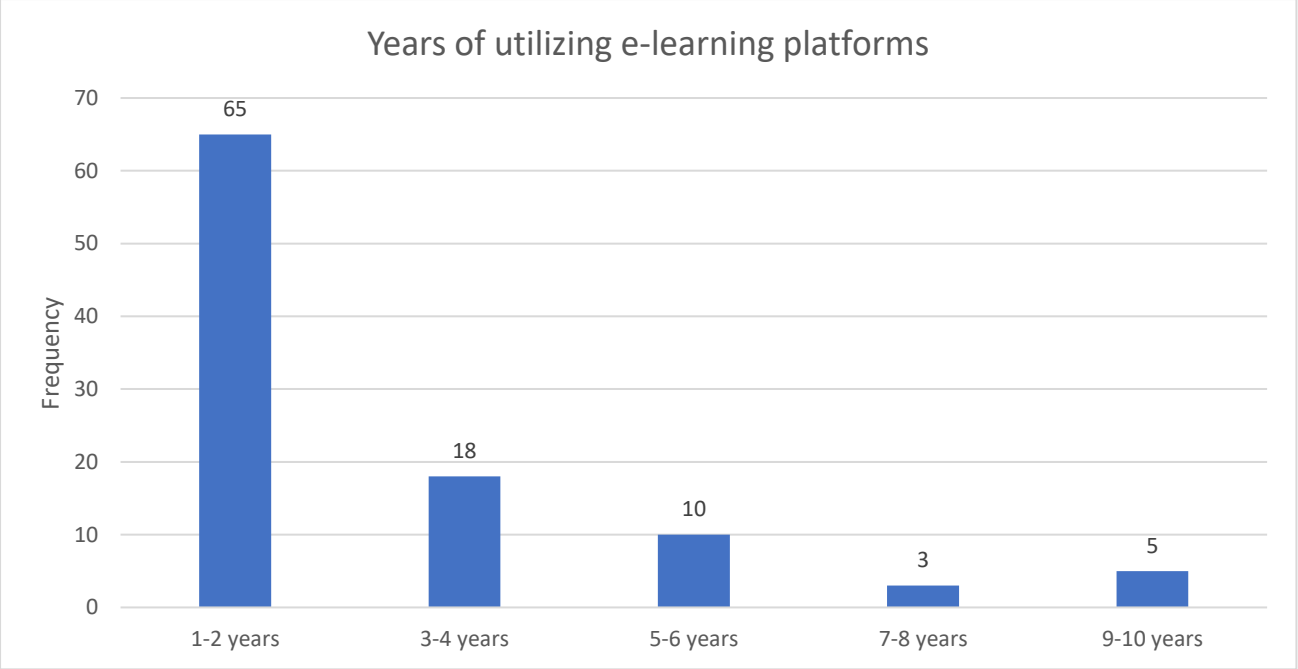

Figure 4: Years of utilizing e-learning platforms.

4. Results and Discussion

4.1 Blackboard (BB)

BB was the most popular among all the e-learning platforms studied in this research, as it received the highest number of responses (n=74). Most EFL teachers in Saudi Arabia were approached, and most responses were received from Saudi universities using BB as an e-learning platform.

Reliability analysis was performed for each Section resulted in healthy Cronbach's Alpha values, especially section C (α=0.834) and section E (α=0.855). High mean values per item generally coincided with a high agreeable rate (AR). The BB questionnaire had an average AR of 68.09% and an average mean of 3.694. Table A provides the descriptive statistics of results for each section of the BB questionnaire, which answers the research question(a) about the effectiveness of BB as an e-learning teaching tool. (See Appendix.1).

The results show that 73.26% of the teachers (n=74) filled out the BB questionnaire. Section A assesses the accessibility and usability of BB as an e-learning tool. The teachers find BB to be fairly accessible and usable (Ave. ARA=76.35%, Ave. MA=3.822), especially, creating an account and signing into Blackboard is convenient (AR=83.78%, M=4.041, SD=0.898). Most are satisfied regarding the sharing of audio/video materials (AR=58.11% M=3.91, SD=1.044), but almost one quarter of the teachers believe it is not easy to apply. For section B, the extremely high agreeable rate (AR=93.25%) and mean (M=4.365) of the responses to Q8 suggest sending notifications to the students about assignments, quizzes, and exams is one of the most efficient features. Furthermore, most teachers feel comfortable delivering the lecture on BB (AR=85.14%, M=4.108, SD=0.751). The difference in AR is also seen for the BB grading system. Although most teachers (AR=68.92%, M=3.75, SD=0.781) agree to grade and monitor their students' performance by the BB grading system, the rest disagree with this usability. The results are in line with Alturki, Aldraiweesh, and Kinshuck (2016) that the King Saud University's faculty members can successfully use BB LMS to offer lectures to students.

Almost the same is the difference of opinion regarding the teacher's satisfaction with the online assessment on BB. Many reasons can be linked to the teacher’s dissatisfaction with the BB grading system. We opine that the teachers who prefer traditional assessment systems may not be fully acquainted with the technological usability of grading on the BB system. Also, there may be various risks involved in online assessment, which can be avoided in face-to-face examinations, such as plagiarism and cheating. These findings are uniquely reported by the present research. However, the BB as a mechanical delivery information tool does not lead teachers to introduce innovative teaching strategies, which can help obtain knowledge in an eLearning environment as Rogerson-Revell (2007) had suggested.

In section C, most teachers consider students engagement (AR=64.87 %, M=3.527, SD=0.982) and participation in virtual class sessions (AR=75.68%, M=3.851, SD=0.871) highly satisfactory. A comparatively lesser AR (=66.22) is seen for teacher's enthusiasm about teaching BB, though the teachers perceive that they are approachable to the students during the class (AR=97.3%, M=4.432, SD=0.599). However, they do not primarily credit BB as a suitable application for group work, pair work, or individual work in class. Notably, 12.16% of the teachers strongly disagree, and 17.57% disagree, accounting for the highest percentage values of disagreement in section C. If in an e-learning environment, the group activities, pair work or individual assignments are not designed to engage the students cognitively, chances are the medium of instruction may not prove fruitful.

In section D, the teachers also believe they should receive training for the new technology used in e-learning (AR=94.6%, M=4.432, SD=0.599), and must be a part of training sessions before using BB (AR=83.79%, M=4.041, SD=0.835). A few teachers face reluctance using BB as the main teaching tool because they are not accustomed to its interface (AR=17.57%, M=2.527, SD=1.037). As is mentioned in figure 7, most teachers have been teaching for more than 10 years, whilst Figure 8 shows that most (n=65) have an e-learning utilization experience of 1-2 years. The reason can be identified that most EFL teachers do not have enough exposure and training to utilize BB efficiently as an e-learning tool (Blin & Munro, 2008). Similarly, Alturki, Aldraiweesh, and Kinshuck (2016) reported that teachers should have updated knowledge about the software usage and they stressed the need to offer the bilingual delivery of the materials.

Section E, reflects that BB moderately satisfies teachers in terms of meeting the learning objectives through its online platform (AR=55.41%, M=3.419, SD=0.876). Only 37.84% of teachers agree with the prospects of the BB's successful application to all subjects (AR=37.84%, M=3.041, SD=1.152). Just 18.92% of the participants prefer to connect remotely through BB than face to face teaching, suggesting that most teachers favor physical teaching on campus compared to BB (AR=18.92%, M=2.419, SD=1.098). In language teaching, physical presence in real-life classes enlightens better learning outcomes. Students and teachers have a direct face-to-face interaction, which cannot be practiced in online classes.

Section F's results indicate that teachers have a positive experience of teaching e-learners with BB during the COVID-19 pandemic (AR=89.19%, M=4.135, SD=0.728). They believe e-learning through BB saves students a lot of time, which could have been wasted during the COVID-19 lockdowns (AR=97.3%, M=4.351, SD=0.535). However, regarding self-learning and curiosity to gain information, teachers expressed a lower agreement rate (AR=68.92%, M=3.811, SD=0.7.53). This can be attributed to the fact that students may lack self-learning motivation in an e-learning environment because the relevant teaching strategies are still to be worked out. Most teachers agree to learn new teaching strategies, which they had never used before in a traditional academic setting (AR=85.13%, M=4.041, SD=0.730). Hence, these findings respond to the second research question (a) about the efficiency of the e-learning platforms during the COVID-19 pandemic.

4.2 Zoom

The second part of the first research question (c) is obtained by evaluating Zoom's effectiveness as an e-learning platform. 14.85% of the total participants (n=15) completed the survey for the Zoom application. Cronbach's Alpha values ranged from α=0.704 to α=0.939, while the average AR of the questionnaire reached 61.85% with an average mean of 3.544. Table B, Appendix. 2 shows the descriptive statistics of results for all sections of the Zoom questionnaire.

In section A, most teachers like the Zoom interface and respond satisfactorily (AR=73.33%, M=3.667, SD=1.234). The account creation with an easy sign-in feature is appreciated (AR=80%, M=4.000, SD=0.845). In contrast, a lesser AR is recorded for assignment reception and teacher's feedback (AR=46.67 %, M=3.267, SD=1.280), and almost the same for assignment notification (AR=46.66 %, M=3.067, SD=1.387), which is the lowest proportion in this section. However, essential e-learning platform features such as sharing audio/video materials with the students are very convenient in Zoom (AR=73.33%, M=3.933, SD=1.100). They help in creating an ideal e-learning environment for English language teaching. These findings affirm the Archibald et al. (2019) study that whilst a few participants had technical difficulties, the vast majority rated their experience as great and preferred Zoom over other interviewing methods such as phone and face-to-face interviews.

For section B, most of the teachers can organize their teaching material on Zoom (AR=60 %, M=3.400, SD=1.056); however, the agreement is less positive when sending student notification about the assessments (AR=46.67 %, M=3.200, SD=1.182). These Zoom features can be developed to help EFL teachers in the future. A large number

of teachers show dissatisfaction regarding monitoring the student's performance on Zoom (AR=26.67 %, M=3.000, SD=0.756) and assessment system (AR=33.33 %, M=3.133, SD=0.743). These novel findings of the survey indicate the drawbacks of using Zoom as an e-learning platform for teaching the English language. The authors believe that if teachers cannot monitor and assess student performance, they would not achieve the desired learning outcomes. Further, it can lead them to uncertain situations about their students' language skills improvement. More than half of the teachers agree to the lecture delivery statements (AR=53.33 %) and annotation while delivering the lecture (AR=66.66 %).

For section C, many teachers believe that they can engage the students in the productive discussion (AR=66.67%, M=3.733, SD=1.163). They show their satisfaction for students understanding the explanation of the topics in class (AR=66.67%, M=3.867, SD=0.915). Interestingly, most teachers are approachable to students (AR=73.34%, M=3.733, SD=0.704) using private or public chat. However, they are less enthusiastic about using Zoom as a teaching tool (AR=53.33%, M=3.400, SD=1.242). It seems that they are more comfortable with the traditional classroom setting. This finding indicates that further research is needed to investigate why teachers lack enthusiasm for using e-learning platforms.

For section D, teacher's attitude and training sessions are thought to be necessary before adopting Zoom as an e-learning tool (AR=73.33%, M=3.800, SD=0.941). Except for 6.67% of the total, the teachers claim that they can use the Zoom application with comfort after training (AR=73.33%, M=3.800, SD=1.041). As discussed in the opinion section of BB, technical expertise is essentially required for the optimum utilization of any e-learning platform.

Section E shows teacher's satisfaction towards using Zoom as digital technology for teaching the English language. Two-thirds of the participants agree that the course could meet the learning objectives using Zoom (AR=66.67%, M=3.533, SD=0.990). Almost half believe that Zoom can be used to teach all subjects (AR=53.34%, M=3.067, SD=1.280). If given a choice, a majority agrees to select Zoom over traditional teaching, which is a good sign and reflects that teachers are eager to adopt e-learning (AR=60 %, M=3.400, SD=0.910). Over 70% of teachers thought Zoom could boost motivation and learning initiative (AR=73.34%, M=3.667, SD=0.816). Surprisingly, a lower proportion prefers connecting remotely via Zoom over on-campus courses.

Lastly, section F's results suggest that teaching with Zoom during the COVID-19 pandemic has been a good experience for most teachers (Ave. AR_F=76.67%, Ave. M_F=3.789), as shown by Ave. AR and Ave. Mean. According to most of the participants, e-learning is one of the few activities that students look forward to during the COVID-19 lockdowns (AR=86.67%, M=4.000, SD=0.756). They agree that self-learning and curiosity in students can be promoted through e-learning because they search for the relevant topics on the internet to prepare their assignments during the COVID-19 lockdowns (AR=80%, M=3.667, SD=0.900). The findings identify Zoom as a potential e-learning platform during the COVID-19 pandemic by responding to the second research question (c).

4.3 Google Classroom (GC)

To obtain the answer to the first research question (b), twelve teachers filled the survey for GC, which accounted for 11.88% of the total participants. Reliability Analysis showed adequate Cronbach's Alpha values, prominently for section C (α=0.713), section E (α=0.854) and section F (α=0.704). Average AR reached 72.92%, with an average mean of 3.887 for the GC questionnaire. Table C, Appendix.3 shows the descriptive statistics of results for each Section of the GC questionnaire.

The results indicate all the teachers like receiving updated notifications about the assignments submitted by the students, shown by the perfect agreeable rate and high mean value (AR=100%, M=4.417, SD=0.515). They also appreciate the feature of submitting feedbacks after receiving the assignments (AR=91.67%, M=4.417, SD=0.669). The teachers find it easy to share audio/video teaching materials on GC (AR=83.33%, M=4.167, SD=0.718) due to its uncomplicated interface. Timely notification of the students about assignments, quizzes, and exams is also a well-liked feature of GC (AR=100%, M=4.417, SD=0.515), with great comfortability delivering the lectures on this application (AR=83.34%, M=4.000, SD=0.603).

They can successfully keep the students engaged in productive discussion on GC (AR=83.33%, M=3.917, SD= 0.515), and are easily approachable by the students for questions during the class (AR=100%, M=4.250, SD=0.452). The majority of teachers also feel enthusiastic in teaching via GC (AR=83.33%, M=3.917, SD=1.084). Likewise, Fauzi et al. (2021) investigated student's acceptance of Google Classroom during the Covid-19

pandemic. They state that students profited from the platform's features since they were easy to use and made studying more enjoyable. Azhar & Nayab (2018) agree with GC's popularity. However, the present research findings contradict with Azhar and Nayab (2018) that according to teacher's perception GC is somewhat inefficient and the key reason for its inefficiency is the absence of a user-friendly interface

The teachers deem that training for the new technology used in e-learning is necessary (AR=100%, M=4.583, SD=0.515). Many researchers also consider teacher's training a vital factor (Kebaetse, Nkomazana, & Haverkamp, 2014). Only a few are unwilling to use GC as the main teaching tool because of its unfamiliar interface (AR=16.67%, M=2.583, SD=0.996). The course can meet the learning objectives on GC (AR=75%, M=4.083, SD=0.793). It can be a source of motivation booster to teachers and students (AR=75%, M=3.917, SD=0.669).

The present study reports a novel finding that most teachers agree that e-learning is a healthy interactive activity that helps with student depression and mental stress during the COVID-19 lockdowns (AR=91.67%, M=4.167, SD=0.577). E-learning through GC saves students time which could have been wasted during the COVID-19 lockdowns (AR=91.66%, M=4.167, SD=0.835). The results confirm the positive impact of GC as an educational tool during the COVID-19 pandemic, which addresses the second research question (b).

5. Conclusion

Three e-learning platforms, BB, GC, and Zoom, were comprehensively studied in this research. The study focused on the teacher's academic outlook on e-learning platform's potential and possible issues in e-learning and their adoption during the COVID-19 pandemic. The research findings conclude that GC is the most effective educational tool in e-learning, followed by BB and Zoom. However, teacher training is deemed necessary for implementing new technology in language teaching and learning. The teachers need to be creative and tech-equipped to overcome these issues in the future. Due to limited resources and time, our study was confined to three e-learning platforms. To get a wider perspective, we recommend that future studies take into consideration all reputable e-learning sites.

Furthermore, the study acquired just EFL instructors' views, and it would be more valuable if student's perspectives were recorded. Future research initiatives should consider the technical issues and challenges related to accessibility and usability among e-learners. Overall, the study's findings support that during the COVID -19 pandemic, utilizing authentic eLearning platforms can make a difference in the online teaching scenario.

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Appendix. 1

Table A: Descriptive statistics of Blackboard questionnaire results

N = 74	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
A. Accessibility and usability									0.691
1. BB has an intuitive and flexible interface.	4.05	1.35	16.22	63.51	14.86	78.37	3.838	0.844	
2. Creating an account and signing in to the BB is easy.	2.70	4.05	9.46	54.05	29.73	83.78	4.041	0.898	
3. I can receive the assignments and submit the feedback.	1.35	5.41	22.97	56.76	13.51	79.73	3.757	0.808	
4. I can receive updated notifications about the assignments submitted by the students.	2.7	5.41	29.73	50	12.16	79.73	3.635	0.869	
5. I can share audio/video teaching materials easily.	4.05	8.11	9.46	48.65	29.73	58.11	3.919	1.044	
6. I can design the course materials easily on BB.	1.35	6.76	21.62	56.76	13.51	78.38	3.743	0.829	
B. Efficiency and Convenience									0.764
7. I can organize my teaching material online on BB.	1.35	4.05	13.51	66.22	14.86	81.08	3.892	0.751	
8. I can send notifications to the students about assignments, quizzes, and exams.	1.35	1.35	4.05	45.95	47.3	93.25	4.365	0.751	
9. I can grade and monitor students' performance by the BB grading system.	1.35	1.35	28.38	58.11	10.81	68.92	3.757	0.718	
10. I am satisfied with the online assessment on BB.	2.71	5.41	33.78	54.05	4.05	58.1	3.514	0.781	
11. I can annotate while delivering the explanation of a topic during the lecture on BB.	1.35	2.7	27.03	63.51	5.41	68.92	3.689	0.681	
12. I feel comfortable delivering my lecture on BB.	0	4.05	10.81	55.41	29.73	85.14	4.108	0.751	
C. Communication and Interaction									0.834
13. I can keep students engaged and participate in productive discussion.	4.05	13.51	17.57	55.41	9.46	64.87	3.527	0.982	
14. I believe students can understand	2.7	4.05	17.57	56.76	18.92	75.68	3.851	0.871	

N = 74	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
when I explain a topic in the online class.									
15. I am enthusiastic about teaching via BB.	2.7	10.81	20.27	55.41	10.81	66.22	3.608	0.919	
16. I am approachable, and students can ask me questions during the class.	0	1.35	1.35	50	47.3	97.3	4.432	0.599	
17. BB is a perfect educational tool for teacher-student interaction and collaborative work among the students.	6.76	8.11	31.08	43.24	10.81	54.05	3.432	1.021	
18. I think BB is helpful for group work, pair work, or individual work in class.	12.16	17.57	28.38	37.84	4.05	41.89	3.041	1.103	
D. Teacher's Attitude									0.475
19. Teachers and instructors should get trained for the new technology used in e-learning.	0	0	5.41	45.95	48.65	94.6	4.432	0.599	
20. I am reluctant to use BB as a main teaching tool because the BB interface is new to me.	9.46	52.7	20.27	10.81	6.76	17.57	2.527	1.037	
21. It is difficult to use BB without training.	5.41	24.32	20.27	36.49	13.51	50	3.284	1.141	
22. Teachers should have training sessions before using BB.	2.7	1.35	12.16	56.76	27.03	83.79	4.041	0.835	
23. I can use all BB applications comfortably after training sessions.	1.35	5.41	13.51	51.35	28.38	79.73	4.000	0.876	
24. I recommend using BB as a main instructional tool in education.	4.05	16.22	18.92	47.3	13.51	60.81	3.500	1.050	
E. Teacher's Satisfaction									0.855
25. The course can meet the learning objectives through BB online platform.	1.35	16.22	27.03	50	5.41	55.41	3.419	0.876	
26. BB online learning platform can be applied to all the subjects.	10.81	21.62	29.73	28.38	9.46	37.84	3.041	1.152	
27. BB is my first choice in active learning compared to traditional learning.	9.46	17.57	32.43	37.84	2.7	40.54	3.068	1.025	
28. I think BB can be a learning initiative and motivation booster.	5.41	8.11	37.84	39.19	9.46	48.65	3.392	0.963	

N = 74	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
29. I think BB can be a motivation booster for both teachers and students.	4.05	16.22	31.08	36.49	12.16	48.65	3.365	1.028	
30. I prefer to connect remotely through BB than teaching a course physically on campus.	22.97	33.78	24.32	16.22	2.7	18.92	2.419	1.098	
F. E-learning Experience during COVID-19									0.788
31. I had a positive experience of teaching e-learners with BB during COVID-19.	1.35	1.35	8.11	60.81	28.38	89.19	4.135	0.728	
32. I believe e-learning through BB saved students a lot of time, which could have been wasted during COVID-19 lockdown.	0	0	2.7	59.46	37.84	97.3	4.351	0.535	
33. I believe e-learning was one of the few activities that students looked forward to during COVID-19 lockdown.	0	2.7	16.22	58.11	22.97	81.08	4.014	0.712	
34. E-learning emerged as a healthy interactive activity that greatly helped with depression and mental stress during COVID-19 lockdown.	0	0	20.27	60.81	18.92	79.73	3.986	0.630	
35. E-learning during COVID-19 promoted self-learning and curiosity in students as they searched the relevant topics on the internet to prepare their assignments.	0	4.05	27.03	52.7	16.22	68.92	3.811	0.753	
36. I learned new teaching strategies to teach e-learners, which I had never used before in traditional teaching.	1.35	1.35	12.16	62.16	22.97	85.13	4.041	0.730	

Appendix.2

Table B: Descriptive statistics of Zoom questionnaire results

N=15	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
A. Accessibility and usability									0.744
1. ZOOM has an intuitive and flexible interface.	13.33	0	13.33	53.33	20	73.33	3.667	1.234	
2. Creating an account and signing in to ZOOM is easy.	0	6.67	13.33	53.33	26.67	80	4.000	0.845	
3. I can receive the assignments and submit the feedback.	6.67	26.67	20	26.67	20	46.67	3.267	1.280	
4. I can receive updated notifications about the assignments submitted by the students.	20	13.33	20	33.33	13.33	46.66	3.067	1.387	
5. I can share audio/video teaching materials easily.	6.67	0	20	40	33.33	73.33	3.933	1.100	
6. I can design the course materials easily on ZOOM.	13.33	13.33	20	40	13.33	53.33	3.267	1.280	
B. Efficiency and Convenience									0.704
7. I can organize my teaching material online on ZOOM.	6.67	13.33	20	53.33	6.67	60	3.400	1.056	
8. I can send notifications to the students about assignments, quizzes, and exams.	6.67	20	26.67	40	6.67	46.67	3.200	1.082	
9. I can grade and monitor students' performance by the ZOOM grading system.	0	26.67	46.67	26.67	0	26.67	3.000	0.756	
10. I am satisfied with the online assessment on ZOOM.	0	20	46.67	33.33	0	33.33	3.133	0.743	
11. I can annotate while delivering the explanation of a topic during the lecture on ZOOM.	6.67	0	40	33.33	20	53.33	3.600	1.056	
12. I feel comfortable delivering my lecture on ZOOM.	6.67	6.67	20	53.33	13.33	66.66	3.600	1.056	
C. Communication and Interaction									0.939
13. I can keep students engaged and participate in productive discussion.	6.67	6.67	20	40	26.67	66.67	3.733	1.163	

N=15	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
14. I believe students can understand when I explain a topic in the online class.	0	6.67	26.67	40	26.67	66.67	3.867	0.915	
15. I am enthusiastic about teaching via ZOOM.	6.67	20	20	33.33	20	53.33	3.400	1.242	
16. I am approachable, and students can ask me questions during the class.	0	6.67	20	66.67	6.67	73.34	3.733	0.704	
17. ZOOM is a perfect educational tool for teacher-student interaction and collaborative work among the students.	0	26.67	13.33	40	20	60	3.533	1.125	
18. I think ZOOM is helpful for group work, pair work, or individual work in class.	0	6.67	33.33	40	20	60	3.733	0.884	
D. Teacher's Attitude									0.802
19. Teachers and instructors should get trained for the new technology used in e-learning.	6.67	0	20	40	33.33	73.33	3.933	1.100	
20. I am reluctant to use ZOOM as a main teaching tool because the ZOOM interface is new to me.	13.33	33.33	13.33	26.67	13.33	40	2.933	1.335	
21. It is difficult to use ZOOM without training.	0	26.67	20	40	13.33	53.33	3.400	1.056	
22. Teachers should have training sessions before using ZOOM.	0	13.33	13.33	53.33	20	73.33	3.800	0.941	
23. I can use all ZOOM applications comfortably after training sessions.	6.67	0	20	53.33	20	73.33	3.800	1.014	
24. I recommend using ZOOM as a main instructional tool in education.	6.67	13.33	33.33	26.67	20	46.67	3.400	1.183	
E. Teacher's Satisfaction									0.812
25. The course can meet the learning objectives through ZOOM online platform.	6.67	6.67	20	60	6.67	66.67	3.533	0.990	
26. ZOOM online learning platform can be applied to all the subjects.	13.33	26.67	6.67	46.67	6.67	53.34	3.067	1.280	
27. ZOOM is my first choice in active learning compared	6.67	6.67	26.67	60	0	60	3.400	0.910	

N=15	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
to traditional learning.									
28. I think ZOOM can be a learning initiative and motivation booster.	0	13.33	13.33	66.67	6.67	73.34	3.667	0.816	
29. I think ZOOM can be a motivation booster for both teachers and students.	6.67	6.67	20	53.33	13.33	66.66	3.600	1.056	
30. I prefer to connect remotely through ZOOM than teaching a course physically on campus.	6.67	33.33	13.33	26.67	20	46.67	3.200	1.320	
F. E-learning Experience during COVID-19									0.892
31. I had a positive experience of teaching e-learners with ZOOM during COVID-19.	6.67	13.33	13.33	53.33	13.33	66.66	3.533	1.125	
32. I believe e-learning through ZOOM saved students a lot of time, which could have been wasted during the COVID-19 lockdown.	0	6.67	13.33	46.67	33.33	80	4.067	0.884	
33. I believe e-learning was one of the few activities that students looked forward to during COVID-19 lockdown.	0	6.67	6.67	66.67	20	86.67	4.000	0.756	
34. E-learning emerged as a healthy interactive activity that greatly helped with depression and mental stress during COVID-19 lockdown.	0	13.33	13.33	53.33	20	73.33	3.800	0.941	
35. E-learning during COVID-19 promoted self-learning and curiosity in students as they searched the relevant topics on the internet to prepare their assignments.	0	20	0	73.33	6.67	80	3.667	0.900	
36. I learned new teaching strategies to teach e-learners, which I had never used before in traditional teaching.	6.67	6.67	13.33	60	13.33	73.33	3.667	1.047	

Appendix. 3

Table C: Descriptive statistics of Google Classroom questionnaire results

N = 12	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
A. Accessibility and usability									0.656
1. GC has an intuitive and flexible interface.	0	8.33	16.67	41.67	33.33	75	4.000	0.953	
2. Creating an account and signing in to the GC is easy.	0	0	16.67	41.67	41.67	83.34	4.250	0.754	
3. I can receive the assignments and submit the feedback.	0	0	8.33	41.67	50	91.67	4.417	0.669	
4. I can receive updated notifications about the assignments submitted by the students.	0	0	0	58.33	41.67	100	4.417	0.515	
5. I can share audio/video teaching materials easily.	0	0	16.67	50	33.33	83.33	4.167	0.718	
6. I can design the course materials easily on GC.	0	8.33	50	16.67	25	41.67	3.583	0.996	
B. Efficiency and Convenience									0.613
7. I can organize my teaching material online on GC.	0	25	8.33	41.67	25	66.67	3.667	1.155	
8. I can send notifications to the	0	0	0	58.33	41.67	100	4.417	0.515	

N = 12			Frequency Table (%)			Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
students about assignments, quizzes, and exams.									
9. I can grade and monitor students' performance by the GC grading system.	0	16.67	25	41.67	16.67	58.34	3.583	0.996	
10. I am satisfied with the online assessment on GC.	0	8.33	33.33	41.67	16.67	58.34	3.667	0.888	
11. I can annotate while delivering the explanation of a topic during the lecture on GC.	0	16.67	16.67	50	16.67	66.67	3.667	0.985	
12. I feel comfortable delivering my lecture on GC.	0	0	16.67	66.67	16.67	83.34	4.000	0.603	
C. Communication and Interaction									0.713
13. I can keep students engaged and participate in productive discussion.	0	0	16.67	75	8.33	83.33	3.917	0.515	
14. I believe students can understand when I explain a topic in the online class.	0	8.33	33.33	41.67	16.67	58.34	3.667	0.888	
15. I am enthusiastic	8.33	0	8.33	58.33	25	83.33	3.917	1.084	

N = 12			Frequency Table (%)			Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
about teaching via GC.									
16. I am approachable, and students can ask me questions during the class.	0	0	0	75	25	100	4.250	0.452	
17. GC is a perfect educational tool for teacher-student interaction and collaborative work among the students.	0	0	25	41.67	33.33	75	4.083	0.793	
18. I think GC is helpful for group work, pair work, or individual work in class.	0	16.67	16.67	33.33	33.33	66.66	3.833	1.115	
D. Teacher's Attitude									0.610
19. Teachers and instructors should get trained for the new technology used in e-learning.	0	0	0	41.67	58.33	100	4.583	0.515	
20. I am reluctant to use GC as a main teaching tool because the GC interface is new to me.	16.67	25	41.67	16.67	0	16.67	2.583	0.996	
21. It is difficult to use GC	0	33.33	16.67	41.67	8.33	50	3.250	1.055	

N = 12			Frequency Table (%)			Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
without training.									
22. Teachers should have training sessions before using GC.	0	16.67	16.67	50	16.67	66.67	3.667	0.985	
23. I can use all GC applications comfortably after training sessions.	0	0	33.33	41.67	25	66.67	3.917	0.793	
24. I recommend using GC as a main instructional tool in education.	0	0	25	41.67	33.33	75	4.083	0.793	
E. Teacher's Satisfaction									0.854
25. The course can meet the learning objectives through GC online platform.	0	0	25	41.67	33.33	75	4.083	0.793	
26. GC online learning platform can be applied to all the subjects.	8.33	25	8.33	33.33	25	58.33	3.417	1.379	
27. GC is my first choice in active learning compared to traditional learning.	0	0	33.33	50	16.67	66.67	3.833	0.718	
28. I think GC can be a learning initiative and motivation booster.	0	0	33.33	50	16.67	66.67	3.833	0.718	

N = 12	Frequency Table (%)					Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
29. I think GC can be a motivation booster for both teachers and students.	0	0	25	58.33	16.67	75	3.917	0.669	
30. I prefer to connect remotely through GC than teaching a course physically on campus.	16.67	25	16.67	16.67	25	41.67	3.083	1.505	
F. E-learning Experience during COVID-19									0.704
31. I had a positive experience of teaching e-learners with GC during COVID-19.	0	0	16.67	58.33	25	83.33	4.083	0.669	
32. I believe e-learning through GC saved students a lot of time, which could have been wasted during the COVID-19 lockdown.	0	8.33	0	58.33	33.33	91.66	4.167	0.835	
33. I believe e-learning was one of the few activities that students looked forward to during COVID-19 lockdown.	0	16.67	8.33	50	25	75	3.833	1.030	
34. E-learning emerged as	0	0	8.33	66.67	25	91.67	4.167	0.577	

N = 12			Frequency Table (%)			Agreeable Rate (AR)	Mean	SD	Cronbach's α
	1 = Strongly Disagree	**2 = Disagree**	**3 = Neutral**	**4 = Agree**	**5 = Strongly Agree**				
	a healthy interactive activity that greatly helped with depression and mental stress during COVID-19 lockdown.								
35.	E-learning during COVID-19 promoted self-learning and curiosity in students as they searched the relevant topics on the internet to prepare their assignments.	0	8.33	25	33.33	33.33	66.66	3.917	0.996
36.	I learned new teaching strategies to teach e-learners, which I had never used before in traditional teaching.	0	0	16.67	66.67	16.67	83.34	4.000	0.603

The Effect of Gender and STEM/non-STEM Disciplines on Remote Learning: A National Study of Undergraduates in Qatar

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Abstract: The sudden and prolonged disruption to learning caused by the COVID-19 pandemic has exposed the vulnerabilities of traditional higher education and revealed the need for a rapid transformation. Lessons from the pandemic have made it clear that the future of higher education will rely heavily on e-learning and the agility of institutions to seamlessly transition between face-to-face, blended/hybrid, and fully online learning. As institutions begin their post-pandemic planning, the online experiences of different groups of learners during the pandemic offer valuable insight into what is working and what isn't. Consequently, this study explored the effect of gender and discipline (STEM/non-STEM) on students' perceptions of (1) course design, (2) assessment, (3) student behavior, (4) instructor behavior, and (5) tools and technologies during forced online learning. Additionally, the researchers investigated the effect of gender and discipline on students' overall satisfaction with remote learning and explored the influence of students' perceptions on satisfaction. Study participants were 1,825 undergraduates at eight universities in Qatar. Using the QLT evaluation rubric, the researchers adapted a 27-item survey to measure students' perceptions of key aspects of quality online teaching and learning and to gauge overall satisfaction. Using a SEM approach, study results showed that (1) male students had more positive perceptions of instructor behavior, assessment, and tools and technologies compared to females, (2) males were more satisfied overall with their remote learning experiences, (3) students in STEM disciplines had significantly more negative perceptions of all the aspects of online learning explored in the study, (4) students in STEM disciplines were significantly less satisfied overall with remote learning, and (5) students' perceptions of tools and technologies, assessment, and course design most influenced their overall satisfaction. This study also considers the unique cultural context in Qatar when interpreting results, particularly in regards to women. These findings have important implications for faculty development and post-pandemic planning in higher education in general and the Gulf in particular.

Keywords: remote learning, student satisfaction, STEM, COVID-19 pandemic, gender, Qatar

1. Introduction

Since early 2020, virtually every Higher Education Institution (HEI) around the world has been mandated to deliver education remotely in response to the COVID-19 pandemic. Such drastic and prolonged measures pose significant challenges to institutions, faculty, and students. While distance and online learning are well-established modes of delivery at distance education institutions, that is not necessarily the case at traditional HEIs. That is, faculty may not have the skill sets needed, students are not choosing the online mode, and institutions may lack needed infrastructure and support. Further exacerbating the challenges posed by the pandemic is the lack of clear contingency plans for what Hodges et al., (2020) termed "emergency remote teaching" or ERT. With ERT, the aim is to provide temporary access to instruction and instructional support in a way that is quick to set up and reliably available during a crisis (Hodges et al., 2020, p.6). However, even those institutions with contingency plans in place were likely not prepared for more than a year of ERT.

The growing body of pandemic research suggests traditional higher education (HE) is heading for a rapid transformation full of uncertainty. In such cases, studies of students' satisfaction offer valuable insight into areas for improvement (Schlesinger, et al., 2016). Although there are many studies investigating student satisfaction throughout the pandemic, there is limited research exploring the effect of gender on students' experiences with remote learning. Likewise, the literature investigating the experiences of students in STEM and non-STEM fields during the pandemic is lacking. Furthermore, to the authors' knowledge, there are no other studies investigating the impact of gender and discipline on student satisfaction with remote learning at a national level in the gulf region. Consequently, the current study seeks to add to the literature by investigating these factors and taking into consideration the unique cultural context in Qatar, particularly in regards to women.

2. Literature Review

The terms *satisfaction* and *quality*, particularly in the context of HE, generally go hand-in-hand. In fact, it is widely accepted that quality drives satisfaction and that satisfaction is an excellent measure of quality (Drugas, 2020). Satisfaction has also been linked with students' persistence, graduation rate, and learning (Bryant and Bodfish, 2014). Furthermore, student satisfaction is an indicator of institutional performance (Nastasić, Banjević and Dragana, 2019); a global concern given the prolonged period of ERT imposed by the pandemic and the real likelihood of future crises. Investigating students' experiences with remote learning, then, offers insight into areas where student satisfaction is strong and where improvement is needed (Smimou and Dahl, 2011).

2.1 Gender and Satisfaction with Online Learning

The literature regarding the effect of gender on students' perceptions of and satisfaction with online learning is quite mixed (Ekawati, Sugandi, and Kusumastuti, 2017; O'Driscoll, 2012; Sultan and Wong, 2012). On one hand, relatively early studies have reported that males have more experience using technology for different purposes and are, consequently, more comfortable with it, giving them an added advantage and creating more positive online experiences (Tucker, 2014; Lin et al., 2012). Similarly, studies of technology-supported learning have shown that female students have more anxiety around online assessment due to fewer computing experiences and lower levels of computer self-efficacy (He and Freeman, 2010). Other studies have shown that females prefer e-learning assessments that involve projects and group work, while males prefer to solve problems on their own (Adamus et al., 2009). More recent work has suggested the gender-based differences reported in earlier studies are less applicable to technologically adept millennials and Generation Z learners (Cutler, 2014; Harvey and Parahoo, 2017). However, a study by Hsiao and Shiao (2018) investigating gender differences in distance learning found that female students outperformed male students and, subsequently, indicated a higher level of satisfaction. During forced online learning due to the COVID-19 pandemic, however, Hsiao (2021) investigated 18,085 university students in Taiwan and found that although females outscored males , they were significantly less satisfied with online learning ($P < 0.0001$). A study investigating students' satisfaction at universities in Saudi Arabia found that females were more satisfied with their learning experience when courses with male instructors were taught in a blended learning environment (Alebaikan, 2010). Such findings support Albalawi's (2007) study, which showed that university lecturers believed web-based instruction enhanced learning among students at gender-segregated HEIs in Saudi Arabia. For students coming from regions where gender segregation is commonplace, it is conceivable that gender may influence their experiences with online learning.

2.2 Online Learner Satisfaction and STEM/non-STEM Disciplines

Several studies have reported discipline as a significant factor influencing student satisfaction with online learning (Lim and Richardson, 2021; Smith et al., 2008). Similarly, Nelson Laird et al, (2011) highlighted the differences in learning approaches used in STEM and non-STEM fields. Nonetheless, there are relatively few studies investigating the unique challenges of delivering STEM instruction online (Chen, Bastedo, and Howard, 2015; Lee, 2014; Watkins and Mazur, 2013). Of the research available, recent studies suggest students in STEM fields highly value interaction and collaboration in their online learning experiences. For example, in a study comparing student satisfaction with face-to-face and online learning among nursing students, Abdelaziz et al. (2011) reported that students were accepting of online instruction as a temporary mode of learning but complained that their online experiences lacked the desired interaction with students and instructors. Hegeman (2015) found that math students in online courses preferred instructor-generated videos and guided note-taking sheets over publisher materials such as textbooks. In an investigation of undergraduates in an online calculus course, Vajravelu and Muhs (2017) found that participation in small group problem-solving sessions for homework assignments and online skills tests significantly increased engagement and overall satisfaction. In

addition, Chen, Bastedo, and Howard (2015) explored the influence of online design elements on learner satisfaction and found that students in STEM fields were most satisfied with online learning experiences characterized by active learning activities, interactive engagement strategies, and robust assessment design. Most recently, a study of satisfaction with online learning during the pandemic conducted by Faize and Nawaz (2020) surveyed 196 Bioscience undergraduates using closed and open-ended items. Study results revealed that students were largely dissatisfied with their online learning experience citing lack of interaction with students and instructors as well as an inability to do hands-on experiments as the main cause. These findings emphasize an urgent need for more studies aimed at understanding STEM students' perceptions of online learning, enhancing the delivery of STEM instruction online, and improving STEM instruction in ERT contexts.

3. Cultural Considerations for Remote Learning in Qatar

Although many institutions around the world struggled to ensure learners' had access to internet and needed tools and technologies in the early stages of the pandemic, oil-rich Qatar with its relatively small population (less than 3 million inhabitants) suffered little in this regard. When all HEIs in Qatar were mandated to switch to fully online learning in early March 2020, the transition was facilitated by existing learning management systems such as Blackboard, increasing support to faculty, a COVID hotline established by MOEHE (Ministry of Education and Higher Education), and increased support from the country's national telecommunications provider to guarantee accessibility and connectivity. Furthermore, the MOEHE worked with institutions to ensure that learners who did not have access to needed devices or internet were provided for.

Qatar's deeply rooted values, on the other hand, likely have bearing on the learning experiences of students during the pandemic, particularly for women who are cornerstones of Qatari culture carrying substantial responsibility for maintaining social institutions such as marriage and family (Liloia, 2019). The Arabic phrase, "Rabbaitul Bait" (meaning queen of the house) embodies the significance of Arab women's roles in the home. The country's national development strategy also elaborates on the vital role of women, "Through their nurturing of language, codes of ethics, behavioral patterns, value systems and religious beliefs, women play an indispensable role in upholding traditional, familial, and cultural values" (General Secretariat for Development Planning, 2011, p.165). These values reinforce women's primary role as a domestic one and instill a sense of pride and honor in prioritizing family responsibilities over individual ambitions (Al-Malki et al, 2012; Golkowska, 2014). In the context of the pandemic, then, women are likely disproportionately responsible for the online learning of their children, siblings, and other family members in the home. Although size and composition of households in the Gulf have been affected by globalization, late marriage, and divorce, many Arab households are still large by Western standards and often include extended family (Al-Khraif et al., 2015). The average Qatari household, for example, consists of 10 individuals (Qatar Public Statistics Authority, 2018). It is also important to point out that prioritizing a "domestic" role is not a contradiction to Gulf women pursuing HE. In fact, nearly 70% of the 31,000 students enrolled in HE are female (Qatar Public Statistics Authority, 2018). This cultural context should be considered when interpreting study results.

4. Research Model and Hypotheses

Based on a review of the literature and consideration of the QLT online course evaluation rubric (California State University, 2021), a conceptual, structural model was designed to investigate the effect of gender and discipline (STEM/non-STEM) on students' perceptions of (1) course design/materials, (2) assessment and evaluation, (3) student behavior, (4) instructor behavior, and (5) tools and technologies during remote learning. The research model was also designed to study the effect of gender and discipline on students' overall satisfaction and to explore the influence of students' perceptions on overall satisfaction. The research model is presented in figure 1 below. The specific research hypotheses are:

H1: Gender influences students' perceptions of course design/materials, assessment and evaluation, instructor behavior, student behavior, and tools and technologies.
H2: Gender influences students' overall satisfaction with remote learning.
H3: Discipline (STEM/Non-STEM) influences students' perceptions of course design/materials, assessment and evaluation, instructor behavior, student behavior, and tools and technologies.
H4: Discipline (STEM/Non-STEM) influences students' overall satisfaction with remote learning.
H5: Students' perceptions of course design/materials, assessment and evaluation, instructor behavior, student behavior, and tools and technologies influence their overall satisfaction with remote learning.

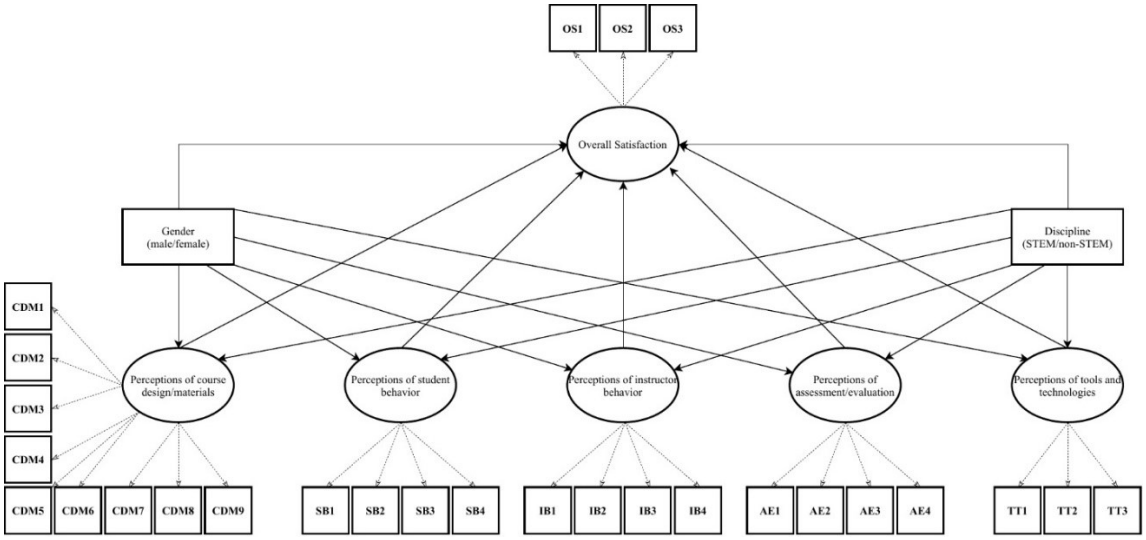

Figure 1: Research model

5. Methodology

5.1 Setting

This study took place at a large HEI in the State of Qatar during fall 2020. A total of 14 public and private HEIs were invited to participate. Of those, eight confirmed their willingness to take part. Participating HEIs were Qatar University, Community College of Qatar, College of the North Atlantic-Qatar, University of Calgary-Qatar, Qatar Finance and Business Academy of Qatar with Northumbria University, Virginia Commonwealth University-Qatar, AFG College with the University of Aberdeen, and Stenden Qatar-University of Applied Sciences. Because all undergraduate courses at these institutions were mandated to be taught fully online and some graduate courses, primarily those with labs, were permitted to have periods of face-to-face instruction (likely due to their significantly smaller class sizes) during the fall 2020 semester, the researchers only targeted undergraduate students. Additionally, because this study investigates STEM/non-STEM students, the researchers targeted only those undergraduates who had declared an area of study. Table 1 details the demographics of the HEIs that participated in the study.

Table 1: Demographics of Participating HEIs (Qatar Planning and Statistics Authority, 2019

Institution	Sector	Undergrad Population	Male	Female	STEM Learners	Non-STEM Learners
Qatar University	Public	20,396	4,226	16,170	5,986	14,410
Community College of Qatar	Public	5,120	1,331	3,789	422	4,698
College of North Atlantic-Qatar	Public	3,378	1,919	1,459	1,385	1,993
University of Calgary-Qatar	Private	409	36	373	409	0
Qatar Finance and Business Academy of Qatar with Northumbria University	Public	272	106	166	0	272
Virginia Commonwealth University School of the Arts in Qatar	Qatar Foundation	333	136	197	0	333
AFG College with the University of Aberdeen	Private	339	171	168	132	207
Stenden Qatar-University of Applied Sciences	Private	248	116	132	0	248
Total		30,495	8,041	22,454	8,334	22,161

5.2 Sample and Data Collection

All undergraduates at participating HEIs who had declared an area of study were invited to participate in an online survey via their institutional email address. Data was collected from November to December during fall 2020 near completion of the third semester of forced online learning. The survey included informed consent and was voluntary with the option to exit at any time. The study population consisted of 30,495 undergraduates (male = 8,041 and female = 22,454). Study participants were *n* = 1,825 undergraduates comprised of 482 males

(26.4%) and 1,343 females (73.6%), which is representative of the population. Furthermore, there were 1,119 study participants (61.3%) from non-STEM disciplines and 706 participants (38.7%) from STEM disciplines, which reflects the higher percentage of non-STEM students in the population. The survey response rate was 6 percent, and the sampling margin of error was ± 2%. The institutional review board did not permit the researchers to ask respondents to identify their institution; consequently, this study deals with aggregate data from those institutions who confirmed their participation.

5.3 Instrument

The researchers adapted a student survey from the widely used QLT course evaluation rubric (California State University, 2021) to explore students' perceptions of key aspects of quality online teaching and learning. The QLT rubric is grounded in Chickering and Gamson's (1987), *Seven Principles of Good Practice in Undergraduate Education,* which presents a philosophy for quality teaching and learning (whether face-to-face or online). QLT is commonly used by instructional designers, faculty developers, and faculty, particularly those new to online learning, to effectively design and deliver online, blended, and flipped courses (Cain, 2017). Due to the length of QLT (9 sections comprised of 53 objectives) and the technical language of the rubric, the researchers condensed the sections based on five overlapping themes present in the rubric to construct the student survey; Consequently, the survey sub-scales were: (1) Course Design/Materials, (2) Assessment and Evaluation, (3) Instructor Behavior, (4) Student Behavior, and (5) Tools and Technologies with a sixth scale for Overall Satisfaction. The survey consisted of 27 Likert-type items adapted from the QLT objectives using a scale of 1 to 5 (1 – strongly disagree to 5 – strongly agree). The survey was reviewed by an expert panel of faculty, staff, and administrators from three institutions who had extensive experience in either survey design, course/instructional design, or online pedagogy. The review process resulted in the rewording of several items to be more student friendly. Information on the 27 individual items is provided later in Table 4. A confirmatory factor analysis (CFA) was performed to evaluate the construct validity of the instrument. The results of the CFA are reported below.

6. Data Analysis

The current research utilizes the partial least squares path modeling (PLS-PM) procedure using SmartPLS 3 software (Hair et al., 2016). PLS-PM was selected because of its ability to estimate complex cause-effect relationship models with latent variables. This technique is appropriate when all components are measured through a questionnaire. Compared to other similar procedures like regression analysis, this procedure is more powerful. It investigates linear causal relationships among variables while concurrently minimizes bias caused by measurement error (Ullman and Bentler, 2003). The model was assessed and interpreted in two stages: (1) the measurement model, which assessed the relationship between observed data and latent variables and (2) the structural model, which assessed the relationship between latent variables (Benitez et al., 2020, Henseler, 2018).

6.1 Assessment of Measurement Model

The researchers assessed the convergent validity of survey items through a confirmatory factor analysis. According to Hair et al. (2019), the standardized factor loading for all items should be greater than 0.7. As shown in Table 2, the standardized factor loadings of all the constructs in the model are between 0.706 and 0.904.

Cronbach's alpha and composite reliability were measured to evaluate construct reliability. According to Hair et al. (2019), the minimum acceptable value for both Cronbach's alpha and composite reliability is 0.70. Table 3 shows the range of Cronbach's alpha values are between 0.751 and 0.937, and the range of composite reliability values are 0.842 and 0.947. For convergent validity, the researchers adhered to the suggestions of Henseler et al. (2014), which suggests the average variance extracted (AVE) should be greater than or equal 0.50. Table 3 shows the AVE values are greater than 0.50. Discriminant validity was measured using Fornell Larcker's (1981) criterion, which suggests the square root of AVE of each factor (main diagonal) must be greater than the absolute value of their correlation coefficients (off-diagonal). Table 3 shows the square root of AVE for all factors are greater than the correlation coefficients in the corresponding rows and columns.

Table 2: Factor loadings of constructs

Constructs	Code	SL	SE	t-values
Course Design/Materials (CDM)	CDM1	0.816	0.011	77.136
	CDM2	0.820	0.010	84.478
	CDM3	0.864	0.008	114.153
	CDM4	0.848	0.007	113.362
	CDM5	0.803	0.011	76.392
	CDM6	0.808	0.010	81.365
	CDM7	0.840	0.007	118.807
	CDM8	0.772	0.012	64.462
	CDM9	0.762	0.012	61.677
Student Behavior (SB)	SB1	0.802	0.010	82.861
	SB2	0.749	0.014	52.860
	SB3	0.766	0.013	56.865
	SB4	0.706	0.016	43.354
Instructor Behavior (IB)	IB1	0.840	0.009	90.664
	IB2	0.895	0.006	153.814
	IB3	0.867	0.007	129.282
	IB4	0.855	0.008	106.520
Assessment/Evaluation (AE)	AE1	0.801	0.011	73.519
	AE2	0.888	0.006	144.684
	AE3	0.854	0.009	90.630
	AE4	0.904	0.005	180.262
Tools and Technologies (TT)	TT1	0.863	0.008	113.852
	TT2	0.832	0.010	82.650
	TT3	0.789	0.014	54.487
Overall Satisfaction (OS)	OS1	0.881	0.004	208.047
	OS2	0.875	0.006	145.403
	OS3	0.783	0.013	58.413

Notes: SL= Standardized loadings, SE = Standard error, t-values are significant at the level of 0.1%

Table 3: Measurement statistics for instrument validity and reliability

Latent Constructs	α	CR	AVE	Latent Constructs					
				CDM	SB	IB	AE	TT	OS
CDM	0.937	0.947	0.665	**0.815**					
SB	0.751	0.842	0.572	0.743	**0.757**				
IB	0.887	0.922	0.747	0.794	0.734	**0.864**			
AE	0.884	0.921	0.744	0.781	0.685	0.803	**0.862**		
TT	0.771	0.868	0.686	0.736	0.645	0.702	0.738	**0.828**	
OS	0.808	0.884	0.718	0.639	0.587	0.610	0.642	0.637	**0.847**

Table 4 below shows the descriptive statistics, relative importance index (RII), and rank of items based on RII value for the 27 items included in the questionnaire. The item means ranged from 2.59 to 3.84. The RII values ranged from 51.86% to 76.82%. According to RII, the highest five ranked items belong to "Tools and Technologies" and "Course Design"; Those items were "TT3", "CDM2", "CDM5", "TT1", and "CDM1", with RII values that ranged between 75.03% and 76.82%. Conversely, the lowest five ranked items belonged to "Assessment/Evaluation", "Instructor Behavior", "Student Behavior" and "Overall Satisfaction". Those items were "AE3", "AE2", "IB1", "SB2", and "OS2", with RII values that ranged between 51.86% and 61.88%.

Table 4: Descriptive statistics and relative importance index (RII) of survey items

Code	Items	Mean	SD	RII (%)	Rank
CDM1	My online courses included clear instructions on how to get started, including how to navigate the course	3.75	1.21	75.03	5
CDM2	My online courses provided contact information for the instructor and/or the program/department	3.81	1.24	76.14	2
CDM3	My online courses provided clear course objectives	3.74	1.19	74.74	6
CDM4	I understood what was expected of me in terms of my participation in online courses	3.59	1.29	71.86	11
CDM5	My online courses provided clear instructions for completing assignments in a timely manner	3.80	1.19	75.93	3
CDM6	My online courses provided clear rubrics that helped me understand how I would be graded on assignments/assessments	3.65	1.26	73.06	7
CDM7	The content of my online courses helped me deepen my understanding of the course topics	3.29	1.33	65.82	19
CDM8	My online courses utilized a variety of sources that supported my learning (articles, videos, tutorials, websites, etc.)	3.62	1.22	72.41	10
CDM9	My online courses provided links to help me access campus support and resources	3.58	1.24	71.51	13
SB1	I had many opportunities to participate in group/class discussions during online classes	3.65	1.25	72.97	8
SB2	I visited my instructors during their online office hours	2.96	1.29	59.23	26
SB3	I utilized the online support and resources provided by my institution (i.e., library, writing/research support, counseling, etc.)	3.15	1.25	63.07	21
SB4	When taking an online course, I prefer to join live video lectures	3.64	1.38	72.87	9
IB1	My instructors provided me with frequent feedback on my progress and performance throughout my online courses	3.07	1.28	61.39	25
IB2	My instructors provided feedback that helped me improve my learning	3.13	1.29	62.56	22
IB3	During my online courses, I was usually able to get timely help when I had questions	3.44	1.30	68.81	18
IB4	My instructors were able to manage group discussions effectively	3.50	1.21	70.06	16
AE1	My online courses included a variety of assessments/evaluations	3.58	1.20	71.52	12
AE2	The grading in my online courses was fair	3.09	1.37	61.76	24
AE3	My grades were accurate reflections of my learning	3.09	1.34	61.88	23
AE4	The assessments used in my online courses helped me keep track of my own progress	3.25	1.30	65.09	20
TT1	I had the technology skills needed to succeed in online courses	3.75	1.21	75.03	4
TT2	My instructors had the technology skills needed to teach online	3.50	1.23	69.99	17
TT3	I had adequate internet access/devices to participate in online courses	3.84	1.14	76.82	1
OS1	I am confident in my ability to succeed in online learning	3.54	1.36	70.85	15
OS2	I prefer online learning over face-to-face learning	2.59	1.61	51.86	27
OS3	I would like to have the option to take some or all of my courses online in the future	3.57	1.54	71.35	14

6.2 Structural Model Assessment

The structural model was assessed by analyzing the variance inflation factor (VIF) values, coefficient of determination (R^2) and the predictive relevance of the structural model (Q^2). According to Hair et al. (2016),

to have minimal collinearity, obtained VIF values must be less than 5. The VIF values for the structural model ranged from 1.035 to 3.887. The coefficient of determination (R^2) estimates the total variance explained, which in turn estimate the model predictive accuracy. In the current study, the R^2 statistic was 0.508 indicating the total effect size for the structural model is moderate (Henseler et al., 2009). Finally, the predictive relevance of the model (Q^2) estimates the quality of the PLS path model. Since the Q^2 statistic is greater than the threshold limit of zero ($Q^2 = 0.344$), the predictive relevance of the structural model is acceptable (Henseler et al., 2009).

6.3 Model Fit

Several fit statistics were used to assess the structural model, namely standardized root mean square residual (SRMSR), root mean square error of approximation (RMSEA), goodness of fit index (GFI), and the comparative fit index (CFI). According to Cangur and Ercan, (2015) the acceptable threshold for the value of SRMR for a good fit is less than 0.08. Steiger, (2007) suggests a value of RMSEA of less than 0.07 is needed for a good fit, and Hooper et al. (2008) hold that both GFI and CFI values must be greater than 0.95. As reported in Table 5, the value of SRMR was 0.023; the value of RMSEA was 0.044; the GFI value was 0.955, and the CFI value was 0.976. Consequently, the model is a good fit according to all four fit indices.

Table 5: Fit indices for the structural model

SRMR < 0.08	RMSEA < 0.07	GFI > 0.95	CFI > 0.95
SRMR	RMSEA	GFI	CFI
0.023	0.044	0.955	0.976

6.4 Hypotheses Testing

This study sought to explore the perceptions of male and female students as well as STEM and non-STEM students toward various aspects of online learning and to determine whether gender or discipline effects overall satisfaction. Moreover, this study examined the influence of students' perceptions of remote learning on overall satisfaction. To test the specific research hypotheses, a structural equation model (SEM) approach was used. For the structural model of this study, the p-value of the path coefficients were found using a PLS process with a bootstrapping procedure, which consisted of 10000 bootstrap samples and 1825 bootstrap cases. The path coefficients, standard errors, t-values, and p-values are shown below in Table 6.

Table 6: Structural model results

Structural path*	Path coefficient	Boot S.E	t-value (bootstrap)	p-value
Gender (Male) ---> CDM	0.029	0.024	1.199	0.231
Gender (Male) ---> SB	0.019	0.024	0.787	0.431
Gender (Male) ---> IB	0.073	0.024	3.066	0.002
Gender (Male) ---> AE	0.078	0.024	3.308	0.001
Gender (Male) ---> TT	0.061	0.023	2.654	0.008
Gender (Male) ---> OS	0.062	0.016	3.797	0.000
Discipline (STEM) ---> CDM	-0.047	0.024	1.980	0.048
Discipline (STEM) ---> SB	-0.109	0.023	4.674	0.000
Discipline (STEM) ---> IB	-0.102	0.023	4.362	0.000
Discipline (STEM) ---> AE	-0.111	0.023	4.729	0.000
Discipline (STEM) ---> TT	-0.063	0.023	2.701	0.007
Discipline (STEM) ---> OS	-0.084	0.017	4.973	0.000
CDM ---> OS	0.180	0.035	5.128	0.000
SB ---> OS	0.129	0.029	4.437	0.000
IB ---> OS	0.033	0.036	0.911	0.362
AE ---> OS	0.190	0.036	5.352	0.000
TT ---> OS	0.250	0.030	8.296	0.000

*Reference group for the variable gender is "female" and for discipline is "non-STEM"

According to Table 6, there was a significant relationship between gender and perceptions of instructor behavior, assessment and evaluation, tools and technologies at the level of 5%. Likewise, there was a significant relationship between gender and students' overall satisfaction with remote learning. Since the reference group for the variable gender is "female", and the path coefficients are positive, this means that males have more positive perceptions of instructor behavior ($\beta = 0.073$), assessment and evaluation ($\beta = 0.078$), tools and technologies ($\beta = 0.061$) and were overall more satisfied ($\beta = 0.062$). However, the relation between gender and perceptions of course design/materials and student behavior was not significant (p-value > 0.05).

Additionally, there was a significant relationship between discipline and perception of course design/materials, assessment and evaluation, instructor behavior, student behavior, and tools and technologies at the level of 5%. Similarly, there was a significant relationship between discipline and students' overall satisfaction with remote learning. Since the reference group for the variable discipline is "non-STEM", and the path coefficients are negative, this means non-STEM students have more positive perceptions of course design/materials ($\beta = -0.047$), students' behavior ($\beta = -0.109$), instructor behavior ($\beta = -0.102$), assessment and evaluation ($\beta = -0.111$), tools and technologies ($\beta = -0.063$), and were overall more satisfied ($\beta = -0.084$).

Finally, the results indicate that participants' perceptions of tools and technologies ($\beta = 0.250$), had the highest significant effect on students' overall satisfaction with remote learning followed by their perceptions of assessment and evaluation ($\beta = 0.190$), course design/materials ($\beta = 0.180$), and student behavior ($\beta = 0.129$). The only insignificant factor was participants' perceptions of instructor behavior ($\beta = 0.033$) since the p-value was greater than 0.05.

7. Discussion

7.1 Influence of Gender on Perceptions and Satisfaction

Although Harvey and Parahoo (2017) claim learners' gender is less relevant to studies of online learning among technologically adept millennials, study findings suggest that it influences students' perceptions of online learning as well as their overall satisfaction. Specifically, of the five aspects of online learning explored in the study, male students' perceptions of instructor behavior, assessment and evaluation, and tools and technologies were significantly more positive compared to females. Additionally, male students were more satisfied overall with their remote learning experiences throughout the pandemic. There was no statistically significant relationship between gender and course design/materials or student behavior.

These findings seem to confirm earlier studies of technology-supported learning, which report that male students have more positive online experiences (Tucker, 2014; Lin et al., 2012). It is worth pointing out, however, that many of these studies were conducted among learners who had chosen the online format voluntarily, which is not the case in the current context. Furthermore, because this study took place in an ERT setting, instructors likely lacked sufficient time to create online environments that properly account for different learning styles or learner preferences (Senel and Senel, 2021). Studies conducted among faculty at Gulf universities during the pandemic, for example, reported that instructors perceived themselves to be underprepared for online teaching and believed they needed more professional development, particularly regarding e-assessments (Guangul et al., 2020; Sharadgah and Sa'di, 2020).

Another explanation for study findings is that females in Gulf countries bear the primary responsibility for domestic issues. Paired with the stresses of an ERT environment, this may have impacted female students' perceptions of online learning, particularly high stakes aspects such as assessment and evaluation. Prior to the pandemic, Golkowska's (2014) study of Arab women in the Gulf reported that Qatari women in HE struggled to balance the responsibilities and expectations of university and family. This already difficult balance was likely exacerbated by the extreme mandates issued in response to the COVID-19 outbreak. To illustrate, Al-Rabiaah et al., (2020), reported higher stress levels among female students at Saudi universities during the pandemic. Similarly, researchers at the Institute for Population Health at Weill Cornell Medicine-Qatar found that elevated stress levels among university students during the pandemic was significantly associated with being female (Cheema et al., 2020).

More research is needed to confirm study findings, and the researchers particularly encourage qualitative studies aimed at gaining a deeper understanding of female students' perceptions of the aspects of online learning explored in this study. More studies are also needed investigating gender and perceptions of online learning during the pandemic at other institutions and in different countries. Furthermore, study findings suggest a need for faculty professional development and for careful consideration of how well the online learning environment that is created serves the different genders (Carr Chellman, 2014). While an ERT context arguably provides some justification for a lack of preparedness, we should learn from these pandemic experiences. It is imperative that we work toward a system allowing for a seamless transition between face-to-face, hybrid, and fully online learning that can be utilized in the event of future crises.

7.2 Influence of STEM/non-STEM Discipline on Perceptions and Satisfaction

Study results also showed that students in STEM disciplines had more negative perceptions of all the aspects of online learning explored. Furthermore, results showed that STEM students were less satisfied overall with their online learning experience throughout the pandemic. Study findings are consistent with literature regarding online STEM instruction during the pandemic. In a national survey investigating undergraduates' perceptions of online learning during the COVID pandemic, STEM students perceived lack of face-to-face interaction and the ability to do hands on experiments as their greatest challenges (Means, Neisler, and Langer Research Associates, 2020). Likewise, Karim (2021) investigated environmental engineering students' perceptions of their online learning experiences during the pandemic and reported overwhelmingly unfavorable responses, particularly regarding online assessment; however, regarding instruction, the study results did suggest online synchronous delivery as an acceptable, short-term option.

The most plausible explanation for STEM students' significantly more negative perceptions of online learning during the pandemic is that STEM learners highly value interaction and collaboration in their online learning experiences (Chen, Bastedo, and Howard, 2018). Because of the sudden shift online, universities and instructors lacked the time, and possibly skills, needed to reconstruct the "sophisticated educational ecosystem" they know is necessary for the optimal learning experience (Mohmmed et al., 2020, p.2). While distance learning is more than capable of delivering STEM education under ideal circumstances (i.e., properly trained instructors, well designed courses, willing students, etc.), STEM instruction during the pandemic was far from ideal. Rather, STEM instructors were tasked with converting hands-on, experiential learning to a remote interface essentially overnight, and students were tasked with receiving instruction and processing information in an entirely new way against their choice (Gregory, 2020). It is not surprising under these circumstances that STEM students' perceptions of online learning are less than desirable.

These findings are alarming considering the global advocacy for STEM education (American Institutes for Research, 2016) and our increasing reliance on online learning. Given there are relatively few studies investigating the unique challenges of delivering STEM instruction online and the grim findings from research on STEM instruction during the pandemic, there is an urgent need for continued research. Additionally, the researchers did not explore possible differences in students' perceptions based on synchronous and asynchronous online instruction; therefore, replications of the current study taking this into account are encouraged. The use of synchronous virtual classrooms may prove a viable solution for ensuring the interaction and collaboration highly valued by STEM learners is preserved in emergency settings. Furthermore, clear contingency plans for ERT were scarce in general leading into the COVID-19 pandemic and essentially non-existent for the delivery of STEM instruction (Meyer and Wilson, 2011). Consequently, the researchers urge traditional HEIs to draw from studies exploring STEM instruction throughout the pandemic and from current best practices for STEM online courses to formalize contingency plans regarding STEM instruction in ERT settings.

7.3 Factors Influencing Overall Satisfaction

Of the five aspects of online learning explored in this study, results showed that learners' perceptions of tools and technologies, assessment and evaluation, and course design had the greatest influence on students' overall satisfaction. These findings are compatible with existing research. For example, studies have reported that effective use of technology enhances online learning and subsequently learner satisfaction (JISC, 2018; Shieh and Cefai, 2017). Studies have also shown that satisfaction with online learning is significantly influenced by students' clear understanding of course assessments (Wang et al., 2006) and being assessed in a variety of ways (Richards-Babb et al., 2015). Finally, research has shown that quality course design optimizes online learning experiences and increases student satisfaction (Placencia and Muljana, 2019).

These findings provide insight regarding what could be considered as core components of ERT. However, because ERT occurs under crises conditions that are either mitigated or exacerbated by the geographic, cultural, or economic context, a one-size fits all approach would likely miss the mark. In remote regions or in impoverished communities, ERT may need to account for a lack of accessibility or connectivity necessary to carry out the basics of sending and receiving learning materials, while in wealthy Gulf countries, for instance, and depending on the source of the crises, ERT may involve securing synchronous virtual classrooms. The literature on ERT is largely concerned with quickly providing *temporary* access to instruction and instructional support. However, the COVID-19 pandemic has revealed that ERT can persist for relatively prolonged periods.

Consequently, the researchers encourage colleges and universities to consider the pandemic research relevant to their unique contexts to tailor ERT to their specific needs.

8. Limitations and Further Research

The limitations of this study could be useful in guiding further research. Our results are limited to students' perceptions of their online experiences *overall*, after three semesters of remote learning. Therefore, we recommend researchers to investigate the structural model used in the current study upon students' completion of a hybrid/online course where measures of satisfaction can be directly correlated to a given course and/or instructor. Another limitation of this study is that it measured students' experiences with online learning in courses that were not designed as online courses. The sudden transition online likely left many instructors with insufficient time to create their ideal online course. Future studies could implement the model for courses designed as blended/hybrid/online courses to explore possible similarities. Finally, similar studies at other institutions and in other countries are needed to confirm study findings and inform post-pandemic planning in HE. Further studies differentiating between different fields of study among STEM students, especially those which require lab time (e.g. chemistry) and those which do not (e.g. mathematics) would be of interest. Likewise, studies of instructors' experiences with online learning are needed as well as studies comparing these variables among students and faculty.

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Quality Indicators and Models for Online Learning Quality Assurance in Higher Education

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Abstract: In the scenario of Covid-19, the online learning capacity has increased much more than the face to face or traditional learning. Due to the increased capacity of online learning in higher education, the quality of online learning has serious concerns. To achieve the minimum requirements of quality in online learning for sustainable development, it is important to review the quality assurance principles and strategies. A brief review of the literature was conducted to define the quality of online learning, presented some quality assurance indicators for online learning, and discussed some online learning models by selecting 27 published articles through inclusion and exclusion criteria for performing a systematic review of the literature. The review showed that learner-teacher interaction, learner's prompt feedback, learner's support service, applying appropriate media, tools for online learning, and planned documented technology application for the assurance of quality in online learning are important quality indicators. Some quality assurance models for online learning are also presented in this study for the implication of these models according to the learning requirement to ensure the online learning quality.

Keywords: Indicators, Quality Assurance, Higher Education, Sustainable Development

1. Introduction

Learning is a necessary part of progress and the advancement of a state (Hafeez et al., 2020). There have been two modes of learning: one is called face-to-face mode and the second is called online or blended mode of learning as described in the previous studies (Ajmal and Hafeez, 2021; Saira and Hafeez, 2021). The mode of distance or online learning in higher educational institutions has increased in recent years due to the advancement of technological tools and the spreading of the deadly Covid-19 Pandemic. Distance or online learning happens in environments where learners and teachers are conversating from space and time. In this type of learning mode, technology plays an important role (Martin and Bolliger, 2018).

In Covid-19 pandemic conditions, most the higher educational institutions have shifted their modes of learning from face-to-face mode to online mode. Due to the shifting of learning modes from face-to-face to online modes in higher educational institutions, the instructors and the students faced many challenges including the quality of online learning. The quality of learning is the most important element for the sustainable development of any country in the world (Dhawan, 2020).

Universities are facing significant challenges as a result of increased globalization, transparency, and sustainability consciousness (Salvioni, Franzoni, and Cassano, 2017; Crane et al., 2019). One of the helpful motivators is the use and effects of rapidly evolving technology. In higher educational institutions, a paragon shift is taking place during Covid-19 that mainly concerns how higher education institutions can approach customized and interactive online learning with learning as the primary concentration. Changes in pedagogical and didactic methods that concentrate on the learner and where course content could be accessed through transparency, collaborative learning, and networking are urgently needed in the Covid-19 conditions (Ortagus and Derreth, 2020).

To foster innovation, creativity, and excellence, education and research must be of high quality. Competition and cooperation in education and research are driven by improved efficiency, increased accountability, and transparency. In the international educational arena, universities must cooperate as well as compete. They must be viable not only in sense of their educational, communal, decision-making, and technical dimensions but too

in terms of working internationally as innovators and contributing to sustainable development. Enhancing university efficiency and modernizing universities must be on the agenda for both universities and decision-makers in this context (Markova, Glazkova, and Zaborova, 2017).

1.1 Problem Statement and Objectives of the Study

Due to present COVID-19 conditions, a growing number of higher educational institutions are discovering online delivery choices for course materials (Dias et al., 2020). Exploring present conditions and problems with the higher education system online learning is critical in order to provide a clearer context for ways to enhance the pupil's learning capacity and provide quality education. There are many features of online learning that can affect faculty implementation and course progress (Giatman, Siswati and Basri, 2020). The quality of education is the most important parameter for the sustainable development of a state. It is necessary for an institution to have a clear policy about the assurance of quality in online learning. Facilitating indicators for quality assurance in higher education institutions' learning process provides guidelines for the faculty members and students to work together to achieve the required quality education for sustainable development (Lynch et al., 2017). As many of the higher educational institutions are facing the problems in providing the online quality education due to the suddenly increased shifting of face to face mode of learning to online mode in Covid-19 conditions, the objectives of the current study are (i) To discuss the meaning of quality in higher educational institutions (ii) To present the various quality indicators necessary to achieve the required quality education in online learning (iii) To present some quality assurance models to be used in the different online learning environments to ensure the quality assurance in the online mode of learning in a higher education perspective.

2. Methodology

2.1 Procedure for Article Selection

The main purposes of the current systematic review research were to discuss the meaning of the quality in higher education, to present the quality indicators required for the quality assurance in online learning in higher education, and to present some models used to achieve the quality in online learning under different learning environments in higher education. To achieve these objectives, Scopus and Web of Science indexed databases were searched. In Web of Science and Scopus search engines, "Quality Assurance Indicators", "Online Learning Models" and " Higher Education" were entered as the main contents by selecting custom years from 2005-to 2021. The main reason for using these indexes listing articles was to explore a variety of research and review papers that are related to the quality assurance indicators and models in online learning mode for higher education. The search was completed from 10th to 27th June 2021. Based on the initial outcomes, 123 research and review articles were found. The particular inclusion criteria were implemented to limit the articles based on quality assurance indicators and models for online learning in higher education. The 1st criteria were to practice "Educational research" as a Scopus and Web of Science category. "Only items" as word documents and Pdf were the additional inclusion criterion. After using the inclusion criteria, 45 review and research papers were recorded. Specific exclusion criteria were then adopted in order to bring the research and review papers to be finally selected for the current study. The 1st criterion of exclusion was to reject more than once the repeated research and review papers. Secondly, papers not presented in the full text were to be omitted. The final criteria for exclusion comprised the elimination of papers that had no direct association with online learning. Finally, the main sample of this brief review of the research was obtained by selecting a total of 27 research documents. The article collection procedure is shown in figure 1.

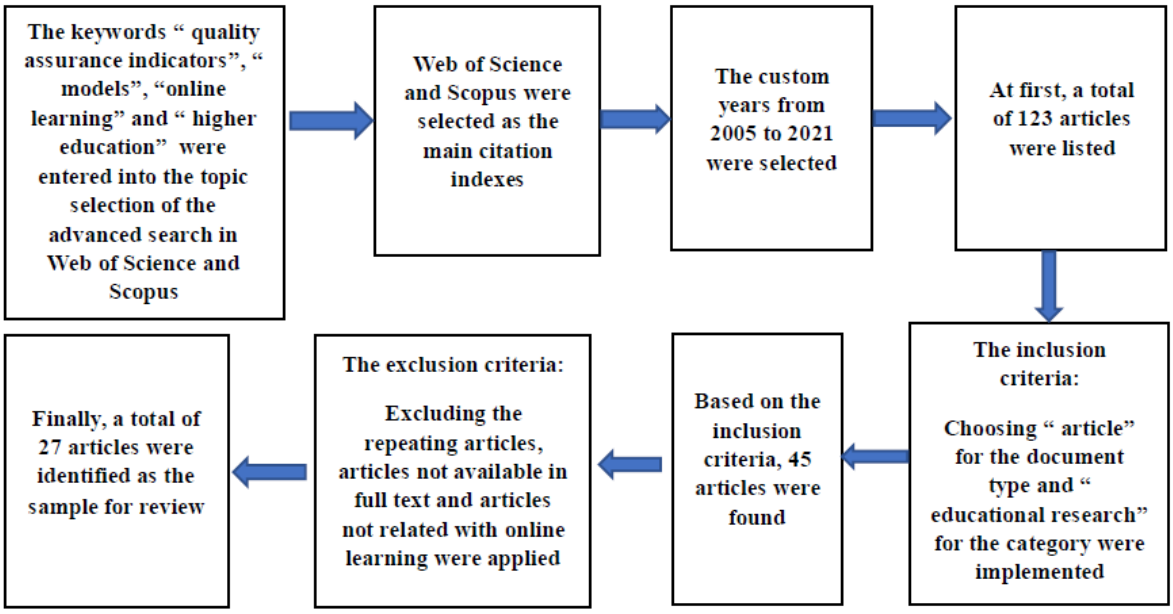

Figure 1: The Article Selection Procedure

3. Results

3.1 Meaning of Quality in Higher Education

To maximize the consistency of online learning services in practice and science, one must essentially understand what is the meaning of quality in higher education and how it is evaluated. The task of determining quality in higher education is fraught with difficulties. First, quality is a nebulous concept that can be interpreted in a number of ways based on the perspectives of various stakeholders (Mantravadi and Snider, 2017). When determining quality in higher education, there are four classes of stakeholders to consider: providers (funding agencies and the general public), students who are product consumers, output users (employers), and employees in the industry (administrators and academics). Each community has a unique viewpoint on the quality of higher education (Badia, Garcia and Meneses, 2018). For example, learners equate quality with the college they attend, the curriculum they participate in, and the course contents they complete. Managers, on the other hand, are concerned about the finished product's efficiency, which can be illustrated by a skilled employee pool. Therefore, all shareholders must be active in dialogue in order to guarantee that diverse viewpoints and requirements are taken into account when defining quality and attempting to create the values of quality in higher educational institutions (Welch et al., 2015). Another issue is that quality is a multifaceted term. As a result, restricting the term to a single sentence description is difficult. Such meanings may be lack context, one-dimensional and detailed, or be broad to operationalize in certain cases (Salman, 2017). A third issue is that quality is a complex, ever-changing quest for distinction that could be viewed in sense of a broader economic, educational, political, and social environment (Brenton, 2015). The classifications of quality in Higher education are shown in table 1.

Table 1: Classifications of the Meaning of Quality

Sr. No	Classifications	Definitions
1	Purposeful	Educational institutions' goods and facilities are compliant with a given vision or mission, as well as a group of criteria, necessities, or values, which may include those established by authorizing or governing bodies (Donnelli-Sallee, 2018).
2	Exceptional	Products and services for educational institutions achieve differentiation and exclusivity by adhering to strict guidelines (Wingo, Ivankova and Moss, 2017).
3	Transformative	Positive changes in learners' performance, as well as individual and professional ability, are influenced by educational institutional products and services (McCabe and Gonzalez-Flores, 2017).
4	Accountable	Educational organizations are held responsible to shareholders for making the best utilization of resources and delivering high-quality educational goods and services (Sharoff, 2019).

Identifying unique indicators that represent desired inputs (attentive faculty and staff) and outputs is one of the strategies for determining quality (employment of graduates). This strategy is reflected in a number of recent publications and quality assurance models (Crews and Wilkinson, 2015). The Quality Assurance Matters Rubric, for example, does not comprise a general description of the term quality, but rather precise criteria that express quality measures (Schultz and Pecheone, 2015). In the literature, there were over 50 different quality indicators. We divided the measures into four groups after analyzing them all: administrative, learner support, instructional, and learner success indicators as shown in table 2. The initial three categories are mainly concerned with the required outputs, such as educational opportunities for learners. The final category, learner success, is more concerned with results, such as learning gains, and represents current trends in evaluating learner's outcomes to ensure quality matters (Prieto-Rodriguez, Gore and Holmes, 2016).

Table 2: Quality Indicators Categories

Sr. No	Categories	Definitions
1	Organizational Indicators	A collection of quality measures that relate to an organization's administrative works, such as generating a relevant vision and mission, creating institutional reliability, meeting internal and external goals and expectations and acquiring capitals for optimal official functioning (Zineldin, Akdag and Vasicheva, 2011).
2	Learner Support Indicators	A collection of quality measures that relate to the readiness and awareness of learner support services such as how well student complaints are handled (Wong, 2012).
3	Instructional type Indicators	A collection of quality indicators that relate to the relevance of instructional content and the instructor's capability (Tam, 2014).
4	Learner Performance Indicators	A collection of quality measures that relate to learner involvement with curriculum, teachers, and academic staff, as well as improvements in awareness, skills, and capabilities that contribute to useful jobs (Iacovidou, et al., 2009).

3.2 Quality Assurance Indicators of Online Learning in Higher Education

3.2.1 Existing Frameworks of Online Learning in Higher Education

In connection to the design, distribution, operation, and assessment of online learning in higher education, (Khan's, 2005) octagonal structure presented 8 dimensions: pedagogical, technical, interface design, assessment, managing, capitals support, ethical and institutional. Pedagogy, according to his octagonal framework, discusses the teaching and learning requirements of online pupils, particularly the connection among course contents and suitable methods of delivery of instructions to permit pupils to attain the learning purposes. Technology support refers to technical setup, hardware, and software, as well as learning atmosphere and distribution of technological tools. Interface design incorporates aspects like the page and web design, navigation, accessibility, and content design however, this feature could be deemed too narrow in sense of institutional evolutions to improve online learning. Evaluation is the term used in North America for assessing learners, which we can classify as pedagogy. Management is concerned with staff, processes, and products, specifically the management team, online learning content transfer management, and online learning situation. resource support resource to account for the various types of services (both offline and online) that are accessible to learners. Communal and cultural diversity, the digital divide, and propriety are all topics that fall under the pre-view of ethics. Institution refers to the organization's readiness in perspectives of organizational and academic relationships, such as organization and transition, faculty, policy, academic staff support, and learner's services.

The eLPF (e-Learning Planning Framework) is a different online working tool that allows institutions and instructors to assess their online learning capabilities and recognize group involvement in digital learning. The framework defines 5 dimensions that essentially operate in tandem for an institution's online learning capability growth to be sustained over time. The vision of the institution, online learning leadership, and strategic planning are all examples of leadership and strategic direction. Curriculum, learning areas, digital citizenship, pedagogy, and evaluation are all part of learning and teaching. Learning communities and online learning inquiry are examples of professional learning. Tools and technologies, administrative assistance, and procurement are all part of the technologies and facilities. Beyond the classroom is the fifth dimension, which examines how institutions can collaborate with the local community to promote digital learning (Akyol, 2011).

A similarly significant aspect of high-quality online course content design and instructions delivery is guaranteeing that learners understand the criteria for good results. According to the Principles of High Expectations, reliable instruction should provide continuing and thorough descriptions of the associations among course contents learning objectives, and requirements required for representing expert levels of success. When presentation goals are articulated explicitly, learners not only have a greater level of understanding the of requirements needed for a good work conclusion, but they also attain insights into the anticipated skills required for real-world problem solving (Veeramani, 2010).

3.3 Guidelines to Evaluate Quality of Online Learning in Higher Education

According to the findings of research on international benchmarking on online learning in higher educational institutions, quality in online learning must be esteemed holistically and, to a greater degree, from the perspectives of learners and learning dimensions (Suárez-Perdomo, Byrne and Rodrigo, 2018). Benchmarking was emphasized in these projects as an influential tactical tool to support decision-makers in enhancing the efficiency and usefulness of organizational processes and, as a result, achieving the status of the best international learner in the higher education arena (Pentaraki and Burkholder, 2017). Online learning environments have grown in popularity among students, faculty, and administrators in higher education. Some learners may be attracted to online classes, while others may choose to participate in them (Money and Dean, 2019). Today, educators can create a variety of learning environments by combining a variety of resources to promote student learning and meet student interests or needs, as well as individual differences (Dziuban et al., 2018). The list of quality assurance indicators in online learning has been discussed in the following lines:

3.3.1 Interaction between Students and Teachers

In online learning, there are several types of interaction, including learner-learner interaction, learner–contents interactions, instructors–contents interactions, instructor–instructor interactions, content–content interaction, and pupil–instructor interaction (Amemado and Manca, 2017). While all of these types of interactions play a vital role in the online learning environment, student-teacher interaction was the most frequently quoted as a quality measure in the literature review (Wright, D'Alba and Jones, 2016). Interactions between students and teachers are particularly important in processes of health education and advancement. In personal health classes, for example, student-teacher engagement offers a platform for students to explore their health habits and the consequences of such behaviors with a health professional (Blaine, 2019).

3.3.2 Active Learning Techniques

Active learning strategies include engaging students in social activities that can result in improved “eagerness for online learning as well as attainment beside the course content expectations.” Strategies for active participation in online learning are mainly relevant to health-related learning and promotion. In order to foster safe online learning and decision-making capabilities, health instructors essentially find innovative means to enable pupils or groups of interested learners to evaluate their individual health-related behaviors. Many constructive learning approaches can be integrated into online courses or health education services (Hyun, Ediger and Lee, 2017).

3.3.3 Prompt Feedback

The vast majority of individuals favor instant knowledge of outcomes over delayed knowledge. This strategy is also adopted different for online programs; so that, timely feedback of pupils is an important quality measure of online learning programs. “communications from staff members that directly engage learners and provide timely feedback can provide to exchange ideas between learners and instructors and learners' consequent achievement in the course content.” Prompt feedback from learners is critical for reducing instructors’ often recorded lack of presence in online or distance learning courses. In this digital era, students can measure prompt feedback in minutes and in hours, while instructors can calculate it in days. It is significant to provide input time in the course contents outline (Davis et al., 2019).

3.3.4 Learners Support Services

To encounter the cognitive, affective, and administrative requirements of the learner, learner’s support services such as admissions, library admittance, and services, financial assistance, and deliberation are provided and these are key to any online learning program's success (Russo-Gleicher, 2013). It's critical to make learner support services accessible to online learning students, and it's a key quality indicator for the effectiveness of online learning. Since the organization controls and maintains several online learning-related support services, the program manager should look for ways to offer equitable student support services (Fedynich et al., 2015).

Faculty support benchmarks were created by the Institute for Higher Education Policy in 2011, and they include the following: the required technical assistance for the development of a course, Written tools to resolve any issues with students accessing electronic course data, ongoing teacher training opportunities and adequate support in the transition from conventional to online instructional approaches are all available. Providing sufficient support materials and preparation to faculty would aid in improving the standard of online learning instruction (Arasaratnam-Smith and Northcote, 2017).

3.4 Evaluation and Assessment of Programs in Higher Education

In order to improve and ensure quality in higher education, it is important to evaluate and analyze the programs of online learning in higher education (Jirgensons and Kapenieks, 2018).

3.4.1 Process of Evaluation of online programs in Higher Education

Online or Distance Learning in Higher Education
Many terms have been found, both in research and practice, to refer to teaching and learning over the Internet. These include distance education and online education. Moore, (2003) defined distance education as all forms of education in which all or most of the teaching is conducted in a different space than the learning, with the effect that all or most of the communication between teachers and learners is through communication technology. Distance education, under this definition, then includes non-Internet technologies such as video or correspondence learning. Since the three evaluation levels being discussed (i.e., programs, courses, and student learning) are all Internet-based, the term online education will be used.

4. Evaluation

There have been many arguments about the correct use of the term evaluation versus the term assessment. One position is that evaluation is different from assessment. Some researchers, especially in North America, use the term evaluation to refer to studies implemented to examine and report on the strengths and weaknesses of programs, policies, organizations, and the like to improve their effectiveness (American Evaluation Association, 1999); Assessment, on the other hand, is used to refer to the formation of value judgments to determine the significance, the importance, the value of learning and knowing, and using a variety of procedures to obtain information about individual's learning (Delandshere and Arens, 2003). Another position regards assessment as a subset of evaluation and a valuable tool in the larger evaluation activity (Thompson and Irele, 2003). As Thompson and Irele, 2003 argued, Assessment asks 'How much?' whereas evaluation asks Is it good enough? and If not why not? In this paper, we used evaluation as a generic term to include evaluation done at the program level, the course level, and the student learning level.

4.1 Macro-level evaluation

Macro-level evaluation refers to the evaluation of the entire online education program. Macro-level evaluation helps ensure the accountability and quality of a program (Fitzpatrick, Sanders and Worthen, 2004). Such evaluation is important for an online education program for several over-arching purposes which include: (a) justifying the investment of resources, (b) measuring progress toward program objectives, (c) measuring issues of quality and effectiveness, (d) providing a basis for improvement, and (e) informing institutional strategic planning and decision making (Thompson & Irele, 2003).

4.2 Meso-level evaluation

Meso-level evaluation refers to the evaluation of individual online education courses. Central to this level of evaluation is the question of what criteria should be used to evaluate the online courses and instruction.

4.3 Micro-level evaluation

The focus of the micro-level evaluation is on the individual online learner. A review of the relevant literature suggests that evaluation of the individual learner typically falls into one or more of the following three categories: (a) the learner's perception of online learning, (b) the learner's process of online learning, (c) the learner's product from online learning, (d) Clear Audience Analysis and (e) tools and media that are appropriate.

4.4 Learner's Perception

When learners enroll in an online course, they enter into an educational experience very different from the usual classroom-based face-to-face environment. Current online education courses are usually mostly or entirely text-based, asynchronous, and have multiple discussion threads. As such, course administrators and instructors are

usually interested to know how their learners "feel" about the course experience. Because of the difficulty of reaching online learners who are often separated by space or time, evaluation of learners' perceptions typically involves questionnaire surveys. Some of the common evaluation questions pertinent to this purpose include: Does the learner enjoy the whole course?

What attitudes do the learners have towards online learning before, during, and after the whole course?

4.5 Learner's Process

While the learner's perception of online learning can be helpful and useful information, it is usually not sufficient to end just there. Most instructors would also want to know about their learners' engagement in online learning through many different processes such as collaboration, cognition, problem solving and others. One common method of determining such processes is through a content analysis of the learners' online discussion transcripts. Table 3 lists some of the content analysis models for evaluating these processes.

Table 3: Content Analysis Models for Evaluating Student Processes in Online Higher Education

Sr. No	Processes	Content analysis models
1	Cognitive processes	Newman, Johnson, Webb and Cochrane (1997)
2	Meta-cognitive processes	Henri, (1992)
3	The social construction of knowledge	Gunawardena, Lowe and Anderson (1997)
4	Collaboration processes	Murphy, (2004)
5	Problem-solving processes	Murphy, (2004)

4.6 Learner's Product

Typically, the evaluation of the learner's product of online learning is used to determine how much knowledge or skills he or she has acquired at the conclusion of the course. This is typically administered in traditional ways such as end-of-course tests, final papers, and final projects. Alternative methods include portfolios and performances (Hew, et al., 2004).

4.7 Clear Audience Analysis

The audience's needs (including those of the institution, teachers, and learners) should be defined before developing a high-quality online course. The learner's characteristics, geographic location, accessible technology, and priorities, as well as the missions and goals of the learning organization, the budgets that must be recovered, the charges of distribution, the political climate for the learning organization at the time, academic faculty compensation and market competition, must all be defined. In the design, implementation, and assessment of online course contents, a holistic approach to identifying requirements and evaluating the envisioned audience would guarantee that the requirements of all stakeholders concerned are discussed and fulfilled (Holland, 2019).

4.8 Tools and Media that are Appropriate

The collection and utilization of suitable resources and media are needed for the creation of high-quality online learning. The most suitable medium for providing instruction to students through online learning does not always imply the most up-to-date, most expensive technology. There are a number of variables to consider, including learner's autonomy, forms of interactions, and media charge. Finally, technical resources and media should be selected based on how it helps or does not enable other essentials of course contents to behave in a system context where all the essentials or variables interact. To determine what is suitable for the quality of online learning, the instructor must first evaluate the audience's needs to determine what best suits those needs, and then look at previous technology and how these forms of media offered admittance while encouraging learner autonomy, engagement and cost usefulness (Panigrahi, Srivastava and Sharma, 2018). The summary of the quality assurance indicators for online learning is illustrated in table 3.

Table. 3: Summary of Quality Assurance Indicators for Online Learning in Higher Education

Sr. No	Indicators
1	Learners Perspectives
2	Learner–Instructor interaction
3	Prompt feedback
4	Learner support services
5	Evaluation and Assessment of Programmes

Sr. No	Indicators
6	Clear Analysis of Audience
7	Quality assurance is ensured by a documented technology strategy.
8	Institutional infrastructure and institutional support
9	Guidelines for Course Layout
10	Active Learning Strategies
11	Respect for various modes of learning
12	A compelling case for online learning that is related to the institution's mission
13	Tools and media that are Appropriate for Learning
14	Reliability of Technology
15	Guidelines for course development are being implemented, and instructional materials are being reviewed.

4.9 Models for Quality Assurance in Online Learning

Some of the models used for the assessment and evaluation of quality assurance in online learning have been illustrated in table 4.

Table 4: Models for Quality Assurance in Online Learning

Model Name	**Reference**	**Characteristics of Model**	**Dimensions for Assessment**
eMM (E-Learning Maturity Model)	Marshall, 2006	This model serves as the foundation for improving the quality of online learning courses. It was created to assist organizations in determining their online learning capabilities and assessing the efficiency of their e-learning.	Learning Development Support Evaluation Organisation
CAPEODL Model	Khan, 2004	This model emphasizes crucial modification of online learning products and facilities by gathering academic data on all facets of e-learning programs from their inception to completion.	Educational Technical Assessment Administration Resource Assistance Ethical Institutional
Evaluation and Assessment Logic Model	Price, Alkema, and Frank, 2009	This model supports in planning, implementation, evaluation, and communication of the program to all stakeholders. Five acts are proposed in online learning programs.	Entrances Outputs Supposition Exterior Factors
A conceptual model for determining the quality assurance of online learning	Raeesi, Qorbani and Akhgar, 2010	This model provides a set of indicators for evaluating the information-sharing process in online learning courses. These indicators are distributed into 2 categories: (1) indicators of online learning quality assessment in terms of information sharing (2) indicators of information sharing that have a direct influence on the e-learning process.	Each set of indicators is evaluated from three different perspectives: Individual Organizational Technical
PDPP model	Zhang and Cheng, 2012	The PDPP Model is constructed on the Stuffle-beam evaluation model as well as online software characteristics. It proposes four-dimensional and 24-indicators for evaluating the quality of these programs.	Planning Assessment Development Evaluation Process Evaluation Product Evaluation
A conceptual framework for quality assurance of online learning	Ossiannilsson and Landgren, 2012	The model's aim is to assist higher education institutions in developing, implementing, evaluating, and internalizing online learning in higher educational institutions.	Accessible Flexible Transparent Interactiveness Personalize Contribution Output
A conceptual model for online learning quality assessment	Giorgetti, Romero and Vera, 2013	This model suggests a set of parameters and dimensions for evaluating educational quality and improving it over time.	Institutional and administrative management Professional training Support for professional training

Model Name	Reference	Characteristics of Model	Dimensions for Assessment
A conceptual model for online learning quality assessment	Petkova and Radeva, 2014	The metrics for a general quantitative assessment and evaluation of the quality of online learning platforms are the subject of this model.	Interaction Institutional quality Staff support Institutional credibility Assurance mechanism Learner support

5. Discussion

Quality assurance of online learning in higher education is a major concern in Covid-19 conditions of many higher educational institutions operating only on traditional learning of face to face modes. . Due to the sudden outbreak of Covid-19, all the higher educational institutions have to change their modes of learning from face-to-face to online modes. Large-scale scale shifting of learning modes increased the challenges for most of the higher educational institutions having no pre-planned structure of online operating systems. One of the most important challenges was the assurance of quality education in online learning modes (Diep, Cocquyt, Zhu and Vanwing, 2017). In the framework of online learning in higher education, defining quality assurance remains to be a great challenge for most of the higher education institutional managers and stakeholders operating on face-to-face modes of learning. A review of related literature shows that there is yet no consent on defining the quality of higher education in the online learning environment, though there are melodies in how the quality of higher education in online learning is assessed and conceptualized in higher educational institutions (Husebø et al., 2018). The review of literature on the quality of education in online learning recommends that there are four comprehensive concepts of quality such as transformative, accountable, exceptional, and purposeful, and a group of quality indicators utilized to evaluate each comprehensive concept of quality in higher education (Ebner and Gegenfurtner, 2019).

In the current study, a review on defining the quality of higher education, quality assurance indicators for online learning in higher education, and different models used to improve and evaluate the quality of online learning in higher education has been done. The review of the literature indicated that quality is the set of standards that have to achieve for sustainable development. From an educational perspective, quality is the minimum required level for the learners that satisfies them and that is very important for sustainable development. In the present scenario of wide-speared COVID-19 pandemic disease, the higher educational institutions have shifted their modes of learning from face to face to online learning modes therefore, quality is most crucial concerns for higher educational institutions (Besser, Flett and Zeigler-Hill, 2020). Many researchers and instructors have indicated various quality assurance indicators for achieving quality education in online learning in higher educational institutions (Biasutti, 2017). These quality assurance indicators are very important to satisfy the requirement of the students in online learning. Some of the quality assurance indicators reviewed in this study are learners-instructor interaction, learner support services, assessment and evaluation of online programs, planned technology implementation policy for the quality assurance in online learning, and active learning strategies. Various models for online quality assurance in higher education have also been reviewed in this article. These models can be applied in different online learning environments to assess and evaluate quality assurance in higher educational institutions.

6. Conclusion

The quality assurance of higher education in online learning programs is the most critical discussion in many higher educational institutions operating face to face modes of learning before Covid-19 conditions due to the large-scale shifting of higher educational institutions from face-to-face learning modes to online learning modes. In the present study, the meaning of quality, quality assurance indicators, and some models used to assess and evaluate the quality of online learning have been discussed. Various indicators of quality assurance in online learning have been present to improve the quality of online learning. The main quality assurance indicators presented in the review are student-teacher interaction, documented plans for the implementation of technology in online learning, students' support center, and evaluation and assessment of quality in online learning programs. Some important models to assess and evaluate the quality of online learning are also presented in the current study to improve the efficiency of online learning. Further, such studies should be conducted to explore the ways to the assurance of online learning quality in the present pandemic conditions of Covid-19.

Conflict of Interest

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The Influence of Policy Formulation Contextual Factors on Implementation: South African White Paper 7 as a Case in Point

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Abstract: Using a qualitative historical research approach, this paper examines the contextual influences, including the formulation motive and their possible impact on policy implementation, of the South African (SA) e-Education White Paper 7 (WP7). A critical discourse analysis (CDA) was conducted on the policy and data was collected through semi-structured interviews (SSI) with purposefully selected participants. Findings of the study reveal tacit contradictions and tensions depicting a policy in contradiction with itself, carrying the hallmark of a symbolic policy. That is, a policy characterised by lack of direction, contradictions in its motive of formulation, no dedicated resources for its implementation, distorted communication resulting from the validity tests, and lack of "material consequences" (Rivzi and Lingard, 2009, p.8). The circumstantial context (socioeconomic and political) of its formulation, dictated to by the prescripts of the negotiated political settlement (NPS), that ushered in the new democratic South Africa (SA), is found to have taken precedence. It further overshadowed critical analysis on the educational needs, which would have informed a better strategic integration of Information and Communication Technology (ICTs) in education. The circumstantial context resulted in a lack of a common goal between policy actors and interest groups. This, to the extent that the former thought of capitalising on the donations of the latter for their own political interests, while the latter saw in the formulation of such policy a way of imposing Government spending in favour of their businesses. These circumstances may have contributed to the policy's failure to reach its set textual objectives and goal by 2013.

Keywords: e-Education, symbolic policy, policy formulation, policy implementation, historical research, active learning

1. Introduction

A new South African post-apartheid era (starting 1994) was ushered in following a pre-1994 negotiated political settlement (NPS). Educational reform was a key focus of the new democracy. The South African e-Education policy (referred to as White Paper 7 (WP7)) was one of many policies that were formulated within the first 10 years (1994-2004) of the post-apartheid South Africa. These policies embody the spirit of the NPS, characterised by the need to address both the legitimate expectations of the previously disadvantaged citizens and the 'no need for change expectations' by the previously advantaged (Jansen and Sayed, 2001).

Set to attain its set objectives and goal by 2013, WP7 is reported to have failed in its vision of transforming teaching and learning through information and Communication Technology (ICTs). Various value driven assessments contrasting WP7 three phases of planning cycle with the recorded achievements have suggested failure to achieve its set outcomes. The failure is characterised by, amongst others, lack/ scarcity of ICT resources in schools, negative attitude of teachers towards ICT integration, lack/ insufficient use of ICT for administration, and its use to change the traditional pedagogy of teaching and learning (TL) (Blignaut and Howie 2009; Pandayachee, 2017; Vandeyar, 2015; Mathevula and Uwizeyimana, 2014).

We argue that WP7 itself has not been interrogated sufficiently to understand the extent of its formulation. The relationship between the context of formulation and the implementation is well documented in public policy literature. Rivzi and Lingard (2009), for instance, note that public policies (PPs) are compromised documents that are influenced by the context of their formulation and embed their actors' ideological contradictions and tensions. Not understanding the compromised nature of public policies often results in misdirected interventions and a cycle of failure regardless of implementation readjustments.

2. Problem statement and rationale of the study

Known causes of WP7's failure, inclusive of those from the value driven assessments (Blignaut and Howie, ibid; Pandayachee, ibid; Vandeyar, ibid; Mathevula and Uwizeyimana, ibid.) and the lack of leeway for relevant adaptations and localisation by Mooketsi and Chigona (2014), are well documented. The value driven assessments only contrasted WP7's achievements against its set textual objectives. Mooketsi and Chigona

(2014) only highlighted but did not probe the context of WP7's formulation, nor any possible ideological contradictions and tensions. Currently, an understanding of the context of WP's formulation and its formulation motives are absent. This constitutes a gap towards a better and comprehensive grasp of the reasons behind WP7's purported failure. We, therefore, argue that known causes of WP7 failure are incomplete considering PPs' intrinsic and sealed actors' ideological tensions that are influenced by the context of formulation (Rivzi and Lingard, 2009). In response, this study sought to unravel the complexities of WP7's formulation through an understanding of its contextual factors, inclusive of its motives of formulation.

2.1 Research Questions

RQ1: How did the socioeconomic and political context of WP7's formulation influence its motive for formulation and to what extent has it remained consistent throughout the three dimensions (PTD) of PP formulation?
RQ2: How did the motive of WP7 formulation, viewed from the three dimensions (PTD) of PP formulation, impact on its implementation?

3. Literature review

3.1 Introduction

Understanding the context of both the formulation of any public policy and their implementation thereof is key in policy studies. In exploring the context of WP7's formulation, the literature on the post-apartheid socioeconomic and political context was sufficiently explored. Further review of the literature looked at ICT integration in education while a deeper exploration focused on public policies, as process, text, and discourse (PTD).

3.2 Post-apartheid socioeconomic contexts in South Africa

South Africa ushered in a new era in 1994 with the end of apartheid. This politically symbolic event did not end the unequal socioeconomic conditions of South Africans (SAs) (Kon and Lackan, 2008; Chisholm, 2012). Gallo (2020) opines that the legacy of apartheid is still present despite the event of 1994, and education is no exception. Inequality is still characterised by racial disparities and a "vicious cycle of poverty" (Siyongwana and Chanza, 2017, p.748; Chisholm, 2012). Persistent socioeconomic and political tensions are indicative of growing dissatisfaction and deepening of inequalities amongst SAs.

Transformative post-apartheid policies have not produced the expected results (Chisholm 2012, p.102). The need to understand the context of policy formulation, including their real motives, is therefore, necessary. Sayed (2000) highlights the two ways that captured SA educational policy discourse. They were both centred on a just and equitable society. They included: (1) the non-redistributive "historical rectification" discourse and, (2) the framing of "equity, justice and redress" in the notion of sameness. The former aimed at assuring protection to the beneficiaries of apartheid through a non-redistributive policy position while promising redress to the previously disadvantaged through bias distributive policy position. The latter aimed at building a non-racially new SA, the rainbow nation. Samoff (1996) in Sayed (2000) refers to this policy position as the breeding ground for symbolic policies. These early post-apartheid policies are referred to as "policy political symbolism" which formed the "overarching framework for education policymaking" (Jansen in Jansen and Sayed, 2001, p.6). Symbolic policies are defined as those designed with sole purpose of appeasing pressure and are characterised by their inability to steer action, lack of funding and resources and lack "material consequences", in view of their no-consequence posture in case of policy failure (Rivzi and Lingard, 2009, p.8).

3.3 Transforming teaching and learning: ICT integration

The integration of ICT in education presupposes "active learning" (AL) strategies. According to Wilke (2003), AL encompasses direct and active participation in knowledge creation, metacognition and problem solving. Sutherland et al., (2004), contend that it is not the availability of ICTs that results in AL, but rather the manner in which ICTs are used. Shaikh and Algannawar (2018, p.89) echo this in their contention that the "…use of technology tools and multimedia help enhance the atmosphere of the classroom". Such enhancements include opportunities for learning through collaborations, critical thinking and creativity in problem solving. According to Sutherland et al., (2004), the varied levels of uptake of the AL paradigm have made ICT in education initiatives unproductive in the past few decades. We may thus infer that transformation of TL through ICTs, is more about the TL paradigm that advocates a shift from a teacher centered (TC) to a learner centered (LC) approach to teaching and learning.

3.4 Public policy: process, text, discourse (PTD)

Public policy (PP) assumes a regulatory framework for the management of public goods (PG). Dionisio and Gordo (2006) contend that the notion of PG is associated with the theory of non-excludability (availability to all citizens) and non-rivalrability (uninterrupted supply). These incorporate the concepts of social welfare, equal access, and equity. Policy exists as a "*process*", "*text*" and "*discourse*" (PTD) (Rivzi and Lingard, 2009, pp.5-8).

Public Policymaking (PPM) is a contested terrain of contradictory ideologies, political bickering and contrasting socioeconomic pathways that ultimately culminate in compromised policy documents [as '*text'*] (Rivzi and Lingard, 2009; Birkland, 2019). The formulation of any PP involves contestations that are indicative of the socioeconomic and political context of the time and commences right at the stage of defining the social problem (Jann and Wegrich, 2007). These contextual influences remain omnipresent throughout all the stages of PPM [the *'process'*]. That is, from the context of influence (CI), through the context of text production (CTP) which seals and codes compromises and trade-offs, up to the context of practice (CP) (Rivzi and Lingard, 2009). Policy as *'discourse'*, is a social practice that embeds both the historical contextual reality inclusive of contradictory ideologies and tensions and current engagements and conversations related to the policy (Ball 2015). Karlberg (2005) contends that social practices are verbal communications and actions influenced by how any subject is considered and expressed. When engaging with policy through past, present or different contexts, inherent policy tensions that could have negatively affect implementation, may be diffused.

The context of practice, specifically the implementation stage, is often perceived as free of tensions and contradictions, often believed to be the easiest stage of the PPM process (Knoepfel et al, 2011). Rizvi and Lingard (2009) state that, given the coded nature of policy texts, policymakers cannot be certain that implementers will accurately decode the policy texts. This suggests that contradictions and tensions of policy formulators may arise during policy implementation, thus the need to thoroughly decode the text for successful policy implementation.

3.4.1 Policy actors

The tense engagements amongst policy actors during policy formulation compel policy analysts to seek a thorough understanding of the roles of key actors of PPM (KAPPM) (adapted from Knoepfel et al., 2011). Figure 1 depicts the roles of the KAPPM. The relationship among the actors is best understood through backward mapping:

- *End Beneficiaries (EB) actors*: These individuals experience the negative effects of the situation requiring the formulation of a PP but are unable to change it on their own. Learners, in the context of this study, represent the EB. Their support to such policy is understood in the context of the benefit they will derive from it, should it be implemented successfully. Supporting the EB are the interest groups (IGs) who are likely to experience positive effects of the policy, in case of its successful implementation (PAIGs) (Knoepfel et al. 2011). These include, in this case, computer manufacturers, vendors, software developers and the likes.
- *Target Group (TGs) actors*: These individuals are usually the root cause of the problem necessitating policy formulation. Policy implementation success usually depends on incentivised interventions targeting the change of behaviour of TGs, in relation to what the policy seeks to address. In the case of WP7, teachers and schools may form part of the TGs. Those that may be negatively affected by the successful implementation of the policy are likely to support and influence the TGs to resist the interventions. They are referred to as negatively affected IGs (NAIGs) (Knoepfel et al, 2011). Print media companies may form part of this group.
- *Policy developers/implementers actors (PDI)*: This refers to the political and administrative authorities at national and provincial legislative levels. They are entrusted with policy formulation in response to identified social needs.

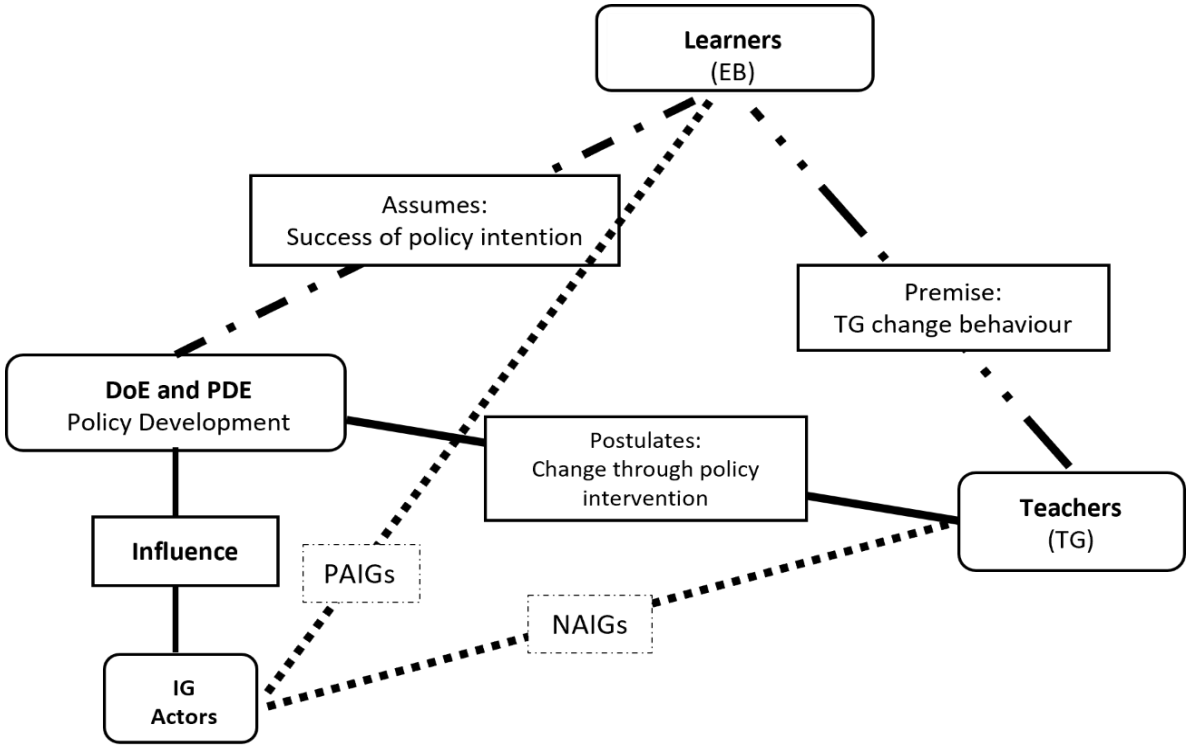

Figure 1: Key actors in PPM (Adapted from Knoepfel, et al., 2011)

3.4.2 Policy implementation

Hudson, Hunter, and Peckham (2019, p.2) identify four contributing factors to policy failure. They include (1) "overly optimistic expectations" (OOE), (2) "implementation in dispersed governance" (IDG), (3) "inadequate collaborative policymaking" (ICPM), and (4) "the vagaries of the political cycle" (VPC). The OOE refers to aspects such as lack of understanding of policy "delivery challenges", misjudgment of the policy "cost, benefits and risks" or inability to identify and collaborate with key stakeholders. The IDG refers to the complexities in implementing a nationally driven policy at various constitutionally autonomous decentralised entities. Inadequate collaborative policymaking (ICPM) refers to a lack of common understanding, by policy actors of the social problem necessitating policy formulation. Thus Knoepfel et al., (2011) contend that successful PPM depends on the key policy actors and a tacit hypothesis of causality (HC) which helps to detect, disentangle, and manage policy actors' relationships to facilitate the intervention hypothesis (IH) for a sound PTD. Lastly, VPC contributes to policy failure due to short-lived political mandates which often blind political heads to only focus on their short-term interests, in view of their term of office. This is often evidenced by political heads limited attention to ill-designed policies. Theirs is to be credited for policy formulation as the implementation, if any, will probably be during the term of office of a different politician. This unfortunate situation creates a cycle of new policy formulation which feeds into a cycle of policy implementation failures.

4. Conceptual framework

Conceptual Framework (CF) encapsulates the notion of PP as PTD, viewed as the logical consequence of its non-rivalrability and non-excludability nature. PP's centredness on equity and justice are premised by the non-rivalrability and non-excludability concept that embody the CF of this paper. This CF depicts the compromised nature of policy as a text that is discursively shaped by the sociocultural, economic and political contexts. Behind the policy compromises are policy actors' contradictory ideologies arising from a linear and cyclic process imposed by the desire to co-manage the PG. In its figurative linear representation, the process is perceived to start at CI, then CTP and finally CP. However, CP loops back to CI, in a cyclic process. The CF highlights cyclic loops that occur within and between contexts. Figure 2 depicts the CF of the paper.

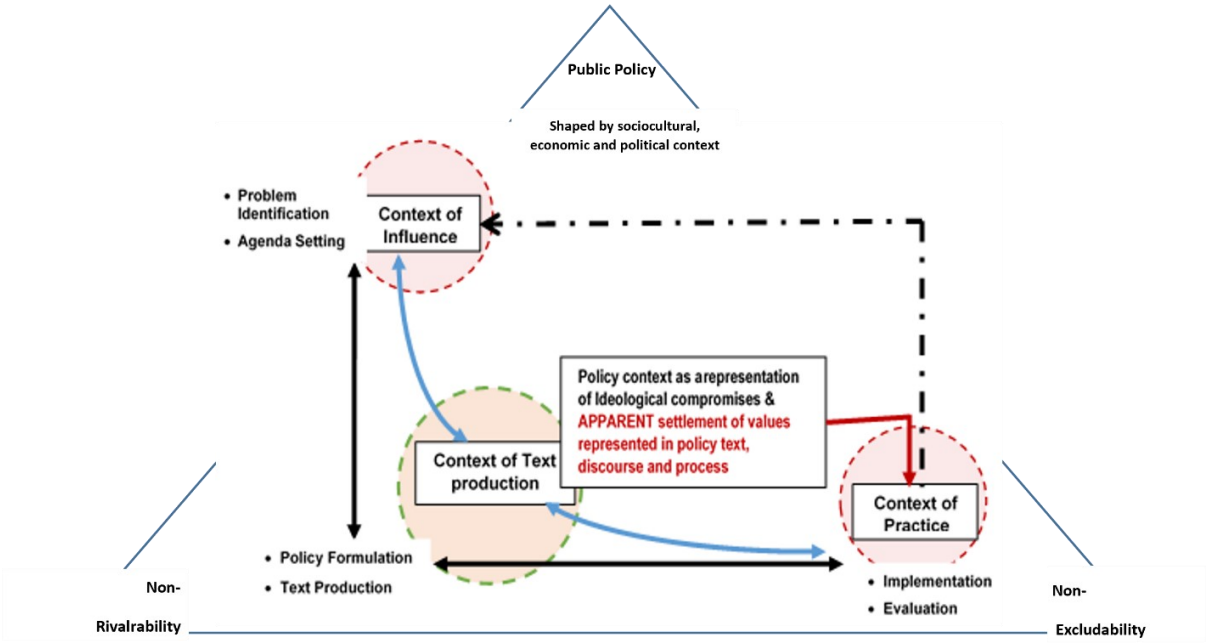

Figure 2: Conceptual Framework

Understanding PP intricacies requires a fit-for-purpose framework of analysis. CDA, particularly the Habermas Theory of Communicative Action – Validity Claims (TCA-VC), is our fit-for-purpose choice. The need to decrypt the context of WP7 formulation and its real motive of formulation (concealed behind the language/ speech), could not be possible by a mere textual analysis only. It further requires both an interpretive and empirical analysis of the speech contained in the text. Establishing the impacts of the context of WP7's formulation on its implementation is dependent on the establishment of the extent to which the policy was communicative (understanding/ cooperation) or strategic (symbolic/ manipulative). That is, the presence or absence of the "ideal speech" (tenet of TCA-VC), is determined by the realisation of the four VC tests (Stahl, 2004), as outlined in Table 1.

Table 1: Guides on Validity Claims tests

Claim	Criteria: ideal communication	Explanation	Potential distortion	Validity test	Speech elements for empirical analysis
Comprehensibility / clarity	Is what that is said audible?	Clarity of the claim (grammar, logical and lexical semantics)	Confusion	• Is the communication intelligible? • Is the communication complete? • Is the level of detail simple and clearer?	Completeness of physical representation
Truth	Is what is said factual/ true?	Claim to stand the test of objectivity	Misrepresentation	Is the provided evidence sufficient?	Argumentation

Claim	Criteria: ideal communication	Explanation	Potential distortion	Validity test	Speech elements for empirical analysis
Sincerity	Honesty of the text	Text intention (through inference/ not observation)	False Assurance	Is what is stated consistent with the manner in which it stated?	Connotative language/ Hyperbole Metaphors/ Jargon
Legitimacy	The correctness / appropriateness of the text vs. acceptable norms/ values	Is the claim in line with socially accepted norms?	Illegitimacy	Are competing "logics" (e.g., stakeholders) equally represented?	Use of "experts" and "authorities" to support the legitimacy of the claim

5. Method

5.1 Research design

A qualitative descriptive explanatory and historical research method was used. It assisted with understanding how WP7's context of formulation, including its real motive of formulation, influenced and impacted its implementation. The approach provided a platform for personal engagements with the key policy actors and textual engagements with WP7's existing text.

5.2 Sample selection

Research sites and participants were purposefully selected. The formulators and implementers of WP7 constituted the population from which key participants were selected while the selection of the sites (from which the participants were preselected) was based on the level of ICT use in schools at the time of WP7's formulation. This led to the selection of provinces of Gauteng (GP), Western Cape (WC) and Northern Cape (NC) as research sites (DoE, 2004 p.13). Table 2 depicts both selected research sites and participants.

Table 2: Research sites and participants

Institution	Participants N=11	Unit/ Branch	Role representation	Criteria
Department of Education (DoE)	5 (4+1)	Curriculum Innovation and e-Learning (X4)	Policy actors (formulators & implementers)	• Have participated in WP7 formulation process and implementation • Considered if in current employ of respective education department NGO or if recently exited the system
		Teacher Professional Development (x1)		
GDE, WCED & NCDoE	4 (2+2)	e-Education	TG actors	
NGO (SchoolNet)	2	ICT integration in education	IG actors	

5.3 Data Collection

Semi-structured interviews (SSI) and documentary evidence constituted the two data collection sources. The choice of SSI was informed by the study's need for rich data which is best gained from firsthand actors. To mitigate possible risks of SSI, i.e., "…time-consuming, labour intensive and the need for interviewer sophistication" (Adams, 2015, p.493), interview questions, including prompt questions, were subjected to a thorough scrutiny. The latter included a recorded pretesting of interview questions and probes. Due to COVID-19 regulations, interviews were conducted telephonically, audio recorded and later transcribed verbatim. To ensure anonymity, all traces of participants' identities were removed during transcription. The focus of the interviews revolved around understanding WP7's context of formulation and how it may have impacted its implementation. The published WP7 document constituted the key documentary evidence.

5.4 Data Analysis

Data analysis involved both the transcribed participants' interview accounts and two sets of corpora from the documentary evidence as to ensure a successful application of CDA (Chigona and Chigona, 2008). The decision to employ two distinct corpora was dictated by the multi-dimensional aspect of the research questions. The first corpus assisted in the identification of WP7's context of formulation, including the formulation's motive, while the second corpus facilitated the establishment of the causal relationship between the context of formulation and implementation impacts (see Table 3).

Table3: Identified corpora for analysis

Corpus title	Source	Focus of the Corpus	Content of the corpus
1	Participants' Interviews and WP7	Identification of WP7 context of formulation.	Chapter 1
			Chapter 3
			Chapter 4: The Policy Framework
			Policy (WP7) vision
			Questions related to the socioeconomic and political context of WP7 formulation
2	WP7	Impacts of the context of WP7 formulation on its implementation.	Policy (WP7) vision
			Chapter 2: Policy goal
			Chapter 4: The Policy Framework
			Chapter 6
			Chapter 7

A textual analysis was first conducted, followed by a more descriptive and interpretive analysis through CDA, especially the Habermas TCA-VC. In order to structurally organise the analyses, ATLAS-ti software was used. The analysis included a validation/ cross-correlation of data from the two sources. While the first corpus was subjected to a standard document analysis, the second was subjected to TCA-VC in order to determine the presence of the ideal speech. This was fundamental in exposing any inherent policy distortion/ hegemonic ideologies in WP7 that could have had bearing on its implementation. A number of leading questions (see Table 4), clustered per each VC, were formulated and facilitated the probing of the corpus (Chigona and Chigona, 2008).

Table 4: Leading questions for the Validity Claims testing

Validity Claims	Leading Questions
Clarity (comprehensibility)	• Are there any jargon/ language not clear or unexplained? • Is there any sense of communication completeness? • How is the level of details provided?
Truth	• What argument is advanced by the text with regard to e-Education, and its role in the improvement of TL? • Was the development of e-Education policy influenced by the need to improve TL? • To what extent does the funding of e-Education demonstrate the desire to transform TL through ICT?
Sincerity	• What false assurances are created by the policy through the use of metaphors/ unexplained jargon?
Legitimacy	• Whose voice is loud and why? • Whose interest is served/ excluded by this policy? • Who is the legitimatising authority/ expert?

The following three main themes with related sub-themes emerged:

1. Theme 1: Socioeconomic and political contexts influence on WP7 formulation:
- The motive of WP7 formulation through the lens of Policy as text: Socioeconomic and political contexts
- The motive of WP7 formulation through the lens of Policy as Process: Influence of Interest group (IG) actors
- The motive of WP7 formulation through the lens of Policy as a discourse: Implementation practices

2. Theme 2: WP7's transformative vision:
- Educational practice and outcomes through ICT integration

3. Theme 3: WP7 and the Ideal Speech (Validity Claim)

6. Findings and discussions

6.1 Influence of socioeconomic and political contexts on the formulation of WP7

WP7 personifies the socioeconomic and political contexts of the period of its formulation, indicative of the pre-1994 negotiated political settlement (NPS) which had contrasting solutions to the imperative transformative agenda. This cautious approach may have contributed to contradictory views on the motive of WP7 formulation—when interrogated from the three dimensions of policy as process, text and discourse—and impacted on its implementation.

6.1.1 Policy as text: Influence of socioeconomic and political contexts

It is established (text perspective) that the formulation of WP7 was a response to the need (political) for equitable socioeconomic and educational opportunities for all SAs. The policy statement is confirmed by the participant in the study. The policy states:

> *"In response to this under-development, Africa has adopted a renewal framework…which identifies ICTs as central in the struggle to reduce poverty on the continent"* (DoE, 2004, p.9)

A number of participants described the period as one of systemic socioeconomic inequality. A GDE participant stated:

> *"…this was a period where the memories of apartheid were still very much fresh, though people still had a sense of hope in the new government to take them out of poverty, characterised by the increasing inequalities"*

The NC participant said:

> *"…that was a time of high unequal resource allocations to schools and institutions".*

One of the participants from DoE pointed out the horizontal dimension of the influence. He claimed that the Department of Communications (DoC), in line with its mandate of ensuring the use of ICT for "economic growth", also influenced the formulation of WP7. The 2001 amended Telecommunications Act, Act No. 103 of 1996 affirms DoC implication through its instruction to the Minister of DoC, with concurrence of his DoE counterpart, to:

> "…establish an entity to construct and operate an educational network" (Government Gazette, Act No.64 of 2001).

The presence of international influences is also noted. A critical analysis of the text suggests that the effects of globalisation discourse also played a role. The policy speaks of:

> *"… global revolution" that was "taking place in education", "… driven by the changing nature of work …and an awareness of the need for equal distribution of educational opportunities"* (DoE, 2004, p.8).

Centering the policy framework on "*equity*", as one of the four elements of the policy (DoE, 2004, p.22), is indicative of policymakers' awareness of the socioeconomic and political discourse of the time and the role education and ICTs in particular were to play in the redress efforts. The policy contends that ICT was:

> *"…a critically important tool in the struggle… for liberation against poverty, against under-development, against marginalisation"* (DoE, 2004, p.10).

6.1.2 Policy as Process: Influence of Interest groups (IGs) actors

No evidence of formal *context of influence*, through which the social problem necessitating the formulation of WP7 and culminating into the agenda setting, was established. However, the influence of PAIGs is prominent and premises the assertion that, from the process perspective, WP7 was initiated and developed to serve as a guiding framework for the coordination of ICT related donations.

A DoE participant stated that:

> *"…people were offering huge offers, both in terms of money but also in terms of resources and equipment and training. When the Minister of Education asked: 'What is the policy saying about how we should engage with these people', there was no policy. So, the policy was then developed to serve as guide for engagement with all these donors" … "… looking back it appears to me that these donations were not just acts of good philanthropic hearts but they were meant to influence Department spending towards*

> *the procurement of ICT hardware and software". The fact that WP7 insists on the use of "legal software"* (DoE, 2004, p.40) *and the "honouring of licensing rights to trading rights" seems to give credence to the assertion* (DoE, 2004, p.24).

A WCED participant confirms the assertion by stating:

> *"…WP7 was developed because of political pressure and pressure from multinational organisations. They were offering solutions and all types of resources".*

Lamenting on this tacit motive of formulation, a DoE participant highlights a series of simplistic assumptions that are made by the policy:

> *"… There were many assumptions made which never materialised. E.g., the policy goal assumed that upon provision of computers and connectivity to schools, etc. learners will be ICT capable. It was assumed there will be money from somewhere, that provinces would just go ahead and roll out ICTs in all schools, that once devices (ICTs) are in the schools, they will be secured".*

The contention by this participant relates to the oversimplification of critical matters that were at the centre of the policy. For example, the achievement of the policy goal that, according to the participant, was just simplified as no clear mechanism of achieving the goal was outlined. The same applies to the policy funding and policy adoption by provinces which find expression in Hudson, Hunter and Peckham (2019) contention on contributing factors to policy failure, from the perspective of the policy itself.

6.1.3 Policy as a discourse: Implementation practices

The *discourse* perspective indicates that WP7 was formulated for the purpose of proactively replacing teachers in the light of the prevalence of HIV/AIDS during the period of its formulation. A number of participants suggested that the prevalence of HIV/AIDS, during the period, influenced the formulation of WP7. A WCED participant said:

> *"…there was a very real fear at that stage of the game that HIV/AIDS was going to have a massive negative impact on education. If teachers contracted HIV/AIDS and started dying, the process of replacing them was going to be under strain. Getting around this challenge was, therefore, the use of technology".*

Another WCED participant stated:

> *"…we were facing in many schools shortage of suitably qualified teachers to teach. We got a feeling that technology can play a role in improving classroom situation".*

These views are indicative of some policy actors' philosophical underpinning of ICT in education. From their perspective, the integration of ICTs in education is perceived more as a means to increasing access to mass education. The view finds expression in the policy itself as it suggests:

> *"...in the context of developing countries, quality improvement and the enhancement of excellence must take into consideration the need for increased access, equity and redress*" (DoE, 2004, p.8).

The excessive use of the word "*access*" (98 times versus 74 times for three keys words: "*improve*", "*enhance*" and "*quality*", associated with ICT and AL) is indicative of the pendulum's inclination. This tends to favour the discourse of traditional TL through ICTs which interestingly contradicts the discourse of LC advanced by the policy goal and vision.

6.1.4 Discussion: Policy as process, text and discourse: Motivation for WP7 formulation

The literature review and the CF of this study have outlined how PPs are compromised documents, inherent with contradictions and tensions which find expression in contemporary PP's democratic tendencies (Rivzi and Lingard, 2009). WP7 is not an exception as it embodies the dichotomy of the pre-1994 NPS whose tenets is the non-redistributive policy position that subscribes to a bias but non-racial resources distribution (Sayed, 2000). A multi-dimensional assessment of the policy (as PTD) has revealed inconsistencies and contradictions with regard to the motive of formulation.

We contend that it is the context (socioeconomic and political) of formulation that premises these inconsistencies. The finding from the "textual" perspective, for instance, finds expression in the tenet of the negotiated political settlement (NPS), dictated by the socioeconomic and political context. From the "process"

perspective, while there is no evidence of any formal process leading to WP7 formulation, the excessive influence of PAIGs is evident and can be located within the same socioeconomic paradigm. A context that might have blinded policymakers (or deliberately for political interest) into believing that ICT donations to mainly previously disadvantaged schools was a missing puzzle for the search for an equitable and just education system. Equally, the perception that the integration of ICTs into education could lead to dealing with health and social problem created by the HIV/AIDS pandemic as a political crisis.

The fact that a three-dimensional assessment of WP7 produced three distinct motives of its formulation is concerning and indicative of a policy that may have been directionless and symbolic. Varied contradictory claims on the policy formulation motive may have negatively impacted the attainment of its stated goal and objectives.

This is because they lacked explicit connections with the stated policy goal and objectives, thereby misled various assessments of its implementation. For example, the provision of computers to schools, in view of various donations, could have been seen as a successful achievement of the policy goal. Although a necessary building block towards the ultimate goal, we offer that it is rendered insignificant in the absence of the achievement of the set goal. We argue that the socioeconomic and political context that prevailed during the period of WP7's formulation is reminiscent of the sophistication of the apartheid system and contributed greatly to the symbolic nature of the policy. The socioeconomic and political context of the period seems to have overshadowed key considerations for an implementable policy that is not drawn into over-committing. It is established that there was a lack of funding and other key resources. Furthermore, there was no structured mechanisms to manage the operational autonomy of provinces (Hudson, Hunter and Peckham, 2019, p.2). The failure, though not absolute, was predictable as it was intrinsic to the policy design that had the hallmark of a symbolic policy.

6.2 WP7's transformative vision of ICT

WP7 vision of transforming TL through ICTs (DoE, 2004) presupposes a change in the business of TL, to the extent of centering all TL activities on the learner and learning as opposed to a teacher-centred approach (Wilke, *2003*). The policy in this regard states that:

> *"… ICT integration supports outcomes-based education, which encourages a learner-centred and activity-based approach to education and training"* (DoE, 2004, p.22).

Policymakers' understanding of the context that permits reaping the results of ICT integration is evidenced, at least from the textual analysis.

6.2.1 The Educational practice and outcomes through ICT integration

Even though policymakers were aware of the appropriate educational context in which ICTs could potentially benefit the system, no evidence of a formulation motive, arguing a case for education transformation, is established. While the policy vision speaks of transforming TL through ICTs, it seems, at a practical level, that the notion of education transformation is narrowly equated to the provision of computers and other ICT hardware to schools. We are unable to find any evidence that points to the strategy behind the provision of computers to schools which would have foregrounded the whole concept of transforming TL through ICTs. The mere provision of computers to schools seems to be simplistically equated to the transformation of TL through ICTs and believed to "*… creating new ways for students and teachers to engage in information selection, gathering, sorting and analysis*" (DoE, 2004, p.6). At least two participants highlighted the fact that WP7 contains a number of swiping statements that had nothing to do with the reality. One of the participants from WCED stated:

> *"…most of the stuff stated in WP7 were never implemented at all. Worse is the policy vision that seems to have remained just as a title given to that document. What is prevalent ...is the provision of ICT resources to schools".*

The participant from GDE contended that:

> *"…there was no implementation plan. Even the 2015 Operation Phakisa (A Big Fast Result policy methodology engineered to facilitate the development of detailed plans with a strong theory of change) for ICT in education never produced one"*

Participants' statements are indicative of a policy that has not known a structured and costed implementation plan that could stand the test of time.

6.2.2 Discussion: Policy as process, text and discourse: Motivation for WP7 formulation

The political agenda, driven by the socioeconomic conditions of the previously disadvantaged, seems to have overshadowed the need to critically look at what is needed educationally to change and further establish the meaningful role of ICTs. No substantial evidence to suggest the pursuit of WP7's educational vision was found. The omission of the classroom context seemed to have set the scene for policy failure, at least, in view of its textual policy goal and vision. The prospect of failure was exacerbated by the absence of a structured and costed implementation plan for the majority of the provinces.

We argue that while policymakers correctly framed and positioned WP7 as an instrument for redress and the fight against inequality amongst SA citizens, they failed to identify and articulate the social problem in education. This resulted in the policy (WP7) goal and vision attempting to address an unidentified social problem. We contend that this misalignment might have given rise to unfocused and "uncoordinated" implementation activities that the policy speaks about (DoE, 2004, p.12). These are uncoordinated activities that are directionless in the absence of a strategy document that would have provided the intelligence/ reasons behind any action. The situation gives credence to the finding that has suggested that WP7 was formulated to coordinate ICT-related donations.

6.3 WP7 and the Ideal Speech (Validity Claim)

6.3.1 Clarity of the text

With exception to a few instances, WP7 is clear and comprehensive in its language. No use of jargon was found. Key words/ concepts are well explained. For example, the term "outcomes-based" is explained/ contextualised. The policy states:

> *"… ICT integration supports outcomes-based education, which encourages a learner-centred and activity-based approach to education and training" (*DoE, 2004, p.22).

Similarly, the key word (transformation) in the policy vision is explained, though not in a focused manner aimed at drawing policy implementers' attention. The explanation is given in Chapter 2 (paragraph 2. p. 18), which states:

> *"… in a transformed teaching and learning environment, there is a shift from teacher-centred…to an inclusive and integrated practice where learners work collaboratively, develop shared practices, engage in meaningful contexts and develop creative thinking and problem-solving skills" (DoE, 2004, p.18)*

However, there are few instances where clarity is lacking and others where there is none. For instance, the word "*quality*" is used 28 times. Attempts to explain it is found in its second time of use. Clarity, however, is not as sharp and easy to understand. The policy states:

> *"Education systems have an obligation to deliver on public expectations of quality education for economic growth and social development"* (DoE, 2004, p.8).

Some attempts to explain "*quality education*" are present but are maybe not clear enough or emphasise the view of the policy vision. Instances where there is no clarity at all are also observed. These include, amongst others, no explanation given on terms such as "*high-quality*" (DoE, 2004, pp.6;13;16), "*national education goals*" (DoE, 2004, p.14).

6.3.2 Truth claim

The "*truth claim*" checks the correctness of the text. The investigated corpus revealed that WP7 advances compelling, contemporary and factual arguments in relation to the importance of e-Education. For instance, paragraphs 2.18, 2.20 and 2.21 (DoE, 2004) provide factual information on ICTs contributions to the fight against education inequalities. The statements were scrutinised against the literature and were found to be factual. Some contradictions within the very same paragraphs are, however, present. While their contents are correct, the phrasing of some sentences create an impression of: (a) ICTs being the enhancer of "*education reform*" (DoE, 2004, p.16); (b) ICTs being the one that improves "*inventive thinking skills*" (DoE, 2004, p.16), etc. These contradictions are prevalent throughout the corpus. It is further established that some statements can be easily referred to as untruths, in the absence of grasping the context in which they were written. Read in isolation to the context, this statement may be untrue as regular access is not the only determinant of e-learning success. The policy states:

> *"… for e-Learning to be successful, learners must have regular access to reliable infrastructure"* (DoE, 2004, p.22).

With regard to funding, WP7 states:

> *"Certain inherent cost implications such as the cost of usage, network rental and maintenance, and the cost of protection are planned for" (DoE, 2004, p.35).*

This is untrue when contrasted with the reality and participant accounts. One participant claimed: "WP7 never had a formal and costed national implementation plan". Another one said: "It was assumed that there would be money from somewhere which was never the case".

Furthermore, while it is correct that the Telecommunications Act (Act No. 103 of 1996), amended in 2001, called for the development of an educational network, it is untrue that the same Act called, "*… for the implementation of an E-rate for GET and FET institutions*" (DoE, 2004, p.12). The E-rate Act refers to the Electronic Communications Act (Act No. 36 of 2005).

6.3.3 Sincerity claim

No usage of metaphorical language was found. However, there are several statements that project false assurances, thus misrepresenting the reality. For example, while the Telecommunications Act does not provide any timeline to construct the educational network, WP7 commits to access such infrastructure (as of 2007) by 50% of schools and all schools by 2013 (DoE, 2004, pp.40 and 41). The pattern is the same throughout the "*planning cycles*" of the policy (DoE, 2004, pp.38-41). The words "*every*" and "*all*" are the hallmarks of the planning cycle. Yet there is no evidence of financial and other infrastructural resources to justify such boldness and assurances. The policy, for instance, states that by the end of 2007:

> *"Every teacher and manager" would have had "the means to obtain a personal computer for personal use, administration and preparation of lessons". By the end of 2010, "All institutions" would have had "access to an e-Rate". By the end of 2013, "all learners and teachers" would have been "ICT capable", "ICTs" would have been "…integrated into teaching and learning in all institutions", and "all teachers" would have been able to "…integrate ICTs into the curriculum"* (DoE, 2004, pp.39-41)

The above statements are indicative of false assurances as there is no evidence or any material conditions that were put in place for such forecasting.

6.3.4 Legitimacy claim

The legitimacy claim reveals how WP7 sought to legitimatise its existence, and in the process, power relationship at play was exposed, including absent forces/actors. It is established that, in order to ascertain its legitimacy and authority, policymakers used both the concurrence of the global community, SA Government and various stakeholders. The paper speaks of:

> *"… a global revolution… taking place in education and training …driven by the changing nature of work, the realities of the information age, new global partnerships and an awareness of the need for equal distribution of educational opportunities"* (DoE, 2004, p.8).

Locally, Government served as the principal legitimiser of WP7. The word "*Government*" is used no less than 62 times. Government legitimisation is expressed, amongst others, by the WP7's publication in a *Government Gazette*. Further legitimisation is provided by the head of State at the time (President Thabo Mbeki) *"underscoring the importance of ICTs for social and economic development in numerous SA and international fora"* (DoE, 2004, p.10).

Many other instances include the following, though not limited to:

> *"Government will facilitate the establishment of training programmes and small business incubators"* (DoE, 2004, p.33).

It is further established, in terms of other stakeholders, that those named by the policy were the loudest and powerful. The unnamed, such as the print media, teachers and learners were absent yet key and indispensable actors for a successful implementation.

6.3.5 Discussion: WP7's and the ideal speech (validity claim)

While there is clear evidence of considerable efforts for ideal speech, it is also evident that the policy did not pass the VC test. False assurances and incorrect statements are indicative of policy distortion. Once again, the conclusion of a symbolic policy is affirmed on the basis of the socioeconomic and political context that influenced an appeasing policy, rather than one aimed at achieving its set goal and objectives that has a built-in material consequence mechanism.

7. Conclusion

The process of policy formulation is a complex enterprise that endeavours to account for political and socioeconomic context in which the policy is enacted (Rivzi and Lingard, 2009). Democratic public policymaking is intrinsically political, premised on negotiations dominated by the most powerful, and culminates on textual policy compromises. However, regardless of how a policy is negotiated and accounts for compromises from policy actors, PPs in their textual form, remain embedded with contradictions and tensions which are indicative of their context of formulation. These tensions, if not well decoded, understood, and contextualised are likely to manifest themselves during the implementation phase and disrupt the attainment of the policy goal.

WP7 has been entangled in the circumstantial context of its formulation which seems to have dictated its symbolic nature and remained confined in the contested pre-1994 negotiated political settlement discourse. Like many of the policies of the period, and contrary to its stated textual goal and vision, WP7's true intention was to appease the tense post-apartheid socioeconomic and political climate through an apparent provision of ICT devices to schools. The donation of computers to schools by various interested parties (stakeholders) was viewed as a way of achieving this hidden goal, yet the interested parties were interested in swaying Government spending on ICT-related matters.

It is common and logical to assess a PP by contrasting its set objectives and goal against its recorded achievements, or even relativising the said assessment by taking into consideration local factors. This paper, however, has demonstrated that the socioeconomic and political context of such policy formulation may be the reason for its own purported failure. Value driven assessment may be misleading on the basis that the real motive of formulation is elsewhere or was never sharply stated or known from the onset. It is therefore recommended that a holistic understanding of the causes of policy failure also considers interrogating the context of formulation of such policy. We strongly argue that failure to do so may result in an endless cycle of failed interventions, regardless of their adjustment.

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A Novel Synchronous Hybrid Learning Method: Voices from Saudi Arabia

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Abstract: The current article investigates tertiary level learners' satisfaction with a novel synchronous hybrid learning method (SHLM) that combines face-to-face and virtual teaching simultaneously using real-time audio and video technology to facilitate interaction between two groups. The originality of this approach stems from teaching two groups simultaneously (one group face-to-face and the other online) and rotating them consecutively in order to offer them 50% of the classes face-to-face and 50% virtually. This approach gave students equal learning opportunities by studying at home on specific days whilst not depriving them of face-to-face communication with their tutors, as well as establishing contact with their peers. We believe that this learning model has not been implemented in this fashion before and that the study has not been conducted elsewhere. For the most part, it was introduced as a solution to provide face-to-face teaching during the COVID-19 pandemic. This study aimed at examining learners' opinions, motivation, attention, and success in this new learning environment. The study employed a mixed methods approach that included a survey and semi-structured interviews to collect quantitative and qualitative data. The overall results revealed that learners were generally in favor of SHLM. Furthermore, it found that reducing the group sizes from 40 to 20 students had a positive impact on learner satisfaction. Students also highlighted that feeling safe, use of technology, teachers' attention during classes, sense of equality, and collaborative efforts between students contributed to their positive learning experience as a whole. Learners also indicated that their experience during classes with various digital tools such as Padlet, Google Jamboard, and Nearpod had a positive impact on their learning. However, the findings from some of the interviews revealed that there was a variation in opinion dependent on the students' learning style, personality traits, and linguistic ability. Some beginner and intermediate learners pointed out that at times, their proficiency level hindered their understanding when alternating to online classes. The study alluded to the fact that the implemented learning approach is subject to modifications and may remain in place for an extended period in case the pandemic still poses a problem or in the event of a shortage of physical classrooms or faculty. This model can also be applied during emergency remote instruction in educational institutions that have a suitable infrastructure. Since this study only focused on the students' perception of this hybrid approach, it is recommended that the teachers' experience with the approach should be examined. It is also recommended that the teaching of the four English language skills should be examined through this model to find whether all the skills can be taught effectively.

Keywords*:* novel synchronous hybrid learning method (SHLM), Saudi EFL context, learner satisfaction, tertiary level, emergency remote teaching (ERT)

1. Introduction

1.1 Defining the problem

The COVID-19 pandemic has drastically impacted every aspect of our lives, especially education at very short notice. Initially, all educational systems around the world were left with no option but to manage the unprecedented situation and shift to emergency remote teaching (ERT). Hodges et al. (2020, p. 5) defined ERT as "a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances." For instance, PKY, a public school in Gainesville (Florida, USA), which is also part of the University of Florida's College of Education, explained how they transitioned seamlessly to ERT (Geiger and Dawson, 2020). The school was closed on March 16th 2020, followed by two weeks of an extended spring break. Before the break, the faculty within the school was looking into the possibility of teaching under the pandemic circumstances. The team came up with an initiative called Virtually PKY, which was based on experimentation through teacher inquiry cycles where teachers identified problems of practice, collected data, consulted relevant literature, modified their practices and, in the end, shared them with their peers. One of the primary aspects that the school took into consideration was teacher-student, teacher-family, and student-content interactions. Multiple platforms were used according to the students' level and type of interaction required. For example, elementary-level students utilized Zoom for student-to-student interaction. In contrast, high school level students used Khan Academy to meet curricular goals for student-content interaction. In short, various platforms were used to meet different goals to adapt to ERT. This study recommended that future research should consider factors that influence the learner experience such as satisfaction and engagement (Geiger and Dawson, 2020).

Unlike Virtually PKY, the experience with ERT was not satisfactory in a Malaysian school (Chuah and Mohamad, 2020). For instance, Chuah and Mohamad (2020) indicated the following challenges associated with ERT: motivating students remotely and unavailability of internet connection in certain areas for some students, which affected communication between teachers, students, and parents. The shift to ERT has also affected teacher efficacy (Reich et al., 2021). Evidently, the sudden shift from in-person classes to remote teaching required teachers to exert efforts and adapt quickly to a new learning environment. As a result, they have become burned out. This is one of the unexpected factors that exhausted teachers when dealing with emergency remote instruction. Consequently, the shift to ERT led teachers to make more effort and experiment with digital tools to meet the new needs of learners (Hodges et al., 2020).

Without doubt, the remote learners' needs are different from the in-person learners' needs. For instance, some learners suffer from societal inequalities, i.e., sometimes siblings share one room and many do not have access to individual devices. In such cases, the learning experience will be greatly affected with challenges including noise, lack of space, and privacy (Hodges et al., 2020). Student needs have taken a different shape during the COVID-19 crisis; therefore, proposing and examining solutions should correspond with the "new needs for our learners and communities" (Hodges et al., 2020, p. 6). Hodges et al. (2020) also revealed that learners' needs vary according to their age. For instance, adult learners' needs might be met through an asynchronous mode of delivery while younger learners' needs may be better met via a synchronous mode.

Further challenges prevalent during the pandemic included difficulty accessing the internet and a lack of technical support. In a Malaysian context, material, and lesson input were affected by the aforementioned obstacles (Chuah and Mohamad, 2020). Malaysian teachers, for example, implemented solutions that incorporated both the instructional goals of a subject and access to the digital material. Usually, in a face-to-face environment, learners had access to hard copies. In the virtual classroom, however, digital copies were affected by several technical factors such as the device type, the browser, and the operating system of a device. In the planning stage, teachers selected the topics, designed the syllabus, and planned activities to provide students with comprehensible input. Lesson input including teacher-student interaction, however, was sacrificed, and instead, students were provided with tasks to work on since not all learners had the same level of accessibility to the internet. Thus, course objectives, lesson planning, and input were notably impacted by technology. Within the Malaysian context, teachers expressed a degree of satisfaction in the way that they explored solutions to adapt to emergency remote teaching. Namely, the teachers who participated in the Malaysian study noted a level of confidence in the way they put their knowledge of online learning into practice. While this level of confidence is somewhat encouraging, it is important to point out the need to also investigate learner satisfaction with this particular experience.

Asynchronous modes of online instruction were also a common way of communicating during emergency remote teaching. Evidently, this mode did not allow live interaction between the teacher and students, which made it difficult to evaluate learner engagement while attending recorded sessions. Furthermore, providing live tailored and effective feedback was drastically affected by this mode (Lapada et al., 2020). In comparison, synchronous modes filled in this gap and allowed direct interaction between teachers and learners.

Having effective interaction and feedback are two key aspects for making the learner experience more meaningful in ERT. Durden (2020) explained that remote instruction will probably still be available either in the form of fully or partially synchronous learning for more effective communication. On the other hand, Genone (2020) emphasized that the focus should be on pedagogy rather than on technology to engage students more in emergency remote education. In other words, the use of technology should serve pedagogy to augment students' motivation, engagement, and enable teachers to provide timely feedback. Reich et al. (2020) found that video conferences facilitated classroom discussion in a synchronous mode, and it was more effective when the learners were split into smaller groups. They further expressed that students felt connected with their peers and were appreciated.

In the case of the present study, at the Imam Abdulrahman Bin Faisal University (IAU), all faculty were informed on March 9th 2020, to start delivering classes entirely online by utilizing the pre-existing learning management systems (LMS), namely, Blackboard Collaborative Ultra, Zoom, and Microsoft Teams. The remaining part of the second term of the 2019-2020 academic year was conducted entirely online. In July 2020, the Department of English Language (DEL) at the Deanship of Preparatory Year and Supporting Studies (PYP) was looking for an emergency remote instruction mode that combined face-to-face and online teaching simultaneously. A

synchronous hybrid learning method (henceforth SHLM) was chosen to ensure an equal chance of face-to-face teaching for all learners by rotating attendance of virtual and face-to-face groups (see Figure 1). SHLM satisfies the four principles mentioned by Beatty (2019), namely learner choice, equivalent learning, reusability and accessibility. In light of the issues encountered with ERTs by learners worldwide, this study aims to explore learners' opinions, satisfaction, motivation, and the technical challenges of applying this model as a case study. In addition, since teachers utilized this mode for the first time, it was essential to investigate how teachers paid attention to both the online and face-to-face classes simultaneously. Furthermore, accessing materials, meeting the needs of learners, and dealing with challenges were considered primary factors that led to the aims and research questions of the present study.

1.2 Goals of the study

The study aims to:

1. Investigate learner satisfaction with the synchronous hybrid learning method.
2. Explore the challenges and benefits of this modality.

1.3 Research questions guiding the study

1. How satisfied were the learners with the synchronous hybrid learning approach?
2. What are the main challenges and benefits of synchronous hybrid learning settings?

1.4 Significance of the study

The significance of this study centers around the novel approach taken by one university to tackle the challenges brought about by the unprecedented spread of COVID-19. In particular, the approach gives all learners equal opportunities of face-to-face and virtual instruction, flexibility, and easy accessibility. It is important to mention that the cohort of the 2020-2021 academic year had experienced an emergency interruption in their high school education due to the COVID-19 pandemic. In the context of this study, the PYP program is essential for ensuring a smooth transition from high school to the university style of learning. Therefore, learner experience during this critical phase of education is of great academic and social importance. Academically speaking, the English language program, which consists of General English and ESP Courses, aims to establish a solid foundation for the students' undergraduate studies. Coming to classes on campus and interacting with peers as well as participating in extra-curricular activities is very important not only academically speaking, but also critical for the students' psychological well-being (Nakayama, Yamamoto, and Santiago, 2007; Irvine, Code, and Richards, 2013; Nae, 2020; Al Rawashdeh et al., 2021).

Results from this study will shed light on future practices in case the pandemic continues or for small-size institutions to accommodate a larger number of students without recruiting more teachers or requiring more classrooms. In support of this view, Raes et al. (2020, p. 281), Bell, Sawaya, and Cain (2014), and Brumfield et al. (2017) believe that the "hybrid virtual classroom eliminates the need to teach the same course twice to different classes on different campuses, which reduces workloads." Liu, Spector, and Ikle (2018) emphasize the importance of providing a fair learning experience to under-represented students by having them interact with one another in this social context. However, the approach implemented in Liu, Spector, and Ikle's (2018) study does not allow switching the learning environments for off-campus and on-campus students. Although the authors allude to the idea that hybrid learning promotes fairness, it would be more evident if their learners were given the opportunity to attend half of the classes online and the other half face-to-face.

Another important aspect of the study is to investigate this novel approach as it has not been applied in this fashion by any other academic institution before. In addition, it shall pinpoint the areas of strength as well as the areas in need of development. Furthermore, the current study aims to provide feedback to the decision makers so as to enhance the student experience with this approach.

2. Literature review

2.1 Emergency remote instruction

COVID-19 has forced transitioning from in-person classes to emergency remote instruction where most educational institutions have utilized similar facilities and infrastructure. In a relatively short period of time, a plethora of studies have emerged to investigate the impact of this on education (Bhuwandeep and Das, 2020; Geiger and Dawson, 2020; Hodges et al., 2020; Jeffery and Bauer, 2020; Wang and East, 2020; Bond et al., 2021; Kovačević et al., 2021). Several issues have been raised during emergency remote instruction, such as lack of

learner motivation, lack of adequate infrastructure, access to learning materials, and technical support. All these factors have profoundly impacted the speed of transitioning and the quality of learning outcomes.

As in the physical classroom, motivation is critical for keeping learners engaged virtually. Online, students do not always participate in classroom discussions for a number of reasons. For example, they may face technical problems or easily avoid discussion because they are not being physically monitored. Another reason is that teachers may not pay equal attention to all students, especially if the class size is large. Singh, Steele, and Singh (2021, p. 154) added that lacking a sense of belonging to a community can also demotivate learners to participate in remote classroom discussions.

IT support and faculty training on using digital platforms are of paramount importance to implement emergency remote instruction effectively. For instance, if technical support is not available during asynchronous and synchronous online classes, the situation becomes beyond the teachers' individual control. Untrained teachers generally try to apply in-person instruction to online teaching (Sumardi and Nughrahani, 2020). Of course, not all faculty had the chance to receive adequate training, especially if they had not experienced virtual learning prior to the pandemic, or if blended learning was not part of their instructional delivery. There are many institutions that relied partially on e-learning and utilized digital platforms which could have facilitated the transition to emergency remote instruction during the pandemic in a much better manner when compared to other institutions. The lack of awareness in utilizing basic digital tools poses a challenge to providing an effective virtual learning experience (Rapanta et al., 2020; Singh, Steele, and Singh, 2021). In summary, faculty training plays an integral role in enhancing teachers' digital awareness and experience for the sake of providing a better learning experience for learners using emergency remote modes.

Accessibility to material and infrastructure are two important factors in enhancing the quality of the learner experience. Singh, Steele, and Singh (2021, p. 152) added that "limited or no access to appropriate teaching resources such as personal computers/tablets, headsets, and printers led to frustration and struggle for the faculty." Being unable to access material is one of the disadvantages that has left a negative impact on the learner experience. Learners are the key stakeholders whose access to learning material should be made available. Hamilton et al. (2020) reinforced that the lack of high-speed internet and unavailability of technological tools hinder the implementation of online learning. Singh, Steele, and Singh (2021, p. 153) explained that these two obstacles are even more serious for in-person students who rely on "on-campus university resources, library and, computer labs to complete their work." Singh, Steele, and Singh (2021, p. 154) summarized the challenges during emergency remote instruction as a "lack of a humanized learning environment, lack of sense of community, lack of student motivation, and accessibility problems."

2.2 Defining the hybrid learning environment

There have been several definitions of the hybrid learning approach by different scholars (Waddoups and Howell, 2002; Pöysä, Lowyck, and Häkkinen, 2005). Their definitions touch on the possibility of having face-to-face meetings and using distance education technologies and practices. Yet, a more specific definition has emerged introducing a synchronous hybrid learning approach which involves providing instruction to some students who attend classes online while some attend face-to-face using real-time audio and video technology (Roseth, Akcaoglu, and Zellner, 2013). This definition is the closest to the method implemented in this study. However, SHLM takes it a step further by rotating the two learning modes in an equal fashion (see Figure 1).

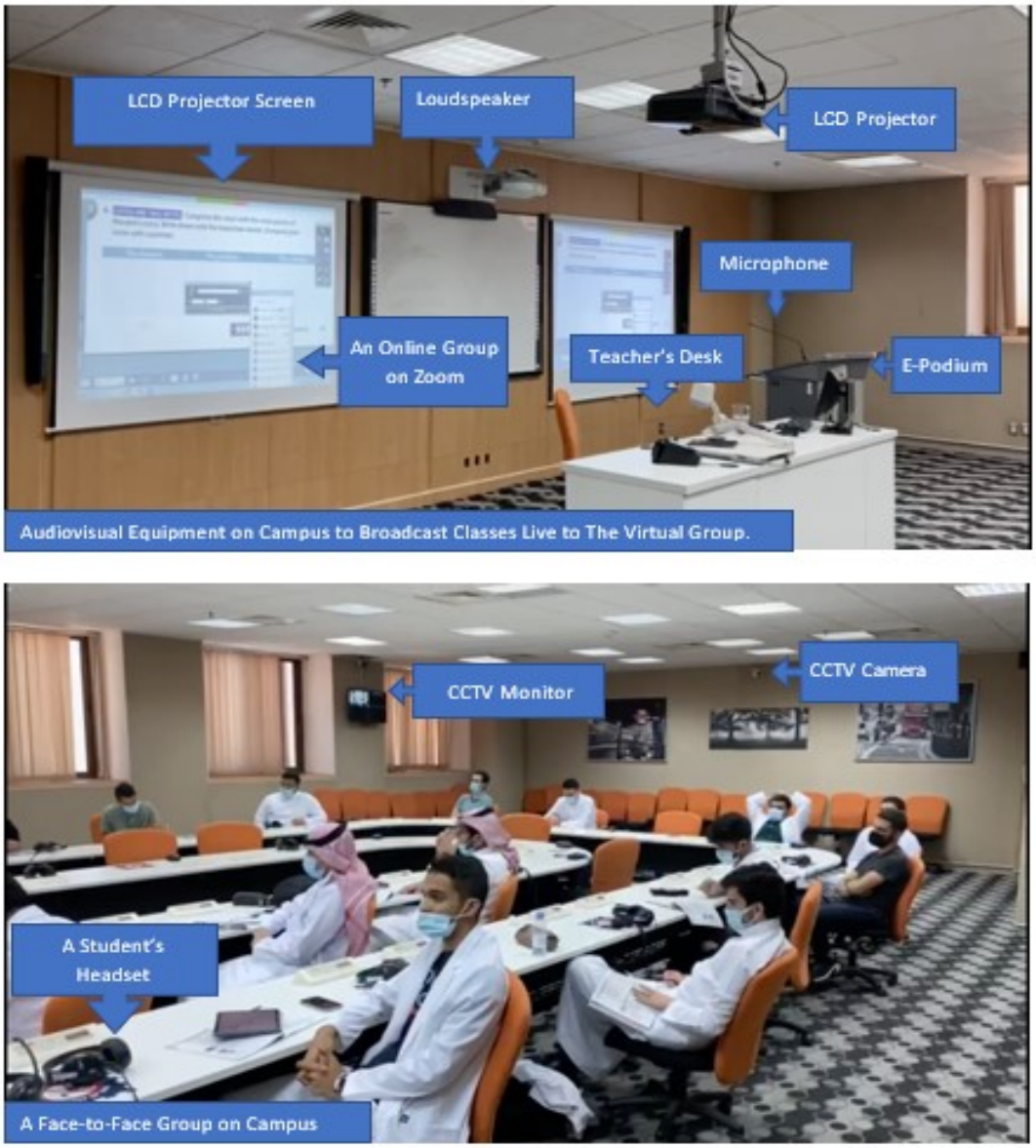

Figure 1: The structure of the synchronous hybrid learning model (SHLM)

2.3 Learner satisfaction of the synchronous hybrid learning model

Glazer and Wanstreet (2011) reported that online students are prone to feelings of social isolation due to a lack of face-to-face interaction (Butz et al., 2014). In the same vein, Butz and Stupnisky (2016) investigated the relationships among students' needs, satisfaction, motivation, and achievement in synchronous hybrid learning environments. One of the aims of their study was to explore student-peer relatedness. They found that the online group expressed that they had less in common with their peers than the on-campus students. Hence, the authors mentioned it as one of the disadvantages of attending classes only online in a synchronous learning environment. A sense of belonging and connectedness are fundamental human needs that are essential to achieving learner satisfaction (Arslan, 2021; Singh, Steele, and Singh, 2021). Furthermore, Singh, Steele, and Singh (2021, p. 155) have emphasized that utilizing hybrid or blended methods of learning can ensure a "safe way to learn digitally" during emergency remote learning.

Integrating face-to-face and synchronous teaching together is seen as a solution that provides face-to-face interaction in the presence of the COVID-19 pandemic which allows physical distance in the classroom, and ensures smooth running of the English program. Romero-Hall and Vicentini (2017) found that distance learners who attended synchronous hybrid classes expressed enjoyment when working with other classmates. The participants also felt that they were involved in the physical classroom community. Distance and face-to-face learners bonded and could maintain connection throughout the entire program. In the aforementioned study,

learners were taught either face-to-face or online. Therefore, students' experience and satisfaction in the present study may not necessarily show the same result since they alternate their learning environment as per their teaching timetable.

2.4 Common challenges faced by learners

Romero-Hall and Vicentini (2017) pinpointed that one of the main challenges posed in the hybrid learning environment was associated with classroom participation. Furthermore, they (2017, p. 153) stated that technical issues sometimes caused "a feeling of embarrassment and discomfort to ask for repetition due to having missed key information created the greatest differences between the distance learners' and the face-to-face learners' experience." Another challenge discussed by Romero-Hall and Vicentini (2017, p. 153) was the lack of "adequate infrastructure (microphones, speakers, and adequate wireless internet) to help establish the interactions, communication, and sense of equality between all learners in the hybrid synchronous classroom." In addition, Evans, Kensington-Miller, and Novak (2021) added that one key challenge was the size of the course including the number of students enrolled in it per term. Thus, the aforementioned factors shall either contribute to the success and satisfaction of integrating hybrid learning or make it more challenging. Other challenges reported in the Saudi EFL context by Gulnaz, Althomali, and Alzeer (2020, p. 323) are "financial obstacles, lack of enough resources, and teaching expertise to effectively deliver online instruction" and computer compatibility which might be similar to other contexts outside of Saudi Arabia.

2.5 Context of the study: Case description

In July 2020, restrictions started to be cautiously eased in Saudi Arabia, and the next academic year (2020-2021) was about to commence. As preparations for the new academic year were underway, the Department of English Language (DEL) at the Deanship of Preparatory Year and Supporting Studies (PYP) searched for feasible solutions that could be implemented using the existing infrastructure and the available faculty members to teach face-to-face. Online teaching was not preferred as off-campus learners were generally found to be more passive and would learn less than their on-campus counterparts. From a pedagogical standpoint, teaching verbal and non-verbal skills is more effective through a face-to-face student-centered approach. In support of this view, Weitze (2015) argues that sometimes students tend to act as if they were watching TV rather than attending a class. Raes et al. (2020) explained that teachers usually deliver online classes using more monologue-based teaching strategies, which is not adequate in our learning context.

In the beginning, seeking a solution that allowed face-to-face interaction, maintained social distancing in classrooms, and permitted approximately 40 students in each group whilst complying with preventive and precautionary measures as instructed by the Ministry of Health in Saudi Arabia (Ministry of Health, 2020), seemed unfeasible. Three primary obstacles that prevented the department from implementing face-to-face instruction were identified. First, the physical space of the classroom did not allow more than 22 students with social distancing measures. Second, the available number of faculty members and classrooms has remained the same, thus, dividing students into smaller groups was not manageable. Finally, the PYP program is intensive, and the official teaching slots were restricted from 8:00 a.m. to 5:00 p.m.

After taking the aforementioned parameters into consideration, SHLM was proposed and approved by the university's administration. The PYP program included 6,500 students, 120 teachers, 141 groups spread across 12 campuses. The plan involved dividing each group into two subgroups i.e., 1-A and 1-B. Each subgroup comprised 20 students to make a total of 40. On the first teaching day of the week, Sunday, subgroup A attended face-to-face while the teacher broadcasted the same class live to subgroup B. Then, on the second teaching day of the week, Monday, the subgroups switched their learning environment so that subgroup B attended classes face-to-face and subgroup A attended classes online (see Table 1). In short, all students attended 50% of all classes face-to-face and 50% online. This novel method of instruction enabled the provision of face-to-face instruction while using the same infrastructure, keeping the same number of faculty, and complying with COVID-19 health and safety measures. After implementing this novel method with relative success for one full academic year, it was paramount to investigate learner experience regarding this learning method, ensure safety, and enhance its modality in case similar circumstances arose.

According to Raes et al. (2020, pp. 277-281) hybrid learning has benefits that fall under two "categories, namely, (1) organizational benefits related to educational access and efficiency in teaching; and (2) pedagogical benefits related to the quality of learning." Overall, the chance to create a connection between on-campus and off-

campus students is believed to create a more positive and richer learning experience (Bower et al., 2015; Bell, Sawaya, and Cain, 2014).

Table 1: A student teaching timetable showing the implementation of SHLM

Teacher's Name Paul Kerton		Sunday 8 a.m.-10 a.m.	Monday 10 a.m.-12 p.m.	Tuesday	Wednesday 1 p.m.-3 p.m.	Thursday 3 p.m.-5 p.m.
Group 1	A	Face-to-Face	Online	-	Face-to-Face	Online
	B	Online	Face-to-Face	-	Online	Face-to-Face

One of the most critical issues in implementing this method was that teachers were unfamiliar with teaching online and face-to-face simultaneously. To ensure that the students received high-quality instruction, effective feedback, and attention from their teachers to both groups, teachers were provided with a six-day professional development (PD) program on delivering synchronous hybrid learning classes. The PD unit invited three international speakers (i.e., Nigel A. Caplan, George Vassilakis, and Nick Thorner). Furthermore, recurring PD sessions were offered throughout the academic year by qualified training staff from the Department of English Language and the university's Deanship of E-Learning to prepare and support teachers. Teachers were introduced to a set of digital learning tools such as Padlet, Google Jamboard and Nearpod to facilitate communication between teachers and students. Additionally, high-internet speed, e-podiums, overhead projectors, IT support, hand sanitizer, and social distancing stickers were made available in classrooms.

3. Methodology

A cross-sectional study was conducted adopting a mixed methods approach to meet the goals of this case study. It is considered exploratory because it examines learners' satisfaction with the hybrid learning modality, a model they have not experienced before. Moreover, it is an initial study that seeks to investigate the specific nature of the issues faced by the learners while implementing this modality. So, identifying its challenges will assist educators in addressing them. The first method was an online survey conducted via QuestionPro, and the second method was in the form of semi-structured interviews. Another reason for using a mixed methods approach is the complementary nature it provides and the possibility to elaborate (Saunders, Lewis, and Thornhill, 2019) and enhance (Bryman, 2004) the results. In other words, the semi-structured interview may enhance the validity of the data collected quantitatively via the survey. Participants' quotes will elaborate on some of the results by providing examples and explanations relevant to the questionnaire items.

3.1 Survey

The survey was divided into two main sections. The first section recorded biographical data, including the track and English proficiency level (questions 1-2). The second section explored learner satisfaction and experience with this modality (questions 3-26). The survey implemented a three-point Likert scale as follows: agree, neutral, and disagree. A link to the survey was sent to all PYP students via Blackboard announcements. The survey was available for one month. After that, the numerical data generated from the responses was quantitively analyzed via the QuestionPro analytical feature and SPSS.

3.1.1 Validity

For the purpose of the survey's validity, students with lower proficiency levels were provided with an Arabic translation to ensure their understanding of the questions. The translation was made by two Arabic EFL teachers and edited by the author. They were also provided with the definition of synchronous hybrid learning in Arabic and English. The questionnaire was also piloted prior to carrying out the main study which was sent to 10 students. Furthermore, it was sent to two arbitrators in the field of e-learning, which then was modified in response to their feedback. Finally, the survey was distributed to all the PYP students enrolled in four tracks across 12 locations.

3.1.2 Reliability

Cronbach's alpha was used in this study to look at the internal consistency of the questionnaire items. According to Gay, Mills, and Airasian (2006, p. 625), this test estimates the "internal consistency based on a determination of how all items on a test relate to all other items and to the total test." Furthermore, Paltridge, and Phakiti (2015, p. 83) explained that a value which ranges from 0 to 1 demonstrates "the extent to which the items are measuring a single (unidimensional) construct. The closer this coefficient is to 1, the more consistently the items are measuring the same thing." It is important to note that the Likert scale data can be analyzed as "interval data" in which "the mean is the best measure of central tendency" (University of St Andrews, n.d., p. 1). Dörnyei

and Taguchi (2010) explained that a small Likert scale ranging from three to four items should have a reliability coefficient alpha no less than 0.70.

The results of the close-ended questionnaire were divided into four categories and analyzed statistically for the mean (M), standard deviation (SD), and the range description of the mean as follows: Agree 1-1.66, Neutral 1.67-2.33, and Disagree 2.34-3. The three-point Likert scale uses alignments which Pimentel (2010, p. 111) called an interval measurement where "the information to all the respondents are summarized in the form of weighted mean … then interpreted using an interval, which in turn corresponds to a verbal description." The Likert scale, therefore, can be interpreted as follows: 1 stands for agree, 2 neutral, and 3 disagree. A summary of the weighted mean is provided in Table 2.

Table 2: Description of the weighted mean

Likert Scale	Interval	Difference	Description
1	1.00-1.66	.66	Agree
2	1.67-2.33	.66	Neutral
3	2-34-3.00	.66	Disagree

Cronbach's alpha test was conducted to measure the reliability and internal consistency of the four fields used in the survey. Cronbach's alpha values were found to be reliable as they fell between (α = .80) and (α = .92). Therefore, the values were statistically acceptable (see Table 3).

Table 3: Internal consistency of Cronbach's alpha test

	Field	Cronbach's Alpha	No. of Items
1	Satisfaction/Opinion on Hybrid Method	0.831	7
2	Learner Motivation	0.803	6
3	Teacher's Attention During Hybrid Classes	0.918	9
4	Technicality	0.857	2

Furthermore, a sample size formula was conducted to select the representative sample of the total population (n = 6,500) via the sample size calculator (Creative Research Systems, n.d.). This non-probability judgment sampling technique calculated the representative population with a confidence interval value of (95%). Although the sample size needed for our 6,500 population was only 363, 1,577 participants have completed the survey.

3.2 Semi-structured interviews

For the purpose of elaborating on the results collected from the questionnaire, semi-structured interviews were used in the present study. Saunders, Lewis, and Thornhill (2019, p. 437) defined semi-structured interviews as non-standardized interviews which start with a systematic "predetermined list of themes." This type of interview was deemed appropriate since the present study is exploratory in nature. As such, the semi-structured interview method was utilized as a second tool in the present study to yield the needed answers for questions in mind. Meetings with 21 participants were conducted via Zoom. The responses from the recorded sessions were transcribed verbatim. Since students were allowed to use either Arabic or English, the Arabic responses were translated into English by two Arabic EFL teachers which were then revised by the author. Responses were then analyzed using a thematic approach which were labeled under 11 categories. While the interviews were based on predetermined themes, other themes were included in the analysis due to their importance and repetition by the participants. The themes that were already present in the survey were taken into consideration while interviewing the participants to provide further explanation or illustrate key concepts from a learner's perspective. Reoccurring key concepts were included in the analysis such as learner success and peer-relatedness. Briefly, the thematic analysis was guided by the research questions of the present study. The survey results and the main findings from the interviews were discussed in accordance with the predetermined and emerging themes.

3.2.1 Reliability

For reliability purposes, the interviewer needed to follow the exact wording of the interview questions (Brown, 2001). The interviewer used follow-up questions based on the flow of individual interviews.

3.3 Participants

The participants in this study belonged to four tracks, namely, health, science, engineering, and humanities. Within the Science Track, participants from two community colleges i.e., Dammam Community College (DCC) and Qatif Community College (QCC) also took part in the study, as shown in Table 4. Learners were placed in three proficiency levels: beginner, intermediate, and advanced (see Table 4 below). 2,306 students took part in the survey, but only 1,577 completed all the questions.

Table 4: Biographical data

Track	Engineering	113	5.12%
	Health	524	23.75%
	Humanities	469	21.26%
	Science (DCC)	179	8.11%
	Science (QCC)	133	6.06%
	Science	788	35.70%
Proficiency Level	Beginner	539	24.17%
	Intermediate	587	40.4%
	Advanced	451	35.43 %
Completed	1,577		68.35%
Dropped	730		31.65%
Total	2,307		100%

4. Results

4.1 Learner satisfaction

As illustrated in Table 5, the satisfaction field indicated that most of the learners were neutral across all the components except for Item 2. The majority of learners agreed that they felt safe as the class was not crowded with many students (M = 1.542, SD = 0.753).

Table 5: Student satisfaction with SHLM

No.	Question	Count	Mean	SD	Description
1	Hybrid learning offers the same learning quality as traditional learning.	1,996	2.036	0.773	Neutral
2	Hybrid learning makes me feel safer because the class is not crowded with students like in a traditional classroom.	1,761	1.542	0.753	Agree
3	I prefer the hybrid learning environment more than the traditional environment.	1,757	1.843	0.83	Neutral
4	The hybrid learning environment facilitates better communication with my teacher more than in the traditional learning environment.	1,757	1.933	0.823	Neutral
5	Hybrid classes have helped me understand English classes overall.	1,757	1.848	0.793	Neutral
6	Hybrid classes make it challenging to communicate with my instructor.	1,612	2.154	0.818	Neutral
7	Information is not delivered the same way in hybrid classes compared to traditional classes.	1,612	2.063	0.835	Neutral

The majority of learners were neutral in terms of feeling motivated to learn English across four items out of six (see Table 6). However, learners agreed that hybrid classes encouraged them to self-learn more than in traditional classes. Furthermore, most of the learners disagreed that the teacher did not encourage the online group to participate in class as they did with the face-to-face students (M = 2.512, SD = 0.701).

Table 6: Student motivation with SHLM

No.	Question	Count	Mean	SD	Description
1	Hybrid learning motivates me to participate more than in a traditional environment.	1,757	1.963	0.814	Neutral
2	I feel more engaged in hybrid classes than in traditional classes.	1,757	1.963	0.819	Neutral
3	Hybrid classes are more interactive than traditional classes.	1,757	2.065	0.819	Neutral
4	Hybrid classes encourage me to self-learn more than traditional classes.	1,757	1.644	0.785	Agree
5	Hybrid classes have helped me enjoy English classes overall.	1,757	1.873	0.821	Neutral
6	The teacher does not encourage the online students to participate as they do with the face-to-face students.	1,612	2.512	0.701	Disagree

In terms of the teacher's and learners' attention in hybrid classes, the results showed that the learners' responses across the following items (1, 5, and 8) were neutral (see Table 7). On the other hand, the learners disagreed that the teacher ignored the face-to-face learners and focused on the online group instead (M = 2.547, SD = 0.663). Furthermore, they disagreed that the teacher did not respond to the online group as they did with the face-to-face group (M = 2.373, SD = 0.755). They also disagreed that the teacher did not give feedback to online students as they did with the face-to-face group (M = 2.341, SD = 0.77). Moreover, learners disagreed that the teachers did not correct mistakes of the online students as they did with the face-to-face students (M = 2.525, SD = 0.693) (see Table 7).

Table 7: Teacher-student attention during SHLM

No.	Question	Count	Mean	SD	Description
1	In SHLM classes, I usually get distracted by other things such as TV, phone, food etc.	1,617	1.754	0.818	Neutral
2	I feel the teacher ignores the online group and focuses on the face-to-face group instead.	1,612	2.324	0.812	Disagree
3	I feel the teacher ignores the face-to-face group and focuses on the online group instead.	1,612	2.547	0.663	Disagree
4	I feel the teacher does not give equal attention to face-to-face and online groups.	1,612	2.547	0.828	Disagree
5	My attention span is short in hybrid classes, unlike in traditional classes.	1,612	1.823	0.834	Neutral
6	The teacher does not respond to the online students as much as they do with the face-to-face students.	1,612	2.373	0.755	Disagree
7	I feel the teacher does provide feedback to the online students' as much as they do with the face-to-face students.	1,612	2.341	0.77	Disagree
8	The teacher directs questions to face-to-face students more than they do to online students.	1,612	2.212	0.818	Neutral
9	The teacher does not correct the mistakes of the online students as much as they do with the face-to-face students.	1,612	2.525	0.693	Disagree

Speaking of challenges related to technology, most of the learners indicated that they were neutral when it came to internet connection (M = 1.706, SD = 0.762). Likewise, they had the same attitude towards using digital platforms (M = 2.251, SD = 0.808) (see Table 8).

Table 8: Technical issues during SHLM

No.	Question	Count	Mean	SD	Description
1	The internet connection always hinders learning for the online group.	1,612	1.706	0.762	Neutral
2	The use of digital platforms for hybrid teaching (i.e., Blackboard, Zoom, Microsoft Teams) is problematic.	1,612	2.251	0.808	Neutral

4.2 Students' grades

To investigate the impact of applying SHLM on learner success, the student grades were compared across three academic years: pre-COVID-19 (2018-2019), during COVID-19 (2019-2020), and the previous academic year (2020-2021) in which this model was implemented. An ANOVA test was carried out to see the impact of SHLM on students' grades in comparison to the previous two years to examine whether there was a statistical significance in the students' final grades. The means of the students' final grades over the following academic years (2018-2019), (2019-2020), and (2020-2021) were (M = 69.92), (M = 71.52), and (M = 72.32) respectively. The result was statistically significant at p = .000 (see Figure 2).

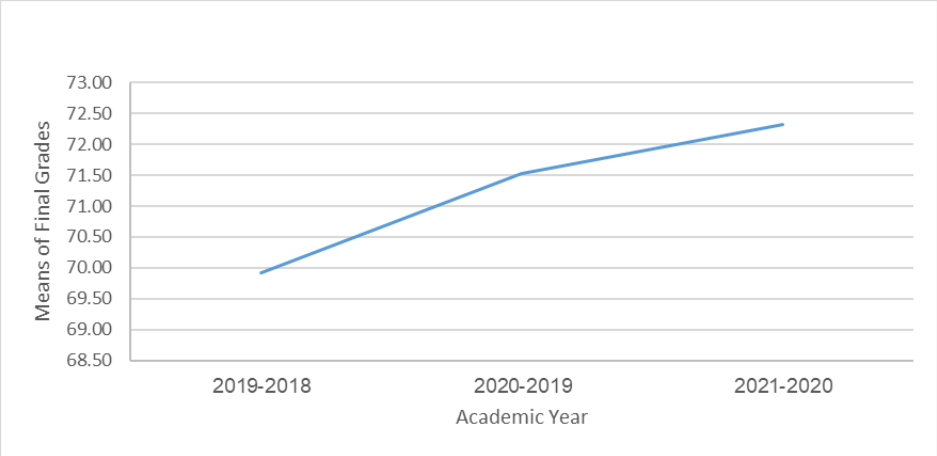

Figure 2: Means of students' final grades

4.3 Efficacy of SHLM

21 participants were interviewed to investigate the model's success from the students' perspective. Most of the participants felt that this model was successful, especially given the circumstances of the pandemic. Although most of them preferred to only have the usual traditional classes, they did believe that the overall experience was positive. The participants then provided an explanation for the model's success. Three common reasons bring this to light, namely the teacher's efforts, students feeling equally treated, and being in a safe environment. Participants' comments included:

The teacher's role was very effective… (A Science Track student)

There is equality when it comes to attending classes. All students get the same chance to come to face-to-face and online classes. (A Health Track student)

… I feel safe because there are not many students in the class. (An Engineering Track student)

4.4 Students' perception

Three factors contributed to the positive impact of the integrated learning environment on students' perception. To begin with, a learner should be able to search for information, exert effort, socialize with their colleagues, and establish a routine convenient for both learning modes. Participants' observations included:

…the other thing is searching for information on the internet, using different platforms and websites. (A Science Track student)

I believe that this experience was a success … Learners need to make efforts to learn by themselves. (An Engineering Track student)

*… focus on communicating with my face-to-face group and socializing with them. (*A Science Track student)

I feel establishing a convenient routine is what makes me succeed in this environment such as sleeping early, waking up early, the environment … I should not attend the class in bed ... it is not important to have my own bedroom but any other place where I feel it is suitable for attending online classes. (A Health Track student)

4.5 Students' needs

Regarding learners' needs, participants mentioned different needs to enable them to adapt and meet the basic requirements of this model, such as internet connection, electronic devices, linguistic ability, and a reliable platform. Participants mentioned:

A laptop, internet, a charger, books, handouts, and vocabs are important needs that the students require in order to be able to succeed in hybrid classes. (A Humanities Track student)

Language ability is very important … to focus and understand what the teacher says. (A Health Track student)

4.6 Face-to-face vs. online classes

Participants were asked how face-to-face classes were different from online classes. Most of the learners mentioned that they preferred to have face-to-face classes since they had a higher level of concentration than in the online sessions. Furthermore, when learners woke up early, they were better mentally prepared for

classes and assignments. Although students were only asked about the English course, they gave examples related to other subjects which served the purpose of the study. They also mentioned that there were differences between both modes of delivery. Participants' comments included:

I do not forget what I have learned face-to-face. (A Science Track student)

I pay attention to the teachers' body language and their eye contact. (A Humanities Track student)

Most learners believed that some of the downsides of online classes were unavoidable as they were in a family-controlled environment. Naturally, each student's circumstances varied according to their family background. For example, participants said:

I get distracted in online classes in the presence of people … chatting with them. Sometimes, siblings share bedrooms and attend classes simultaneously from the same room. (A Science Track student)

… sometimes, my parents ask me to do something during my class time. (An Engineering Track student)

4.7 Student satisfaction with synchronous hybrid classes

Most of the students expressed their satisfaction with this approach as a solution during the pandemic. They were pleased that they did not study remotely, as was the situation in many local universities, and had the chance to be physically present at the university and interact with their peers and teachers. Students mentioned:

I cannot deny that it is the best solution during the pandemic. (A Humanities Track student)

I am satisfied with this model and if they sort out the technical issues, it will be fine. (An Engineering Track student)

4.8 Access to materials

Accessing learning materials was very easy, all students agreed that course materials were available on Blackboard. For instance, two students mentioned:

Books and handouts were available, and we also sent each other materials. (A Science Track student)

I got most of my resources from Blackboard and WhatsApp groups. It was easy to access all materials. (A Health Track student)

4.9 Challenges

Learners encountered various social and technical challenges, but none of the learners indicated health issues related to COVID-19 or their fear of the pandemic. The comments below show the challenges mentioned by the participants as follows:

One challenge was following up on my classes, quizzes, and announcements. (An Engineering Track student)

Some of the challenges I faced were many things I could not understand in class. (A Humanities Track student)

Another challenge was stress … we have long days, many classes that are mixed between face-to-face and online … on the same day we have quizzes or online exams …time management was challenging. (A Science Track student)

Stress … (A Health Track student)

4.10 Receiving teachers' instruction, peer relatedness, class discussion, and SHLM's benefits

In terms of receiving the teachers' instructions, most of the students agreed that the instructions were provided clearly. Furthermore, instructions were delivered in two modes, verbally and written. Participants said:

With regard to assignment instructions, I could understand everything in both online and face-to-face classes. (An Engineering Track student)

My teachers … sent us written instructions via Blackboard just in case some students missed anything. (A Humanities Track student)

With regard to peer-relatedness, most learners felt they could communicate and make friends with both groups. However, learners were able to establish new friendships within face-to-face classes more than within the online ones. Yet, they almost all agreed that it was only a matter of time until they could make friends and communicate with the other group. Additionally, face-to-face learners considered their counterpart group (virtual learners) as competitors during class discussion. Most of the students agreed that social media applications, particularly WhatsApp and Telegram groups, enhanced their relatedness and assisted them in sharing documents, answering each other's inquiries, and explaining parts of their lessons. Participants reported:

> *WhatsApp and Telegram groups have helped me a lot in catching up with any points I missed in class.* (A Health Track student)
> *During class discussions, I participate more and debate issues with the other group…* (A Health Track student)
> *I feel like I really wanted to meet everyone who supported me and responded to my inquiries…* (A Humanities Track student)

Overall, learners felt they could participate in classroom discussion regardless of their learning mode. Nevertheless, they felt more comfortable and engaged in face-to-face group discussions. Participants reported:

> *It was excellent … the environment in the online classes sometimes affects your communication.* (A Science Track student)
> *It was more comfortable to discuss things with the face-to-face group. We get a piece of paper and get a pen, then we start jotting down ideas and talk together.* (A Humanities Track student)

Many students mentioned that there were many benefits to this model. Since this model adhered to precautionary measures and limited the number of students in class, it helped reduce the number of COVID-19 cases among students. Moreover, many students indicated that transportation issues could be easily coordinated when they missed the bus. Or, if there was no available transportation on a specific day, they could attend their classes online on that respective day. Also, when a positive case was reported, the educational process continued remotely following the pacing schedule. Most of the students expressed that they became more autonomous learners. Additionally, students found more time to study instead since they commute to the university only twice weekly. Some students mentioned they had overcome shyness when they spoke. Participants reported:

> *When we realize that a student has COVID-19, we take all the classes online until all students take the COVID-19 test, and if the results prove to be negative … we are already familiar with the procedures of taking online classes*. (A Science Track student)
> *I learned by self-studying and research … I look up information myself and from different sources.* (A Health Track student)

5. Discussion

5.1 Student satisfaction with synchronous hybrid classes

The application of SHLM was employed in response to emergency remote instruction. It has been applied for two consecutive years, 2020-2021 and 2021-2022 and will probably continue. The quantitative results revealed that the learners were neutral with the integrated hybrid model. However, the findings from the qualitative data showed that the learners were satisfied with this model considering the circumstances of the pandemic. They liked it as it provided them with an equal opportunity to attend both face-to-face and online classes. As such, it created a sense of equality among the learners. These findings contradict Romero-Hall and Vicentini's (2017) study in which their participants reported a feeling of inequality in the distance learner group in a synchronous hybrid environment. Their participants felt this way as they did not have the opportunity to attend face-to-face classes or were not given the chance to do so.

Learners in the present study confirmed their awareness of the consequences of the pandemic, and that they felt safe as they were physically distanced and, at the same time, not deprived of communicating with their peers and teachers on campus. Feeling safe was the main reason that contributed to the model success from the learners' perspective. In line with this finding, Singh, Steele, and Singh (2021 p. 163) reported that the "usage of limited on-campus sessions will minimize in-person contact, which in turn would lead to better health outcomes in the long run."

SHLM offered flexibility and balanced variety to learners in terms of attending classes, time, and place when online classes were given. Although the learner timetable was fixed, it was flexible because they were attending classes two days face-to-face and two days online weekly. Gulnaz, Althomali, and Alzeers (2020) reported similar results that flexibility in time created a safe environment for learners. Most of the participants in this study felt at ease in face-to-face classes while taking precautionary measures with a limited number of students in class. Besides, they attended 50% of their classes online which enabled them to save the commuting time and getting ready for face-to-face classes everyday. Furthermore, they were able to independently carry out their e-learning activities at their own pace which was an integral part of the English language program.

Another factor that contributed to the success of this model, perhaps, was the six-day program of professional development prior to implementation and the continuous professional development for teachers. This perhaps played a role in creating a safe and successful environment for the learners as their teachers were trained in utilizing available digital resources and tailoring their teaching methods to suit virtual and traditional classes. This finding is compatible with Chertoff et al.'s (2020, p. 1322) findings which emphasize that "faculty development is key in ensuring competence and confidence" in a new learning environment. Moreover, Raes et al. (2020, p. 284) affirm "that it is important that the educational institution provides sufficient training and support for teachers, both pedagogically and technologically." So, when the course started, the teachers were fully prepared to perform their duties and know how to deal with potential challenges when they appeared, as well as help points being set up on all campuses to provide assistance whenever needed. During emergency remote instruction, Singh, Steele, and Singh (2021, p. 159) reinforced the importance of providing professional development to faculty members since it ensured their success and led "to a better learning environment for students." In short, the SHLM professional development sessions helped teachers diversify forms of hybrid teaching through combining face-to-face and online groups simultaneously and rotating the learning mode consecutively each other day. Therefore, both students and teachers were exposed to a wide variety of digital learning tools such as Padlet, Google Jamboard, and Nearpod which may have enhanced the students' e-learning experience.

5.2 Student motivation in SHLM classes

Motivation is key. The qualitative data revealed that this model has motivated learners to self-learn. Thus, the finding is supported by Al Rawashdeh et al. (2021) in which they explain that lack of self-motivation and lack of self-regulation reflect a tendency to not assign time for completing assignments in online courses. So, since this course combined virtual teaching, e-learning activities, and face-to-face classes, it has forced engagement in the course. Even if learners pay less attention during online classes, they will have to attend the next class face-to-face. Therefore, this constant switch between face-to-face and online modes allows the students to engage in their English courses and with their peers. One learner said:

I learned by self-studying and researching ... I look up information myself and from different sources.

In support of this finding, Ma et al. (2018) stated that flipped classrooms enhanced motivation, critical thinking, self-regulated learning, and problem-solving in environments that were not solely lecture-based. That is to say, integrating e-learning and lectures in a learning environment had a positive impact on the learner experience. This finding is consistent with Singh, Steele, and Singh (2021) who found that one of the strengths of emergency remote instruction was that it led to an increase in learner self-efficacy, self-awareness, and self-paced learning.

Additionally, Gulnaz, Althomali, and Alzeer (2020, p. 322) add that the combination of learning approaches "enhance learners' motivation and enthusiasm for learning as they get the opportunity to feel and work beyond the walls of school" and, "broadens learners' horizons and enables them to receive knowledge and information from diverse channels." Likewise, Watson et al. (2012) agree that combining online and in-person environments aid teachers by using the best of each mode to support learners.

5.3 Student and teacher attention during SHLM

Student and teacher attention is another area that has been investigated in this study. Most learners indicated that they were not ignored by their teachers and teachers gave attention to both groups (see Table 7, Items, 2, 3, 6 & 7). They were mostly positive regarding receiving feedback, receiving instructions, and being treated equally regardless of the teaching mode. A significant factor that may enhance student satisfaction during emergency remote instruction is the e-competency of the teacher. A teacher should be aware of the right platform and how to utilize it to deliver instruction, provide feedback, and treat students in both modes of SHLM equally. This finding is consistent with Singh, Steele, and Singh's (2021) study which also emphasized that motivating students is dependent on the teacher's digital competencies. It is worth mentioning that the majority of the interviewed students stated that they preferred to have only face-to-face sessions because they did not feel as attentive as in the online classes. For example, all the interviewed participants agreed that their attention span in the physical classroom was more evident than in an online setting. Similarly, Raes et al. (2020, p. 283) reported that it "gets more difficult to activate and engage the remote students to the same degree as the students attending face-to-face." The participants provided reasons such as "*I get distracted in online classes especially in the presence of people … chatting with them*." Another factor the students highlighted was not being able to see the teacher's body language which affected their understanding, leading to hesitation in participation in the online mode.

5.4 Technical issues during SHLM classes and challenges

One of the aims of the study was to reveal the challenges associated with SHLM. The quantitative data illustrated that internet connection was an evident issue to some learners, yet most students agreed that the use of digital platforms was not problematic. In opposition to this finding, Nae (2020) reported that learners from some areas in Japan suffered from limited access to the internet and the unavailability of sufficient devices. The interviews revealed other challenges besides technical concerns, such as learning style, personal characteristics, and linguistic ability. This comes in line with Hodges et al.'s (2020) view that learner needs during emergency remote instruction are naturally different from learner needs in an in-person learning environment. For example, participants reported that sometimes they were disconnected from the internet or did not pay the internet bill on time, meaning that they missed classes or part of them. Such a need would not be there in a face-to-face learning environment. Attending to this need, students made up for these classes by relying on their peers or meeting their teachers during their office hours to make up for what they had missed. However, if the teacher was disconnected from the online group, they had to make up for this class either online or face-to-face. In this case, the online group learners fell behind the pacing schedule, and the on-site learners were ahead of them. Another technical challenge was that microphones often did not work, wasting class time conveying the message to the teacher or using the chatbox. The use of technology has become essential since technology-driven education equips the learners with the latest learning skills. In short, these technical challenges can be overcome by learners.

The second challenge was related to participants' learning styles. Some students indicated that they were audiovisual learners who needed to see and listen to the teacher simultaneously. This kind of model affected their understanding and attention span, especially on female campuses where female teachers did not switch on their cameras when teaching the class remotely. However, the benefit of integrating two different learning modes did meet participants' different styles of learning. Furthermore, this model also gave the learner the opportunity to find a learning style that suited them and enhance their self-learning. This result is consistent with Gulnaz, Althomali, and Alzeer's (2020, p. 322) study, which affirms that the "physical learning environment and technology-driven instructional models ideally trigger learners' insight of the course content, meet the needs of varied learning styles and ultimately help accomplish desired learning outcomes."

The third challenge was related to personal traits such as shyness which affected learner participation. For example, one shy student stated that the online mode of teaching has made her feel embarrassed to speak in English and hesitant to speak as this made her feel nervous and uncomfortable. Also, learners' attitudes towards feedback was not always positive, and not all students felt comfortable towards their mistakes being corrected.

Finally, linguistic ability was the most critical obstacle that made it difficult to adapt to this model. To clarify this point, some students from the beginner and intermediate levels thought that a lack of a good command of English language hindered their understanding, especially in online classes. This finding was consistent with Toor's research (2005, p. 36) which touched upon the difficulty "to ask questions and queries through the internet using the English language."

5.5 Receiving teachers' instruction, peer relatedness, class discussion, and SHLM's benefits

According to Evans, Kensington-Miller, and Novak (2021, p. 163), the new typical model of instruction in the 21st century is "the integration of face-to-face and online instruction," which, "is now widely adopted … in course delivery across tertiary institutions." In the present study, most of the students expressed their satisfaction with the instruction delivered by their teachers for classroom discussion and assignment instructions. From the learners' perspective, as indicated in the interviews, participants praised their teachers for giving constant instructions to both groups. Additionally, teachers sent them written guidelines via Blackboard for solidifying the instructions. Moreover, they also added that they communicated with one another on technology-based communication channels such as WhatsApp and Telegram groups to further their understanding and to facilitate their daily assignments. Singh, Steele, and Singh (2021) and Arslan (2021) reinforce that a sense of belonging and connectedness are profoundly important for learner satisfaction during remote emergency instruction. Participants in this study reported that they felt connected to their peers during emergency remote instruction. This finding comes in lines with Arslan's (2021) view that if students are unable to feel socially connected, this feeling may lead to a sense of isolation and disconnectedness from their peers and teachers. Nevertheless, participants did raise one concern regarding instruction and lecture delivery: their wish to have the lectures recorded. However, recording lectures can reduce student attention as the recordings are accessible anytime.

In a study conducted by Evan, Kensington-Miller and Novak (2021, p. 168), it was discovered that "attendance at lectures dropped significantly, and in many cases below 30%" due to the mandatory policy of recording lectures.

It seems that students are comfortable in establishing discussion with their peers either from the face-to-face group or online groups. Therefore, it is easier to initiate conversation and engage in classroom activities with peers from the same learning environment (see 4.10).

Furthermore, this model was beneficial for learners as it promoted learner autonomy, reduced the commuting time, and most importantly, reduced COVID-19 cases during the pandemic. This finding corroborates Toquero's (2020, p. 2) view on "strengthening the educational planning and health measures in the university which provides the students and the rest of the stakeholders with an opportunity to continue learning while preventing the spread of the virus." In short, utilizing digital platforms during remote emergency instruction creates a safe and flexible learning environment (Akcil and Bastas, 2020), and the ultimate goal is to maintain safety. As illustrated in Figure 2, the mean score of learners' grades was slightly higher than the previous years. Learner success might be attributed to the following reasons:

- Students seemed to have gained independent study skills and become more self-reliant. This might be the case because students were required to independently complete e-learning activities on Oxford iQ online platform such as listening comprehension skills, reading comprehension skills, writing assignments on different genres, and grammatical and vocabulary quizzes. Some of the activities were graded, and others were available as scaffolding. Moreover, some of these activities were gamified which might have increased their engagement and motivation.
- Since students attend 50% of classes from home and 50% face-to-face, they gained extra time by reducing the commuting time from home to campus and vice versa. Student might have utilized this time for studying.

In light of the present data, results and findings, learner success may be related to the aforementioned advantages of SHLM application. However, further studies are needed to examine teachers' experience in the approach and the efficacy of the approach in teaching the four English language skills.

6. Conclusion

The evidence from this study suggests that this novel approach of teaching is a workable solution during the COVID-19 pandemic and similar circumstances. Furthermore, most of the learners were overall satisfied with this model. They voiced that the main factors contributing to the success of this model were: the sense of equality among learners, feeling safe, engagement with their peers, and the suitability of the model for different learning styles as it integrated virtual and face-to-face classes simultaneously. In particular, audiovisual learners benefitted from this learning model.

In summary, integrating face-to-face and synchronous online classes is an effective method to transfer knowledge and facilitate learning environment without relying solely on traditional methods. It is worth mentioning that one of the remarkable results which has emerged from the data is that learners have improved their self-learning skills and over time have become more autonomous. Furthermore, using various means of communication has increased discussion between peers, teachers, and learners by means of applications such as WhatsApp and Telegram, office hours, and emails whenever they required further support. Educational institutions with similar infrastructure as of the present study may benefit from the application of this emergency remote instruction mode. Furthermore, this mode may solve the problem of inequality for students who are relying on a single learning environment mode. During emergency remote instruction, learning material should not be sacrificed as was the case in the Malaysian school (Chuad and Mohamad, 2020). Solutions are available, and the application of SHLM can be tailored to the specific needs of an institution.

Most importantly, the semi-structured interviews revealed that the lower proficiency learners raised concerns related to their language ability rather than encountering technical issues, which consequently hindered their comprehension and learning. In other words, the SHLM model was a convenient solution considering the current circumstances caused by COVID-19; however, it should be subject to modifications based on learner proficiency levels. Further research is needed to examine learner satisfaction in acquiring the four skills of the English language separately. These investigations would shed more light on the pedagogy, technology, and training

support needed for this novel approach. Future studies may also look at implementing this approach in secondary level education and gauging young learners' satisfaction with the approach. Besides, future studies may look at teacher satisfaction with SHLM as this study was limited to the students' perspective.

Conflicts of interest

The author has no conflicts of interest to disclose.

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The Accuracy of AI-Based Automatic Proctoring in Online Exams

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Abstract: This study technically analyses one of the online exam supervision technologies, namely the Artificial Intelligence-based Auto Proctoring (AiAP). This technology has been heavily presented to the academic sectors around the globe. Proctoring technologies are developed to provide oversight and analysis of students' behavior in online exams using AI, and sometimes with the supervision of human proctors to maintain academic integrity. Manual Testing methodology was used to do a software testing on AiAP for verification of any possible incorrect red flags or detections. The study took place in a Middle Eastern university by conducting online exams for 14 different courses, with a total of 244 students. The results were then verified by 5 human proctors in terms of monitoring measurements: screen violation, sound of speech, different faces, multiple faces, and eye movement detection. The proctoring decision was computed by averaging all monitoring measurements and then compared between the human proctors' and the AiAP decisions, to ultimately set the AiAP against a benchmark (human proctoring) and hence to be viable for use. The decision represented the number of violations to the exam conditions, and the result showed a significant difference between Human Decision (average 25.95%) and AiAP Decision (average 35.61%), and the total number of incorrect decisions made by AiAP was 74 out of 244 exam attempts, concluding that AiAP needed some improvements and updates to meet the human level. The researchers provided some technical limitations, privacy concerns, and recommendations to carefully review before deploying and governing such proctoring technologies at institutional level. This paper contributes to the field of educational technology by providing an evidence-based accuracy test on an automatic proctoring software, and the results demand institutional provision to better establish an appropriate online exam experience for higher educational institutions.

Keywords: AI-based proctoring, automatic proctoring, online exams, software accuracy, academic integrity

1. Introduction

Remote examination and proctoring have gained significant importance in recent years. The increasing importance is due to the need to accommodate comfort in education, increase security, and accessibility. Besides, the current COVID-19 pandemic has left learning institutions without an option but to adopt virtual learning methods to promote safety and adhere to social-distancing protocols. The increased adoption of remote examination has been linked with other factors besides the importance. For instance, online exams are assumed to help Massive Open Online Courses (MOOCs) and credit-based certifications to achieve credibility. Therefore, instead of students taking examinations in traditional classrooms, emphasis is now on promoting comfort-based learning and effective verification using digital proctoring.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) identified the Coronavirus disease as one of the reasons for the high adoption of remote learning. According to UNESCO, the pandemic disrupted educational activities (UNESCO, 2021). As part of response strategies, governments globally had to shut down learning institutions, and most schools shifted their learning activities online. According to UNICEF (2020) report, an analysis showed high percentages of inability to reach students around the world unless proper educational policies and infrastructure were implemented. Although online learning has shown to work effectively, concerns have emerged about the models that learning institutions have been using for proctoring and the level of analysis used to ensure that students do not engage in malpractices. The concerns are valid because the virtual environment is complex. Therefore, the models used must have a high analogy of suspicious movement detection and the ability to flag and eliminate any aspects that affect accuracy or, at higher level, academic integrity. This type of software invites various detection mechanisms, which include face and noise detection, eyeball movement detection, and device detection. The software can also detect a change of tabs. With this, such a software can add credibility and integrity in examinations to minimize cases of academic dishonesty.

To evaluate, anticipate, and offer ways to defy the infection of COVID-19, new technologies such as Artificial Intelligence (AI), Big Data, and Machine Learning are needed. Artificial intelligence is a branch of computer science that can process large amounts of data and perform functions similar to those of the human brain. AI

technology is rapidly evolving, and its applications span almost every part of our lives, including medical, language processing, business forecasts, the environment, and even our smartphones. AI can also have a positive impact on eLearning processes and serve as a powerful enabler for improvement.

Digital proctoring has been compared with proctoring in traditional examination settings. Arguments have emerged providing various reasons why online courses could be susceptible to academic dishonesty. Kraglund-Gauthier and Young (2012) argued that remote assessments happen in an unsupervised environment. Therefore, it is difficult to determine the correct identity of the individual taking a test. Additionally, online test-takers can have access to materials that are not required in an assessment. It is also speculated that a virtual environment, which is often marked by the absence of an instructor, could encourage collaborative responses from groups of learners (Moore, Head, and Griffin, 2017). Although growing empirical evidence indicates that online examinations are prone to academic dishonesty than other methods, the debate is not yet settled. Therefore, there is a need for experiments to determine the accuracy of online proctoring to eliminate academic dishonesty.

1.1 Research gap

The value of this study paper is derived from filling the gap of testing and assuring the accuracy of auto-proctoring software. The intended contribution of this paper was to examine an AI-based automatic proctoring software and compare it to the human level of proctoring in online examinations. This comparison can be interpreted to better shape the understanding, hence the policy making of online exams' regulation and setup. In addition, this study highlights some of the limitations that may exist in AI-based proctoring software and adds more to the scope of coding improvement for developers (individuals or companies). Moreover, based on the research done by Nigam, et al. (2021) that reviewed 43 papers that were published between the years 2015 and 2021, the focus was mainly on the architecture of AI-based proctoring software in a technical aspect. This study brings human proctoring back to the formula by making the comparison between human decision on online exams and the AiAP decision. The study took place in a Middle Eastern university, which can extend the scope of research to have an international perspective for such technological advancement.

1.2 Research questions

The reviewed literature for this study focused on the improvement of proctoring technology in online exams, and the scope was determined to test the accuracy of one of the proctoring technology types, which is AI-based automatic proctoring (based on a proposed AiAP model). In order to explore the accuracy in terms of the number of cheating cases detected (i.e. number of violations), both Human and AiAP decisions need to be measured, compared, and then the difference between them should be computed to check the variation between a tested model (AiAP) and a verifying benchmark (Human Proctors). Therefore, the study sought to find answers for the following research questions:
RQ 1: Is there a significant difference between the Human Proctor Decision and the AiAP Decision?
RQ 2: Is the AiAP efficient in analyzing and verifying the cases of cheating in online exams?

2. Background review

Despite their different approach to learning, electronic forms of higher education have one objective, which is to help learners achieve the fundamental goals of a traditional university or college setting, such as research. Virtual education relies on the benefits of technology and the skills from campus-based teaching to create efficient designs and delivery. Moreover, it is suggested that an online educational institution must deliver all the aspects of a conventional learning institution, including teaching, staffing, aid, assessments, and evaluations.

2.1 AI-based solutions to maintain academic integrity

Several studies have investigated the accuracy of AI-based online proctoring using experimental approaches. For instance, Alessio, et al. (2017) compared online exam results from proctored and non-proctored online tests. One hundred and forty-seven students enrolled in different sections of a virtual course were assessed using linear mixed effects models. Half of these students were not proctored, while the rest used an online proctoring software. Students who used an online proctoring software required less time for online tests and scored less points. Similarly, another study compared physical processes and online exam evaluation tools.

Another study attempted to revive the unsettled debate concerning academic integrity in online courses. Dendir and Maxwell (2020) used a quasi-experiment where a webcam software was used in online proctoring to

evaluate high stake exams. The courses assessed in the study did not change their structural components even after online proctoring was introduced. Findings from this experiment show that exam scores reduced significantly after online proctoring was introduced in the courses. These results were interpreted as evidence which indicates that cheating happened in online courses before proctoring software solutions were introduced. This implies that online proctoring software is an effective tool for promoting academic integrity in online learning.

Online evaluation is an important part of universities. Evaluation is vital as it helps fulfill the purpose of education, which is to transfer knowledge and skills to students, and award correct credentials. According to Ismail, Safieddine, and Jaradat (2019), the credentials are based on reliable examinations and assessments of specific learning outcomes. Educators make significant efforts to identify and use testing ways to help fulfill the objective of education, while minimizing any form of inconvenient interruption in the process. Considering that most learning processes are conducted virtually, online evaluation relies on technology that can improve the proctoring and review process. AI-based proctoring has been suggested as one of the approaches that can be used to prevent malpractices that reduce the effectiveness of virtual assessments.

2.2 Types of proctoring in online exams: Automated and live

There have been several research papers that categorized online proctored exams in different ways. For example, Nigam, et al. (2021) categorized the proctoring software in general into Live Proctoring, Recorded Proctoring, and Automated Proctoring. Nie, et al. (2020) recommended that live proctoring is more accurate for online proctoring because it does not limit the invigilation process to remote monitoring. In live proctoring, the proctor can view all candidates and their environment through a screen. Live proctoring involves instructors or invigilators assigned the role of monitoring exams and viewing examination candidates in real-time. The proctors review the students assigned to them and confirm their presence. Although the proctor might not always know the identity of all students assigned to them, the device's camera often captures the image of learners holding their identity cards. The proctors monitor students through the process to ensure that there are no cases of impersonation during the exam and to detect any suspicious behaviors.

Live proctored exams are different from automated proctored assessments. Raman, et al. (2021) notes that the former examinees must wait for the specific scheduled time before they can take their exams. This means that many students must undertake an exam at the same time. The method has various challenges that limit its accuracy in online proctoring. One study identified that live proctoring depends on factors like student availability, access to strong Wi-Fi or other networks, and the availability of resources, such as tablets and mobile computers (Kaiiali, et al., 2016). In some systems, the school's preferred environment does not have access to the internet and important applications. This limits examination efficiency.

Recorded proctoring usually involves video recording the student during examination along with other log details. Human proctoring in this case is limited but required. Nevertheless, it can be a time-consuming and costly process (Nigam, et al, 2021). On the other hand, automated proctoring allows examinees to take an examination at their preferred time. The exam can still be monitored despite the time that an examinee takes it. Raman, et al. (2021) report that automated proctoring is fast growing as many educational institutions are adopting it because it saves time and allows individual candidate supervision. Additionally, automated proctoring provides a detailed report about any exam malpractices and fraud. Therefore, device applications like cameras help in monitoring students as they take exams virtually. Automated proctoring allows learners to take their exams without location restrictions. Raman, et al. (2021) found that automated proctoring remains the most effective way of conducting remote examinations.

2.3 Accuracy of AI-based proctoring software

In comparison to the decisions of human proctor versus AiAP, Prathish, Narayanan, and Bijlani (2016) did a study where a fully automated, multimodal proctoring software was used with no requirements to sophisticated or expensive hardware on the students, and without the need of live proctor presence during the exam. A comparison was made between malpractices detected using real (human) proctor and proposed software, and the recorded exam attempts were segmented to 14 timeslots. The human proctor and proposed software had a true false and true negative in terms of decision on malpractice in 11 out of 14 time slots. Their results also showed an accuracy of 80% for the automated proctor software in detecting the active window.

In another study, it was reported by Hussein, et al. (2020) that 12% of the students who took the automatically proctored exam in one of the campuses found difficulties in navigating through the questions. In another campus, there were 14% of students who reported an inability to complete the exam successfully. These are percentages that may require more attention to the technical reasons (if any) that prevented the students from having a seamless exam experience.

False flags are possible in automatic proctoring. In a comprehensive review of facial recognition methods, Anwarul and Dahiya (2020) specified 2 main categories of factors that affect the accuracy of facial recognition algorithms: intrinsic and extrinsic factors. Both types of factors are strongly related to AI-based automatic proctoring because the intrinsic components include the physical characteristics of the human face such as expressions, age, skin tone, and many others. These can affect the accuracy due to their variety and to the limitation of training data (i.e. face samples need to be large enough and representative). Whereas the extrinsic factors can influence the proctoring system because they are responsible for changing the appearance of the face like low resolution, low-quality connection, illumination, occlusion, and pose variation.

Concerning the facial recognition of test-takers, machine learning algorithms that are usually utilized in automatic proctoring are well-trained using thousands of images, nevertheless, they do receive a notable amount of criticism for inaccurate and sometimes biased results against colored skins (Coghlan et al, 2021).

In order to test the accuracy of AI-based automatic proctoring, a method with proper design is needed.

3. Methodology

The study relied on experiments as an effective method to determine the accuracy of AI-based automatic proctoring method. The experiment on 244 online exam sessions were done using Manual Testing methodology, which is a software testing technique used for verification of software to spot and resolve any possible errors or flaws (Anwar and Kar, 2019). Previous experiments used multiple features such as a deep learning neural network called Long Short-Term Memory (LSTM) to compare the proposed software performance with respect to human judgment (Nigam et al, 2021). LSTM are artificial recurrent neural networks (RRN), which is an architecture usually used in several applications, including but not limited to time series prediction, natural language processing, sentiment analysis, image and video captioning, text recognition, and sound detection (Van Houdt, Mosquera, and Nápoles, 2020). In this experiment, it was emphasized that violations of proctoring measurements are assessed collectively rather than individually. Despite this, some essential temporal patterns cannot be identified in original 3D pose. Therefore, LSTMs are important in learning the temporal patterns as they learn them directly from the sequences.

It was assumed that cheating students are likely to look around often, place their hands in their pocket, and keep checking if anyone is looking at them. These students also look at their phones and tablets many times more than individuals in natural conditions. However, proctors should not entirely rely on these findings as some violators are aware of the cues they portray. Therefore, they might intentionally display controlled movements or the opposite of what is expected (Randhavane, et al., 2019). Despite the challenges, universities globally may invest in machine learning technologies to ensure their software can distinguish between deceptive and real cues even as some students keep changing their malpractice tricks. The approach, however, has some limitations, primarily because it is based on information gathered from a lab setting in an educational institution. More accurate studies can be acquired from participants who know little about the context of the study.

3.1 Features

The proposed model of this study is called AI-based Automatic Proctoring (AiAP). The method in this model consists of 5 main measurements: screen violation detection, speech violation detection, different face detection, multi faces detection, and eye movement detection. As illustrated in Figure 1, the features that have been used were: LSTM network is to detect any human sound, the screen detection was performed using a modified version of Safe Exam Browser (SEB), whereas the image processing for facial recognition, eyes movement and identification were performed using Google Vision API.

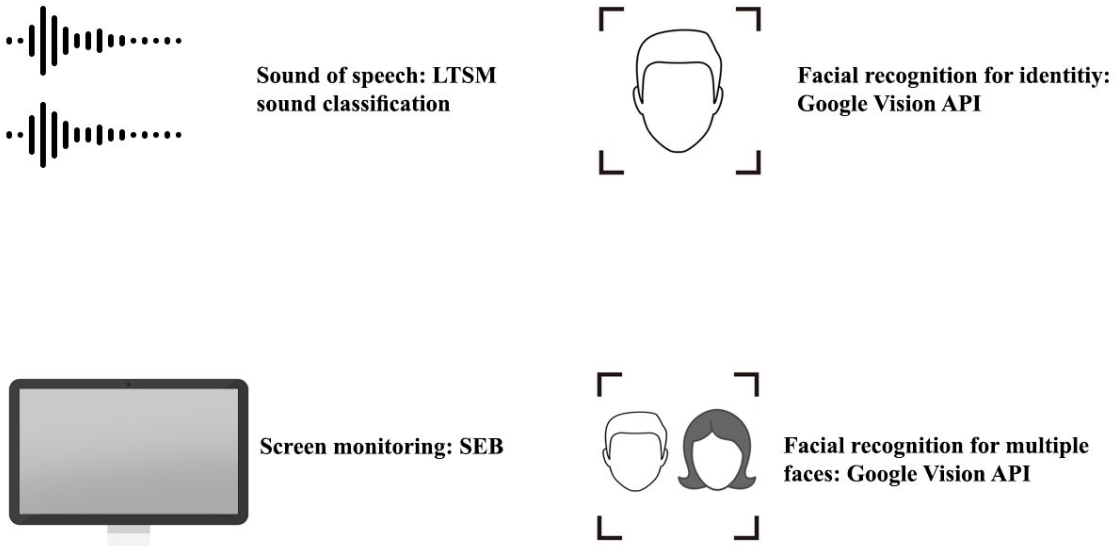

Figure 1: Five measurements taken by the features of AiAP

As previously mentioned, LSTM is an RRN network that is suitable for sound detection. The SEB is an open-source lockdown browser that can detect opened tabs, opened applications in the local computer, Virtual Machines (VM), and internet search or use attempts (SEB, 2021). This lockdown browser can also be integrated into multiple Learning Management Systems (LMS) and other exam solutions. The Google Vision API is cloud-based system that allows developers to integrate multiple features within applications, and these features include optical character recognition (OCR) face and landmark detection (Google Codelabs, 2021).

3.2 Exam structure

The preparations and techniques used in this experiment are summarized in the Figure 2. For more details on each step, the table in Appendix A shows the steps of each part. Screenshots of the online exam within AiAP are included in Appendix B.

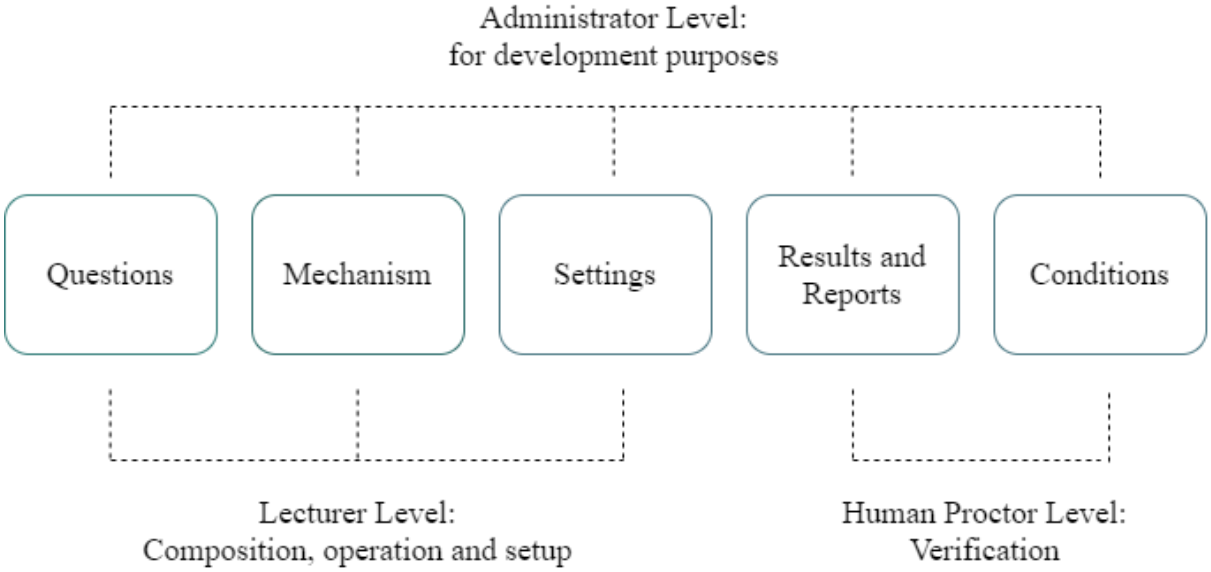

Figure 2: The online exam structure

The online exam consists of 5 parts: Questions, mechanism, settings, results and reports, and conditions. The questions are composed in multiple formats and types depending on the course subject, and they can be put into a specific classification or sub-classification for grouping purposes, in addition to being saved in a question bank. The mechanism consists of the ways the questions behave; for example: how the navigation works (one-way or multi-way), the time counter position and visibility, question shuffling, and live chat box for technical support. The settings are generally about adding and managing the courses and setting up the accounts and

privileges of lecturers and students. Results and reports are basically functions to show the recorded violations, and these violations can be sorted by student or by course. The conditions consist of a list of rules and regulations that students should follow before and during the exam.

The administrator level (i.e. role) has the privilege to control and/or edit all parts for development purposes, the lecturer level can control questions, mechanism and settings of the exam, and the human proctor level is responsible for verification of results and matching them with the conditions. The human proctors are fully aware of the proctoring standards and exam regulations at the university in which the study was conducted.

3.3 Model

The AiAP model is an in-house application designed and developed to help in auto-proctoring the online exams conducted for this experiment. The AiAP proposed model is summarized in Figure 3.

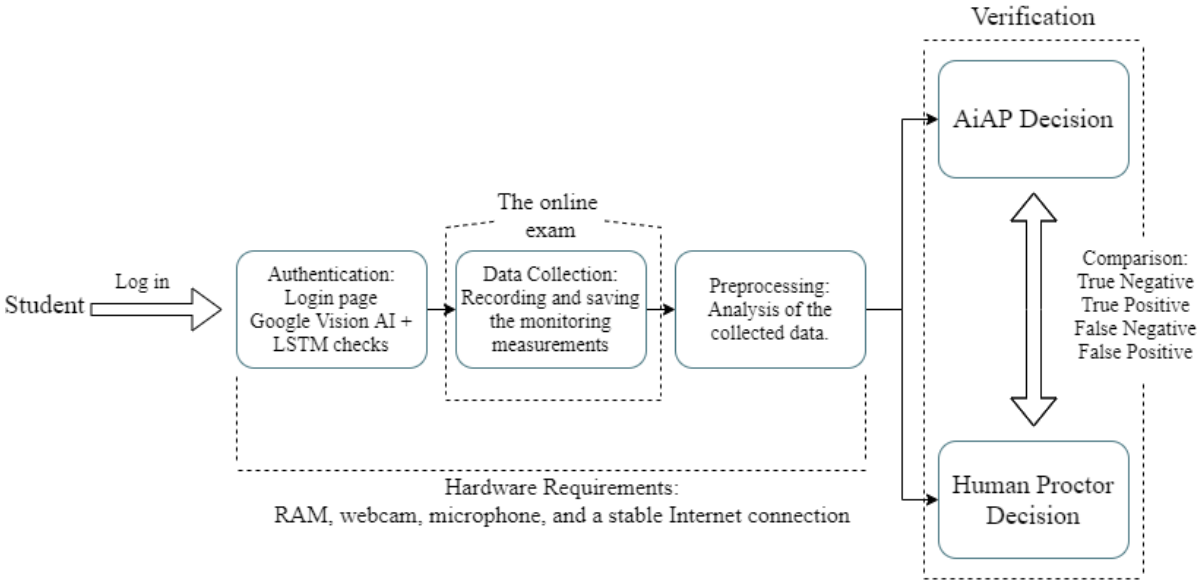

Figure 3: The AiAP proposed model

The AiAP shows the student -at the beginning- an authentication phase that consists of a login page (asking for username and password). Then, once logged in, the authentication continues to another page that asks the student to take a photo, say the word 'Hello' multiple times using the microphone, and then take a photo of their ID card using the webcam. By using Vision API and LSTM features, the software tracks the face, records the voice, scans the ID number out of the card, and finally matches all this information with an external database collected from the student information system (SIS) used at the same university. This process is done for authentication purposes before starting the exam.

The online exam begins, and hence the data collection phase starts. In this phase, the Vision API generates regions of interest from the live videos collected from each student (i.e. object or person), and it recognizes and extracts any suspicious behavior (i.e. the behavior that violates conditions). The pre-processing phase is then done by the software to generate a data of images, screenshots, and voice recordings to collectively form the set of monitoring measurements, namely: eye movement, different face, multiple faces, sound of speech, and screen activity. Lastly, the verification phase (i.e. testing phase 1) is done by AiAP to decide, based on the monitoring measurement results, whether a student has violated the online exam conditions (Positive) or has not violated them (Negative). The same verification is done by the human proctors (i.e. testing phase 2) who labeled the results of each student as positive and negative, in the form of software static (manual) testing methodology. A high number of violations can indicate an attempt to cheat in the online exam. The benchmark to decide whether a cheating case happened or not, was set to a decision of 25% and above. Meaning, if the average of monitoring measurements provided by AiAP or Human proctor was larger than 25% then the student committed a relatively-high number of violations to the conditions and, hence, most likely cheated in the exam.

It should be noted that the software requires some hardware resources, which can be restricted to the availability in every student's device: Random Access Memory (RAM) of a minimum 2GB, a webcam that supports HD aspect ratio, a high-quality microphone, and an internet card with a stable connection. At earlier

development stages, the software was put on training by conducting multiple mock exams to recognize the monitoring measurements (see samples in Appendix B).

3.4 Sampling

The sample of this study was randomly collected from 14 courses in 3 different schools at a Middle Eastern university. These courses collectively consisted of a total 244 students (i.e. 244 online exam sessions). Each online exam was analyzed by the AiAP and given a percentage weight to each monitoring feature: screen violation, speech violation, different face violation, multi-faces violation, and eye movement violation. Afterward, the same online exam results (i.e. data) have been given to 5 human proctors to analyze the behavior of each student, and give a percentage weight for the same monitoring measurements after the exam has been done; which is a part of the verification phase. However, the weight percentages given by AiAP were hidden from the human proctors to avoid familiarity and bias.

4. Results

In this section, we present the results of the experiment done on 244 exam attempts, using the relevant paired sample tests, comparative results, and accuracy measurement. The experiment was based on two hypotheses to compare between both decisions: Human and AiAp.

Null Hypothesis: There is no difference between Human Decision and AiAP Decision (100%).

Alternative Hypothesis: There is a significant difference between Human Decision and AiAP Decision (100%).

4.1 Sample t-test results

A paired sample t-test (see Table 1) was used to compare the mean of Human Decision and AiAP Decision (100%). The t-test was statistically significant, with mean of AiAP Decision (100%) (M=35.6179, SD=12.23946) was significantly higher than Human Decision, (M=25.9552, SD=10.39789, t (245) =-16.146, p<.001, two-tailed.

Table 1: Mean difference of Human Decision and AiAP Decision (100%)

Decision	*n*	*M*	*SD*	*t*
Human Decision	244	25.9552	10.39789	-16.146
AiAP Decision (100%)	244	35.6179	12.23946	
p<0.05				

Therefore, the null hypothesis that there is no difference between Human Decision and AiAP Decision (100%) is rejected. It can be concluded that there is a significant difference between Human Decision and AiAP Decision (100%) in the population. In Table 2, the t-Test: Two-Sample results between Test Phase 1 and Test Phase 2 are included.

Table 2: t-Test: Two-sample assuming equal variances

Decision	Test Phase 1: AiAP Decision Average	Test Phase 2: Human Decision Average
Mean	35.6179	25.9552
Variance	150.90	108.85
Observations	244	244
Pooled Variance		129.88
Hypothesized Mean Difference		0
df		486
t Stat		-9.37
P(T<=t) one-tail		0
t Critical one-tail		1.65
P(T<=t) two-tail		0
t Critical two-tail		1.96

The two testing phases represent the verification process of human proctoring results over AiAP results, leading to a more definitely attributed differences that show the readiness of AiAP. According to Figure 4, the AiAP Decision seems to have detected and classified more violations during the online exams.

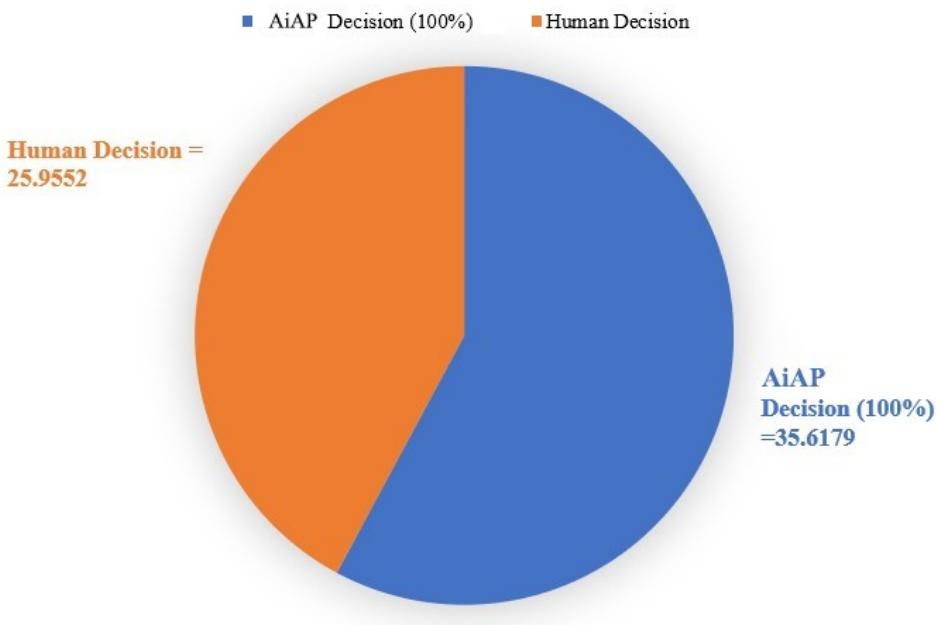

Figure 4: Percentage comparison between Human and AiAP Decisions

According to the AiAP model (review Figure 3), the data was initially collected for pre-processing by the AiAP software and presented in the form of images, recorded sounds, and screenshots. Then the same data was analyzed and verified by the AiAP in the verification phase by highlighting each image, sound, and screenshot that contained a violation with a red color. Each monitoring measurement is accordingly computed and given a specific score (100%). This data was then collected by the researchers and filled in multi-tabbed Excel sheet, sorted by a student sequence number (each student was given a sequence number) and the corresponding monitoring measurements were named after AiAP decision as follows: AI Speech, AI Screen, AI Different Face, AI Multi Face, AI Eye Detection, and finally AiAP Decision.

Then, the same structure was built in Excel and shared with 5 human proctors. The fields were empty, and the data file did not include any percentages/readings from AiAP decision to avoid similarity or bias. The human proctors were asked to perform the verification phase by going through each student record and filling the data under each field (monitoring measurement) as follows: Human Speech, Human Screen, Human Different Face, Human Multi-Face, Human Eye Detection, and finally Human Proctor Decision. The Human Decision is finally computed by finding the average of each monitoring measurement from all 5 human proctors. Two screenshots of the data are provided in Appendix C for reference.

4.2 AiAp accuracy results

In Figure 5, a comparison between the average violations detected by all human proctors and AiAP software is presented. The eye detection was the highest monitoring aspect in terms of the number of violations detected.

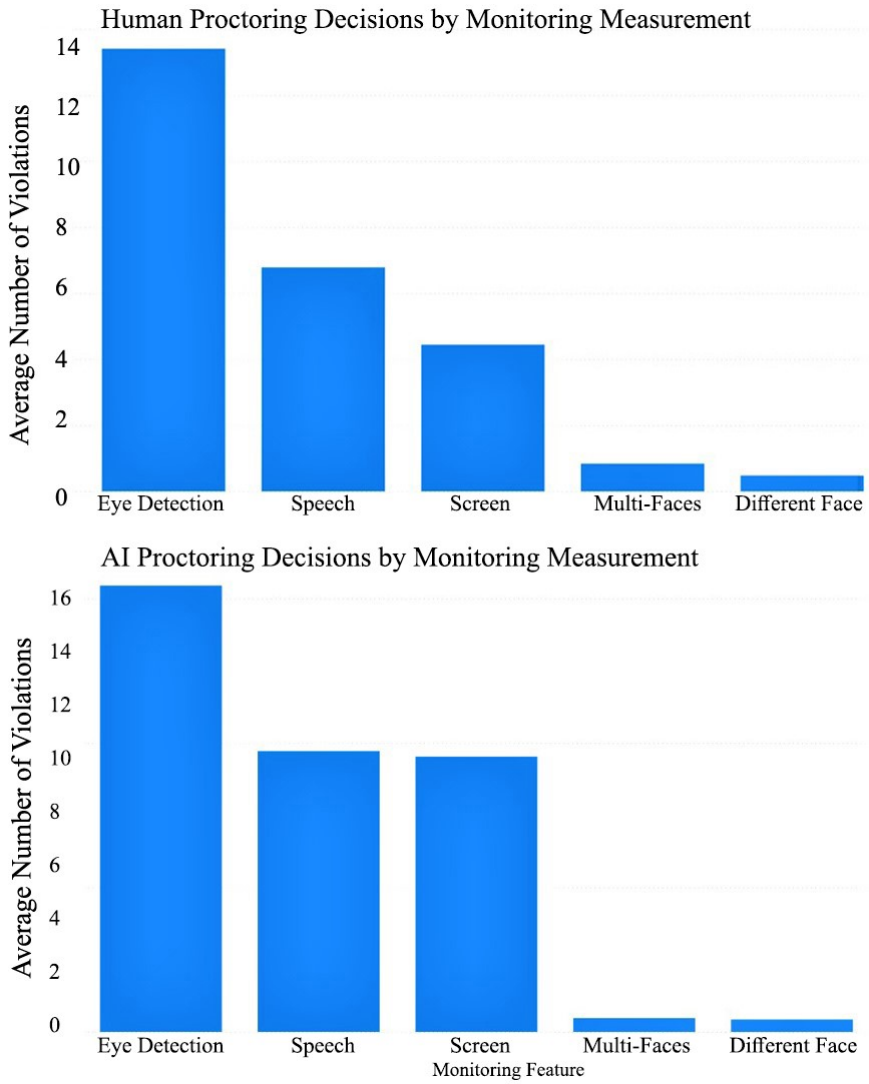

Figure 5: A comparison between the average violations detected by all human proctors and AiAP

The verification phase was done by AiAP to decide, based on the monitoring measurement results, whether a student has violated the online exam conditions (Positive) or has not violated them (Negative). The same verification is done by the human proctors who label the results of each student as positive or negative. A high number of violations can indicate an attempt of cheating in the online exam. As mentioned in Chapter 3, the benchmark to decide whether a cheating case happened or not was set to the average of monitoring measurements of 25% and above.

The final analysis of each decision was based on the following logic:

- If AiAP Decision = 'Negative' AND Human Proctor Decision = 'Positive', then the Result = 'False Negative'
- If AiAP Decision = 'Negative' AND Human Proctor Decision = 'Negative', then the Result = 'True Negative'
- If AiAP Decision = 'Positive' AND Human Proctor Decision = 'Negative', then the Result = 'False Positive'
- If AiAP Decision = 'Positive' AND Human Proctor Decision = 'Positive', then the Result = 'True Positive'

Based on this logic, and since AiAP was set to be compared with Human Proctor decision as a benchmark, the number of correct and incorrect decisions were as shown on Table 3.

Table 3: Number of correct decisions and incorrect decisions of AiAP.

Decision	*n*	AiAP Decision Result	Occurrence
False Negative	244	Incorrect decision	69
True Negative	244	Correct decision	47
False Positive	244	Incorrect decision	5
True Positive	244	Correct decision	123

From these results, the total number of incorrect decisions was 74 out of 244, which counts for approximately 30% of the online exams proctored that were analyzed incorrectly. This outcome leads for a further discussion in the next chapter.

5. Discussion

Debate about the effectiveness of remote online proctoring in online education is bound to continue, especially with the global circumstances that led many educational institutions to adopt distance learning. Despite some drawbacks, there are considerations for automated proctoring methods. It is vital to acknowledge that in-person proctoring has its weaknesses as proctors can miss a cheating incident, leading to ethical issues. Similarly, the analysis presented in this study shows that automated proctoring raises significant ethical concerns. Some of these concerns include cases of unfairness resulting from wrong artificial intelligence-informed judgment. There are also possibilities of intruding students' privacy, autonomy, and various psychological factors (Kharbat and Abu Daabes, 2021), especially in situations where proctoring relies on webcams to monitor learners' environments during assessments. Experiments presented in the study further show that online proctoring relied on data sets. Therefore, it can be speculated that monitoring software can contribute to privacy loss and reduced trust between learners and their instructors as the risk of unauthorized data mining is high. These ethical concerns can be justified by balancing the benefits and developing strategies to minimize risks.

This study sought to answer the following research questions:
RQ 1: Is there a significant difference between the Human Proctor Decision and AiAP Decision?
The answer is yes, there was a significant difference between both decisions based on a Paired sample t-Test. The AiAP made more decisions with 'Positive' cases than Human Proctors.
RQ 2: Is the AiAP efficient in analyzing and verifying the cases of cheating in online exams?

The answer is no, because 30% of the total online exams were incorrectly analyzed. Therefore, the software needs to be considered for further development and improvement in terms of Machine Learning, mechanism, and integration within features.

The analysis of false negative and false positive cases leads to a conclusion that AiAP can be taken to another model of testing and verification over several steps. It is important to notice that some studies found lower incorrectness rates in another AI-based proctoring software. For example, Raj, Narayanan, and Bijlani (2015) worked on an automatic proctoring software with a multi-modal method, through which the test-takers were scanned using image and audio processing, and PC monitoring techniques. The validation of detected malpractices during online exams was made for 12 video segments chosen to measure the accuracy of the software. Out of 12 segments, the software detected higher number of malpractices in 4 segments than the actual malpractices that were done by test takers, and in 6 segments the software detected lower number of malpractices. The overall results of this study showed that auto-proctoring software reached an 8% rate of false positive and 13% rate of true negative. The conclusion by Raj, Narayanan, and Bijlani (2015), however, was about lower necessity of having remote (human) proctors to supervise the online exams.

Based on the finding of incorrect flags, namely the false negative and false positive, some concerns about students' privacy and the accuracy of AI-based proctoring need to be addressed.

5.1 Consequences of using AI-based proctored examination

Any technological change applied in any setting can positively impact individuals and academic institutions regarding reduced time and increased accuracy in conducting online exams (Ilgaz and Afacan Adanir, 2020). However, and while technology is rapidly advancing, it has become imperative for universities to seek solutions for maintaining privacy issues while being connected to intelligent and smart systems.

In some cases, students can be cautious about giving out data that they suppose will not be stored and protected efficiently. Recorded videos, IP addresses, facial identity and ID card scans, and other identity elements are susceptible details that should be adequately preserved. Software solutions should not keep information and store data in a vulnerable way (Slusky, 2020). Moreover, developers of automated proctoring software can consider analyzing the test at any time (asynchronously) in case they suspect any malicious act.

Many universities and higher educational institutions are regularly acquiring novel and intelligent third-party technologies to prevent academic dishonesty aiming to reduce cheating in examinations, and that can replace human proctors. This research suggests that there might be a continuing need of a human presence to control and maintain the quality of examinations, but a robust, reliable, and efficient auto proctoring software can ensure that academic integrity is guaranteed and safeguarded.

5.2 Contribution

This study adds valuable empirical findings and implications targeted at the Middle Eastern region, targeting specific countries with a specific mindset in online examination systems. These countries faced immense examination integrity-related challenges, such as students' high cheating potential, random communication with others using multiple devices, and students who are freely browsing the internet while examining. The mentioned challenges were extremely apparent with the widespread and increasing use of online examinations at many higher education institutions in the Middle East (Tayan, 2017).

However, there are still some concerns about the accuracy of auto-proctoring software. Some studies were made to compare remote and auto-proctoring software with each other. For example, Hussein, et al. (2020) conducted a study of a four-phased method to test multiple auto-proctoring techniques and software for computerized exams at a large scale. The study made an evaluation matrix with the help of students' and professional live proctors' feedback. It is important to notice that software like AiAP requires high costs and efforts to assure the quality of service. Nevertheless, concerns about the accuracy of AI-based proctoring software have been raised, specifically in terms of accuracy of results and flagged behaviors. For example, a report from Clark (2021) showed the results from a well-known remote proctoring software in which there was no correct facial recognition of students from certain ethnicities, which led to putting a red flag on their exam attempt. Another research done by a proctoring company named ProctorU that heavily depends on the post-analysis of human being (similar to the phase 2 testing of this study), has found that no more than 10% of faculty members review the AI-based proctoring results, leaving the verification of flagged exam attempts under suspicion and question. Accordingly, ProctorU announced that their AI-only model would be stopped due to inaccuracy issues (ProctorU, 2021 a and b).

In this case, it is expected that more auto-proctoring development companies will consider adopting the hybrid model in which both AI-based proctoring software and human proctors work together to better shape and control the examination experience. As mentioned by Slusky (2020), ProctorU reported that more than 10% of 1.5 million exams required active intervention within a period of 12 months, which is a statistic that implies the need for this hybrid model where both live (human) and automatic (AI-based) proctors need to work together to assure quality and accuracy of online exam control. This argument was supported by Miguel, et al. (2015).

This study shed light on the need for a smart and state of the art technological proctoring system while conducting online exams and proposed a tested AI-based proctoring system. Thus, the paper similarly suggests that effectiveness of the online exams can be achieved by automated, valid, reliable, and most importantly secure proctoring software with the determination of reassuring and supporting accurate learning outcome production, and safeguarding alignment with constructive implementation. Additionally, the effectiveness and accuracy of such software demands institutional provision and support, as well as the establishment of appropriate atmospheres and surrounding inside most Middle Eastern higher educational institutions (Raza, et al., 2021). There are speculations that online proctoring technologies could lead to social trajectories or similar possibilities. These risks are not easy to assess. Despite this, they should not be ignored. Some colleges and universities have avoided AI-based technology as a way of avoiding such risks. Additionally, it is expected that more universities will make efforts to enhance security to encourage more students to embrace online learning and assessment methods. Besides their efforts, universities should consider reaffirming to stakeholders, including instructors and students that they will not become victims of governments and powerful corporations who might want information to deprive online learning participants of their freedom. This implies that it is the university's responsibility to uphold a culture of trust that has been there in traditional educational settings. Furthermore, higher educational institutions are encouraged, based on the findings of this study, to involve the support of human proctors as a backup, or as an extra verification engine, to seek a higher quality of automated proctoring. A 'Blended' type of proctoring may be proposed for future research.

5.3 Limitations

The proposed software has some technological limitations, however, such as the inability to share the webcam with two distinct applications, which prevents the proctor from utilizing any other online communication application to monitor exam candidates in real-time. This restriction also applies to microphones, which prevent candidates from asking questions or communicating with the human proctor, teacher, or advisor during the exam. Because of these constraints, the auto-proctoring software of this study can only work on its own, with no online (live) monitoring from a human proctor.

Furthermore, in terms of technical capabilities and logistics, the proposed software has limitations and several challenges. The main challenge that may affect the overall performance of the proposed software is the low quality of webcams and microphones (Usually, the auto-proctoring needs a full HD quality to have more accurate results), in addition to internet connection fluctuation and poor internet connection in some areas, especially in the country where this study was conducted. In addition, as proposed by Slusky (2020), there are multiple constraints that need to be considered in terms of cybersecurity for AI-based proctoring software in general, such as compliance with digital criminology and security laws nationally and internationally, lockdown of copying and pasting in the online exam, prevention of proxy in taking the exam (i.e. a student taking the exam on behalf of another), prevention of using virtual machines and remote access, and detection of a second monitor.

5.4 Recommendations and closure

Online proctoring becomes more accurate when the system is automated with less human intervention. Automation allows efficient data transfer and real-time monitoring, consequently detecting malpractice cases that human proctors cannot identify during assessments, especially in the case of large numbers of students. More studies should be conducted to test the AI-based automatic proctoring software in terms of compatibility with Internet browsers, variation of course types, more question types and extra detection techniques.

In terms of methodology, more human proctors can join future studies and participate in accuracy and accuracy testing of auto-proctoring. Testing can be done by taking samples of recorded videos of the students, rather than having to screen and review a full recording. This can be done by choosing random samples from the recorded -proctored- material, which might be labeled as 'violating' and 'non-violating' samples to focus the efforts of accuracy testing.

The primary objective for this study was to evaluate the accuracy of AI-based automated proctoring in enhancing academic integrity. An analysis of various proctoring methods showed that all invigilation approaches have some weaknesses. Therefore, it is recommended that educational institutions should employ a multiple-approach model to improve exam monitoring accuracy. Despite this, delivering and monitoring examinations using an online, automated software have the potential to be more effective and accurate than the traditional approach.

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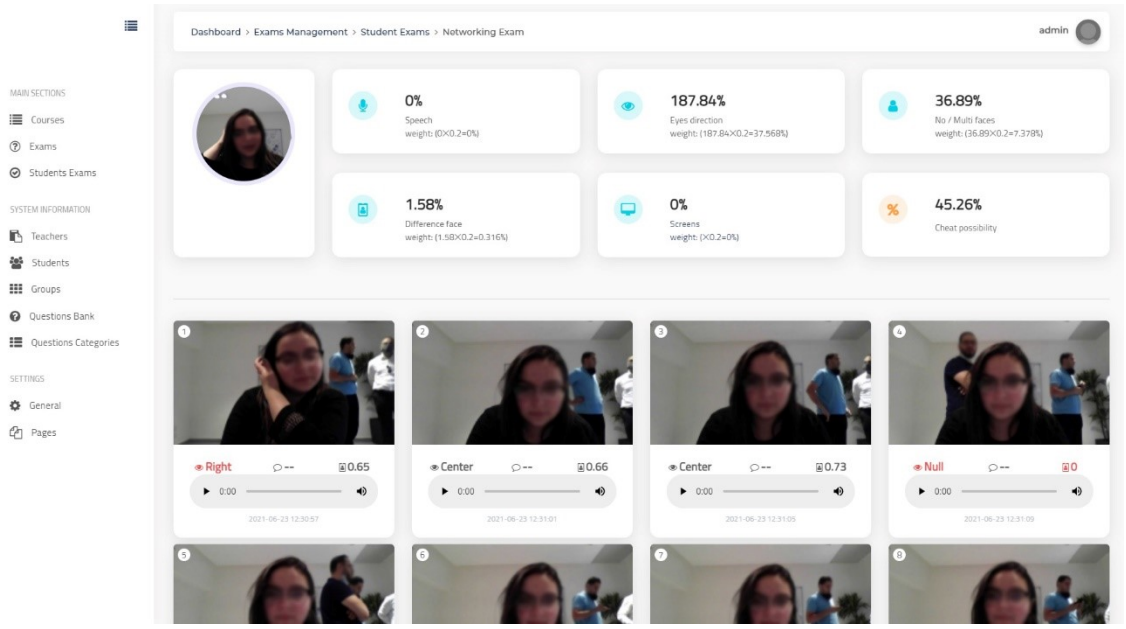
Appendix A: Exam mechanism

Examinations	Examinations are administered as follows:
	1. Adding a classification and sub-classification of questions 2. Choose type of question: a. Multiple choice b. True/False c. Write the correct answer (to be graded manually) 3. Create question bank Add a question a. Name of question b. Question text c. Type of answer d. Add answers if using MCQs e. The question-and-answer text is added using Text Editor to add images and other font formats.
Administration	The system is managed according to the following:
	System General Manager: 1. Managing lecturers 2. Management of teaching materials 3. Student management 4. Managing the question bank 5. Viewing the results 6. Creating an exam 7. Viewing reports Lecturers 1. Managing his/her own teaching materials 2. Viewing examinations 3. Administering of exams 4. Managing the question bank 5. Confirming results 6. Viewing the students
Exam mechanism	The exam has a specific mechanism, as follows:
	1. The exam can be one-way: Each question is allocated a certain time to answer, and the student can/cannot return to the previous question after answering. 2. The exam can be two-way, where students can move between the questions. 3. At the end of the exam, a specific time will be allowed to review the answers. 4. The questions are selected so that they cannot be repeated for any student in the same exam. 5. At the beginning of the exam, the following are checked: a. The student's photo b. Screen sharing c. Sound sharing which is checked by saying "Hello" 6. The exam is shown on-screen with three separate areas: a. Question area b. Answer area c. Online observer area d. Also the clock, the calculator icon, and the chat text. 7. The exam may only be taken on a desktop device, using the Chrome browser. 8. The exam cannot be interrupted. In the event that the exam is disconnected, it is possible to return to the exam at the same point of disconnection.
Obtaining the result	The results are obtained by following criteria:
	1. The number of monitoring violations made by the student is extracted so that the human proctor or the system administrator can see the errors and then either reject or approve the examination and the result. 2. Violations include:

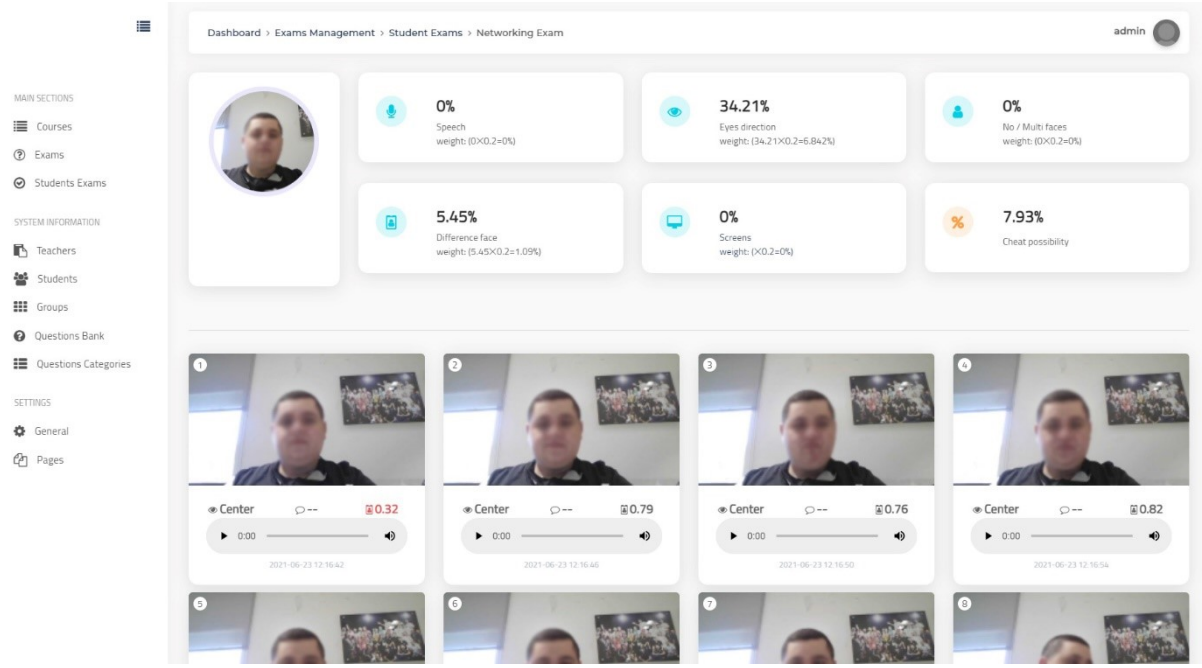
	a. A different face or two faces on the screen, or a face that does not look at the screen or is covered. b. The student cannot use a still image or a static or pre-made video as it is verified during the exam. c. Moving the eyes or fixing them in a place other than the middle of the screen. d. The student speaks. e. The student opens any page on his/her computer that violates the exam interface. f. Use of any still image or pre-made video.
Conditions placed on the student	The following conditions are placed on students:
	1. Opening the exam in the Chrome browser is preferred. 2. The presence of a camera on the device in the middle of the upper part of the screen. 3. Documenting the student file by filming the student during the exam. 4. A microphone that is working properly and is tested prior to the exam by the system. 5. Allow student screen sharing. 6. Take the exam in a quiet room and avoid making human speech sounds. 7. The exam cannot start if one of the control applications is running on the student's device (Zoom - AnyDesk - TeamViewer - Remote Desktop).
Reports	The reports are generated by following:
	The lecturer receives a page showing the names of the students who took the exam in addition to the total number of errors (violations) and the progress of the examination. Pictures of all students who took the exam and pictures of all exam screens.
Technical support	Technical Support includes the following:
	Live chat system between the student and the lecturer in case of inquiries.

Appendix B: Screenshots from the online exam within AiAP, showing a sample of the visual dataset

Faces sample 1:

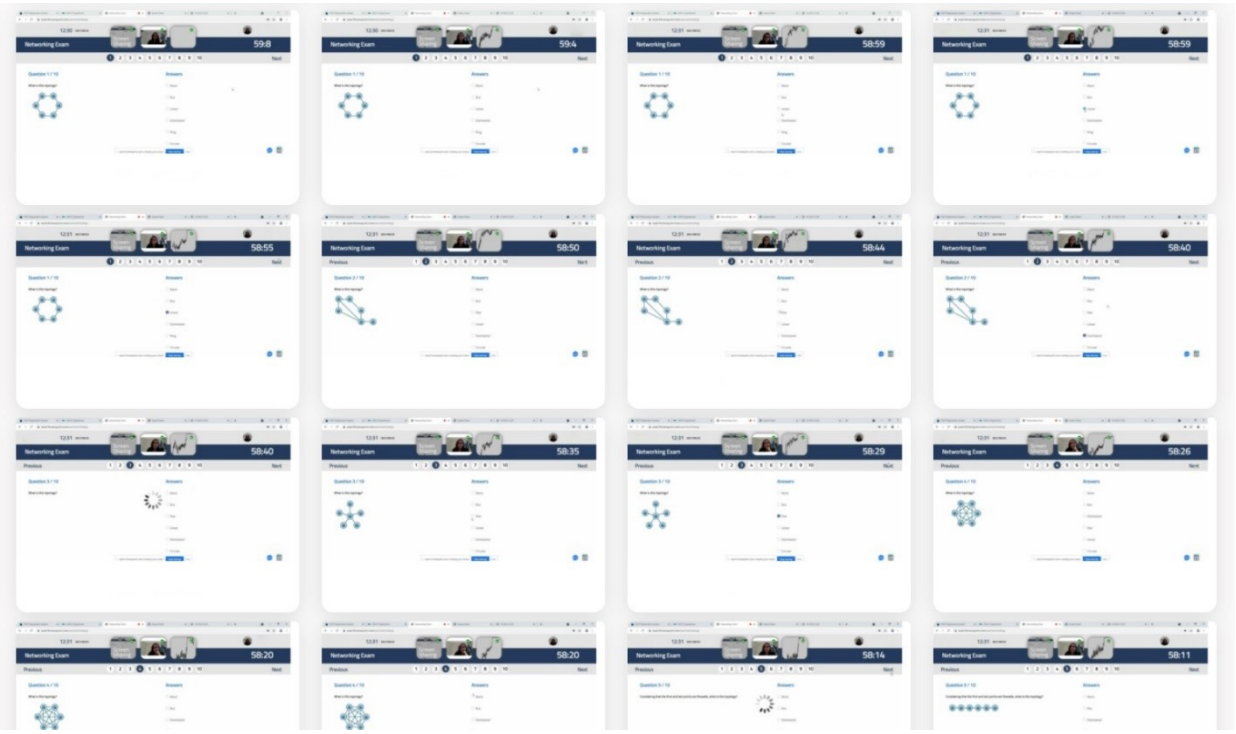


Faces sample 2:



Screenshots from the online exam within AiAP

Screen monitoring sample:



Appendix C: Screenshots showing a sample of the collected data

Student Sequence Number	AI Speech (20%)	AI Screen (20%)	AI Different Face (15%)	AI Multi Face (15%)	AI Eye Detection (30%)	AI Proctor Decision (100%)
1	15	8	0	0	14	37
2	14	8	15	0	29	66
3	19	17	0	11	1	48
4	0	6	0	0	9	15
5	0	2	0	0	14	16
6	8	4	0	0	10	22
7	3	4	0	12	25	44
8	11	9	0	0	14	34
9	18	14	0	0	14	46
10	18	1	0	0	5	24
11	10	18	0	0	12	40
12	4	15	0	0	10	29
13	8	16	0	0	0	24
14	17	6	0	0	4	27
15	14	11	15	0	19	59

Student Sequence Numb	Human 1 Speech (20%)	Human 1 Screen (20%)	Human 1 Different Face (15%)	Human 1 Multi Face (15%)	Human 1 Eye Detection (30%)	Human 1 Decision (1
1	10	5	0	0	11	26
2	12	0	15	0	26	53
3	10	20	0	15	0	45
4	2	3	0	0	6	11
5	2	0	0	0	11	13
6	6	1	0	0	7	14
7	1	1	0	15	22	39
8	9	6	0	0	11	26
9	0	11	0	0	11	22
10	0	0	0	0	2	2
11	8	0	0	0	9	17
12	2	0	0	0	7	9
13	6	0	0	0	0	6
14	15	3	0	0	1	19
15						

From face-to-face to Distance: Towards Flexibility in five Dimensions of Blended Learning: Lessons Learnt from the Covid-19 Pandemic

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Abstract: In the rapid switch from contact to distance learning in response to the 2020 Covid-19 pandemic staff at a university of technology with predominantly vulnerable students had to switch to emergency teaching and learning. This rapid switch required enormous flexibility of all staff and students in relation to five distinct dimensions – place, time, service, technology, and pedagogy. This reflective piece considers implications of each of those dimensions, as well as the extent to which lecturers worked within them in their attempts to save the academic year. Data, consisting of emails, WhatsApp messages, minutes of meetings, lecture notes, Zoom recordings and online forms, were analysed thematically and categorised into the five dimensions. These findings are then compared to the literature on knowledge management, learning theory and emergency teaching during the pandemic. The contribution of the study lies in a decision framework for the selection of technologies and pedagogies along the five dimensions of flexibility in blended learning.

Keywords: blended learning; distance education; place; time; service; technology; pedagogy

1. Introduction

It was while they were in recess at the end of the first term that university staff in South Africa learnt from a television broadcast by the President that they would not be returning to their classrooms for the next term. Everybody – executive management, administrators, teaching staff and students heard it at exactly the same moment, and nobody had been prepared for it. So began the scramble to save an academic year that had hardly started, using whatever means and techniques available. As a lecturer to first-year students, a professor and supervisor of post-graduates and a dean of a faculty with more than 3000 students I was in an interesting position experience the situation at both operational and management level. The emergency teaching and learning situation caused a significant number of conventional and regulatory restrictions to be lifted, and experimentation occurred at an unprecedented level. This article seeks to reflect on what was learnt in the process, in order to consider what new approaches could be followed when we return to the "new normal".

This reflective piece (Ellis, Adams and Bochner, 2011; Chan Kent, 2020; Livesey and Runsen, 2018) aims to explore some of the patterns that emerged as we embarked on a journey of discovery trough extremely troubled waters of emergency teaching and learning. It is told in the context of an institution where more than 70% of students are first-time entrants into higher education and many students' homes are more than 500km away from campus. Most students live in rural areas that have very low internet connectivity. The lockdown came as the students were home during recess.

Lecturing staff at the institution have always exhibited high levels of care for their students. This care was quickly translated to a distance mode. This article will provide some concrete examples of lessons learnt, in order to contribute to the unfolding pandemic stories that shape our understanding of the wide range of lecturers' use of educational technology, when "there has never been a moment in the history of humankind when professional development guidelines, resources, programs, and other training initiatives were more desperately needed" (Bonk, 2020).

The aim is to extract, from the chaos of *emergency remote teaching*, a few insights that would either support or contribute to our existing knowledge of flexible learning with educational technology. These insights will be classified in terms of five types of flexibility: Place, time, size, technology, and pedagogy, and from there a decision framework will be constructed to determine levels of flexibility for blended learning.

2. Problem statement

The problem driving this study lies in how five variables of flexibility, (place, time, service, technology, and pedagogy) may influence the design of blended learning experiences and exploring how the institution in this

case study addressed these variables with their predominantly vulnerable students. The solution was found in the high level of flexibility shown by management, administration, teaching staff and students.

The contribution of the paper is a decision-framework for blended learning, based on five categories of flexibility (Veletsianos and Houlden, 2019).

3. Literature survey and theoretical framework: Media selection and flexibility

The stated objective of the university in this case was to ensure that the pass rate of 2020 is the same as 2019, and that "No student will be left behind". In the process it moved from contact to distance and used an entirely different set of media. This article will consider the flexible design choices made by the institution and its staff in trying to achieve that aim.

In discussing the rapid transfer from contact to distance teaching and learning this article takes note of Tom Russell's *No significant difference phenomenon* (Russell, 1999), an analysis of more than 355 instances dating back to 1928, which suggests that there seems to be no significant difference in outcome between any two different media of instruction. Contact and distance education are thus equally valid.

Closely aligned with Russel is the famous debate between Richard Clark and Robert Kozma about the influence of media on learning. Clark argues that the medium has no more of an impact on the quality of learning than the delivery vehicle has on the nutritional value of the food it delivers. Kozma, on the other hand, argues that certain media may be better suited to certain types of knowledge. Insulin taken orally will be digested. It has to be injected (Clark, 1994; Kozma, 1994).

Following on Kozma's argument, one might draw on the work of Kurtz and Snowden (Kurtz and Snowden, 2003) who propose that there are four knowledge domains, Complex, Knowable, Chaotic and Known (Figure 1). Complex knowledge only becomes evident in retrospect and involves pattern management where learners probe, sense and respond. Knowable knowledge has cause and effect separated over time and space and is the domain of systems thinking where learners sense, analyse and respond.

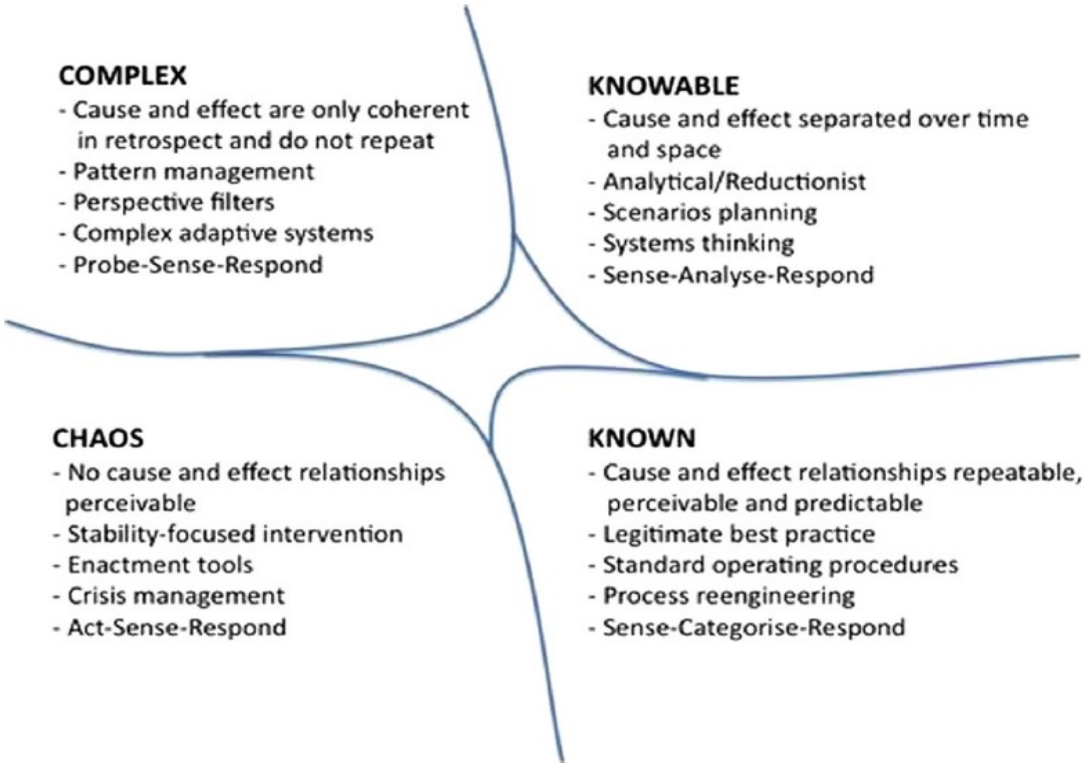

Figure 1: Four domains of knowledge (Kurtz and Snowden, 2003)

Chaotic knowledge has no perceived cause and effect relationship and is the domain where learners act, sense and respond. Known knowledge has predictable cause and effect relationships that learners must sense, categorise and respond to.

Combining this model with Kozma's (1994) argument that different types of knowledge require different media one could argue that known knowledge could be presented directly in the form of text, video or audio. Knowable knowledge may require case studies – actual or virtual – where scenarios are played out. Complex knowledge requires simulations where multiple variables must be manipulated, and the Chaotic domain is where incidental learning takes place as learners make meaning of their experiences (typically during work-integrated learning). The medium for chaotic learning would be log-books, portfolios or other ways of recording incidental learning.

Our experiences resonate with other academics "who had to rely on several learning platforms and adopt different teaching strategies in conditions never experienced before" (Martins et al., 2021, p.1). A case study from Peking University suggests five such strategies: "(a) high relevance between online instructional design and student learning, (b) effective delivery on online instructional information, (c) adequate support provided by faculty and teaching assistants to students; (d) high-quality participation to improve the breadth and depth of student's learning, and (e) contingency plan to deal with unexpected incidents of online education platforms" (Bao, 2020, p.113).

At the heart of the institutional aim to leave no student behind lay a call for flexibility in just about every aspect of the functioning of the university. To make sense of this high degree of flexibility this paper will consider five categories of flexibility: Flexibility of place, flexibility of time, service-oriented flexibility; technological flexibility and flexible pedagogy (Veletsianos and Houlden, 2019). In conceptualising this study our experience will be classified into these five distinct categories

3.1 Flexibility of place

In the design of flexible **places** earning spaces there is a move towards hybrid spaces. These spaces follow four design patterns along two dimensions: formal and informal social structures, and a blend of physical and digital tools (Eyal and Gil, 2020). In terms of deciding between formal and informal learning spaces it was found that students with application-directed learning patterns preferred innovative and flexible learning spaces, while those with a reproductive learning pattern preferred traditional learning spaces. (Yu, Vermunt and Burke, 2020). For the majority of students the home is the preferred informal learning space, and there is a strong correlation of student grades and how long they study at home (Vanichvatana, 2020).

Students have shown a preference for elearning to enhance their learning. Nevertheless, they feel that it leads to social isolation. Thus it is clear that a blend of technology and contact would be appropriate (Zuhir et al., 2021).

One of the most significant aspects of space during the pandemic, lies in its exposure of inequality. While for some working from home has been a welcome luxury, others have found the colonising of their already overcrowded home space by the intrusion of work or school most disruptive (Williamson, Eynon and Potter, 2020). In the South African context it has been argued that rural learners are excluded from education when only online learning is available (Dube, 2020).

3.2 Flexibility of time

The second dimension is time, which may be categorised as full-time, part-time and flexitime (Sheail, 2018). Further dimensions include synchronous to asynchronous, as well as time-on-task: Short and long. The immediacy of synchronous communication allows for the development of a sense of presence (Rehn, Maor and McConney, 2016). Synchronous communication also allows for easier group work which helps build productive social interaction (Walker, 2017). Asynchronous communication gives great flexibility of space and time and also provides learners with time for reflection, which may lead to deeper understanding (Pleines, 2020; Rehn, Maor and McConney, 2016). On the down-side asynchronous communication leads to feelings of isolation that could contribute to a higher attrition rate (Borup, West and Graham, 2013; Asanov et al., 2021). While many universities have had learning management systems in place for quite some time it is synchronous video conferencing that has shown the strongest increase in uptake during the pandemic (Kaqinari et al., 2021).

Gous & Roberts (2015) warn of the impact of technology on instructor time and the potential for academics to be progressively drawn into working longer and longer hours without realising it. This confirms Mike Spector's finding many years ago that while students spent a little more time on online instruction, online instructors spent significantly more time teaching than their face-to-face colleagues (Spector, 2005). Again this resonates with an Ecuadorian study that showed during the pandemic students spent roughly the same amount of time with online learning than they would have in a contact situation (Asanov et al., 2021).

3.3 Service-oriented flexibility

Service-oriented flexibility is associated with inclusivity, accessibility and equity (Veletsianos and Houlden, 2019). The role of the pandemic in exposing social inequity and injustice is well reported (Nicola et al., 2020; El-Mohandes et al., 2020). People with disabilities, as well as those who support them, are particularly vulnerable at this time (Scott and Aquino, 2020). Access to broadband and hardware is one of the most significant concerns in ensuring an equitable service for all (Cesco et al., 2021).

Community engagement has been proposed as a way of addressing inequalities (Aminur Rahman, 2020). group size, was identified as a key variable in creating social presence (Lowenthal and Dunlap, 2020). While group size does not seem to influence individual responses, it has a meaningful impact on interaction. In class-wide groups students receive unequal attention. Some become stars and some are neglected, while smaller groups lead to a sense of community (Wang et al., 2020).

3.4 Technological flexibility

Digital higher education has been seen as both a bridge builder and a divider during the pandemic, with access, learning and collaboration being the strengths, and inequalities at individual, institutional and systemic levels forming the weaknesses (Laufer et al., 2021).

The immediate nature of the pandemic has meant that institutions scrambled to find the first available technology, and thus a plethora of technologies (such as Moodle, Blackboard, Microsoft teams, TV, Zoom, and Google Meet) have emerged without clear guidelines for policy and practice (Basilaia and Kvavadze, 2020). Mobile learning, and WhatsApp in particular, have been suggested as necessities (Naciri et al., 2020; Tarisayi and Munyaradzi, 2021). The diverse range of technologies available makes it necessary train lecturers how to choose and use them (Nguyen and Chung, 2020). The digital maturity of an institution must dictate the educational technology strategy (Kaqinari et al., 2021).

3.5 Flexibility of pedagogy

Despite the debates around the differences that technology can, does, or does not make in delivering learning (Russell, 1999; Clark, 1994; Kozma, 1994), technology has put learners at the centre of their own learning. They can access just about any learning resources at just about any time. The role of the teacher has also changed since the teacher is no longer the main source of information.

Pedagogical flexibility ranges from direct instruction to generative, project-based learning. There is a traditional divide between direct and indirect approaches to learning with some authors claiming them to be mutually exclusive, sometimes in quite explicit terms: "Constructivism is completely incompatible with objectivism" (Duffy and Jonassen, 2013, p.91). Nevertheless The pandemic has resulted in a convergence between traditional direct-instruction based online teaching and problem-based learning (Bumblauskas, 2017). This convergence resonates with Cronjé (2006) who has argued and with Elander, who has demonstrated, that the two can be plotted at right angles to form four quadrants of learning (Elander and Cronjé, 2016). The four quadrants (Figure 2) range from a chaotic quadrant with no overt planning either of constructivist or behaviourist nature, through a quadrant that is highly behaviourist and one that is highly constructivist to a quadrant of integration where an instructor would use both behaviourist and constructivist elements in the same learning event, depending on the learning context. The immersion quadrant is the domain of experiential learning where there is no clear evidence of structured behaviourist learning, nor of scaffolded constructivism. The injection quadrant is for direct instruction of known concepts, and the construction quadrant for project-based learning. The integration quadrant speaks to a design that would use both direct instruction and project-based learning almost simultaneously.

The pandemic resulted in a great deal of "emergency experimentation" (Williamson, Eynon and Potter, 2020), where lecturers experimented with methods that are located in each of the quadrants.

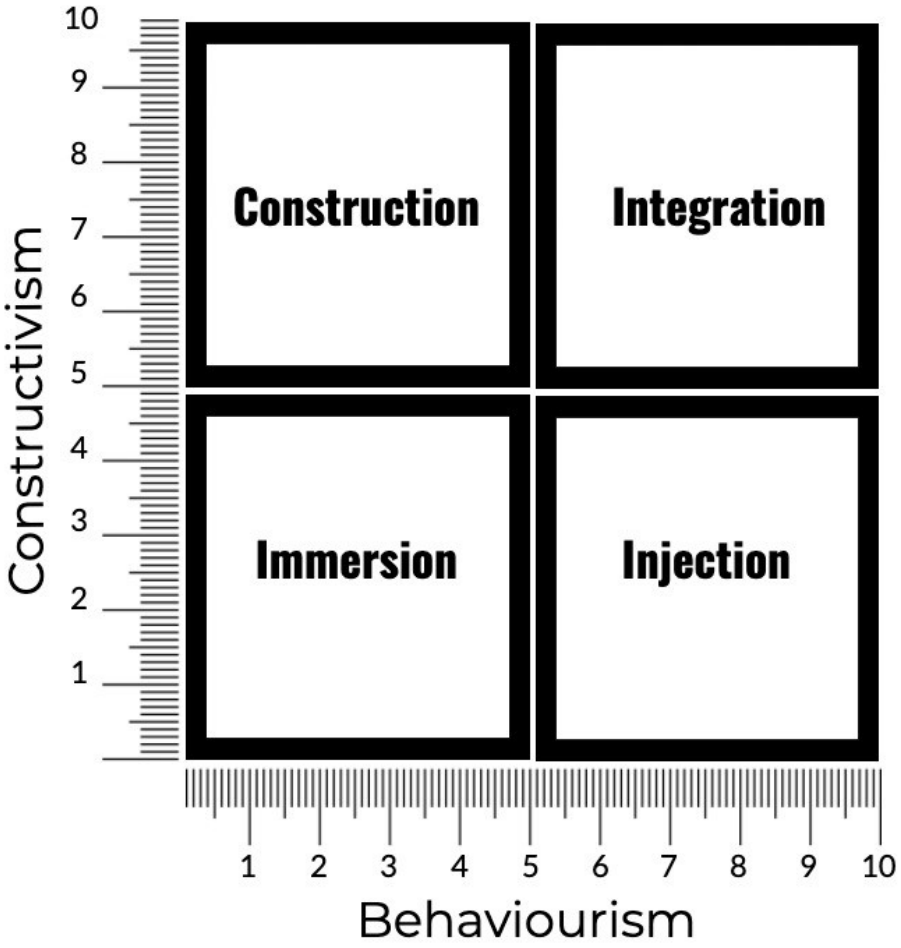

Figure 2: Four Quadrants of Learning

4. Method

The rationale for this reflective case study is to uncover contextual conditions (Yin, 2013) of flexibility (Veletsianos and Houlden, 2019) that may resonate with other stories of higher education institutions (Bonk, 2020) with predominantly vulnerable populations coping with the pandemic (El-Mohandes et al., 2020).

Methodologically, as an educator, I draw on Kolb's experiential learning cycle (Kolb and Kolb, 2017) as I work through my own phases of concrete experience, reflective observation, abstract conceptualization and active experimentation. I also cycle through both reflection in action and reflection on action (Schön, 2017), as I consider our immediate responses to the challenges of the pandemic, as well as the lessons learnt on thinking back on them. I reflecting on communication with students and fellow academics I follow a model of collegial sharing that includes an analysis of the aesthetic, personal, ethical, empirical and reflexive elements experienced (Johns, 1995). The critical reflection is prompted by three questions (Rolfe and Freshwater, 2020), What, so what, and now what?

4.1 Data sources and analysis

The principal source of data is my lived experience, my own recollection of events as they unfolded, backed up by emails, WhatsApp messages, minutes of meetings with my seniors and my staff, lecture notes, Zoom recordings, and online forms that were created to poll staff regarding their progress through the syllabus, and for student feedback on teaching and learning. In this personal reflection, for ethical reasons, I draw only on my reflection on these experiences and do not quote directly from any data source.

In analysing the data I followed a grounded approach where I worked systematically through each of the themes of place, time, service, technology, and pedagogy. For each of the themes I would consider the literature, as well as the reflections that were triggered. I would then look for the most salient resonating factor, be it an email, a discussion, a memory of a discussion at a meeting, etc. From this the reflective piece emerged that forms the discussion part of this article. To ensure trustworthiness, by way of member checking (Birt et al., 2016) the article was circulated to a number of academic and administrative staff and their comments were worked into the final submission.

The next sections will describe the institutional context of the research site, clarify my own position in the research.

4.2 Institutional context

With more than 30 000 students, the institution under discussion is the largest higher education institution in the Western Cape province of South Africa. It is the second largest university of technology in the country. Demographics amount to approximately 68% Black, 25% Coloured, 7% White, and 1% Indian students, of whom 56% are male, and 44% female. The majority of students are the first members of their families to enter higher education (Cape Peninsula University of Technology, 2020). The university had been particularly hard hit during the 2015-2017 #FeesMustFall protests, with serious damage to property and to staff and student morale (Cape Peninsula University of Technology, 2019), but had learnt valuable lessons about business continuity during times of interruption. The university's core values centre around Ubuntu, mutual respect, equity, innovation, accountability and excellence (Cape Peninsula University of Technology, n.d.). University residences can accommodate 38% of the students (Fredericks, 2020), but a week before the national lockdown the University had closed for recess and all students had returned home, many to the neighbouring Eastern Cape province approximately 500 km away.

4.3 My position in the research

This paper draws from my own lived experience as I navigated the pandemic in my roles of a dean, a first-year lecturer and a supervisor of masters' and doctoral students. As a dean it was my duty to lead and to train my staff, during the two weeks of recess, in the basics of technology-based distance education, and then to lead them through the rest of the year. I also had to report to management on a weekly basis on the state of the faculty and participate in strategic planning to save the academic year. As a first-year lecturer I had to look for my students as they were scattered all over the country, allay their fears and introduce them to a new way of learning. As a supervisor, over and above taking care of my own students, I was asked by the Institution to present an online course in proposal writing to about 200 masters' and doctoral students.

I recognise the anecdotal nature of these findings but present them here in the hope that they may resonate with others in the development of flexible technology-supported education.

5. Discussion of findings

The findings will be discussed as they emerged in the dimensions of place, time, service, technology, and pedagogy.

5.1 Place

The institutional experience resonates with the call for hybrid spaces (Eyal and Gil, 2020). During the initial hard lockdown, it was decided that no teaching and learning activities would take place. Instead about two weeks were devoted to staff training in emergency remote teaching, as well as training in using *Linked-In Learning* which had been purchased at the end of the previous academic year. In my faculty we started a series of cascading WhatsApp groups to reach all staff, and to coordinate the training. Teaching staff were instructed to trace all the students they taught using email and WhatsApp and to make a needs analysis in terms of students' ownership of technology and access to bandwidth. The fact that all students were not in one place made it difficult to track and monitor their progress and attendance. Staff found that their homes were not necessarily suited as home office spaces. Some had to get special permission to take their office computers and even office chairs home, as they did not own such items personally.

After the initial hard lockdown was suspended an Institutional directive stated that lecturers who preferred to work from their offices, could do so, but no contact teaching was allowed. Minutes of various meetings show

that, for reasons of social distancing, it was decided that, even when students could return to campus, there would still not be any contact teaching. Students who did not have access to computers for remote learning could come to campus where they had access to socially distanced computer laboratories.

Some staff and students found their homes much more comfortable than their work environment, while others, particularly students from under-resourced communities, found it difficult to study in their sometimes-overcrowded shacks. Many students and staff had trouble incorporating work and home responsibilities – particularly with young children not going to school.

What was also problematic, was the physical distance in kilometres between vulnerable students in deep rural areas and places with good Internet access. From their WhatsApp messages to me I learnt that it could take them hours of walking to get to the closest cell phone reception, or public library or mall with free Wi-Fi.

At the affluent end of the spectrum some students and staff were able to continue uninterrupted and some of my own first-year students used the lockdown to finish all the work for my course so that they could spend that time on other lecturers' work once lockdown was relaxed. These findings underscore the inequalities exposed by the pandemic (Williamson, Eynon and Potter, 2020; Dube, 2020).

Initially inter-provincial travel was banned, so some students had to work from hundreds of kilometres away, while a ban on international travel meant that students who were visiting abroad could be thousands of kilometres away. Emails showed that we had some of our own students marooned in foreign countries, while some foreign students were stuck in South Africa. Ironically the financial situation of both those categories of students had to be carried by my Institution. We had to pay for the extended stay of our student abroad, and we had to forfeit the accommodation costs of the foreign students who could not leave. During the pandemic, therefore, distance could vary from the room next door, to around the world.

A comparison of student grades from 2019 and 2020 showed that the physical distance between students and lecturing staff, or even between students themselves did not have so much of an impact on their performance, supporting the findings of Russel (1999).

5.2 Time

Feedback during meetings with heads of departments indicated that lecturers' first reaction to teaching during the pandemic was to adhere to the current timetable, and teach through Zoom, Collaborate or Microsoft Teams. This resonates with the literature about synchronous video conferencing having the strongest increase in uptake during the pandemic (Kaqinari et al., 2021).

The social imbalance exposed by the pandemic (Nicola et al., 2020; El-Mohandes et al., 2020; Scott and Aquino, 2020; Cesco et al., 2021) became evident quite soon when we found that very few student had good access to technology. Some had to go to friends, public libraries, or shopping malls where free Wi-Fi was provided. Others used their night-time data bundles that were substantially cheaper. Initially lecturing staff would record their synchronous lectures and make them available to students asynchronously immediately thereafter. However, some lecturing staff, who were familiar with the "flipped classroom" took to pre-recording their lectures and then making themselves available for synchronous discussions, usually on WhatsApp, whenever students needed to consult with them.

My own personal experience as a middle manager, as well as a lecturer, resonated with comments from staff during de-briefings meetings that a synchronous Zoom session of 90 minutes was much more taxing than a 90-minute face-to-face class would have been. Lecturers also realized that when they pre-recorded their lectures there was much less repetition and they could edit out errors or irrelevant discussions, and so the actual contact time was reduced.

At a certain stage I presented a five-day writing workshop, which had initially been planned as a contact session. The contact format was an introductory interactive session where each person would present their expectations, then there would be a brief lecture about a certain aspect of academic writing, followed by uninterrupted writing until the close of the day, when participants would first exchange work, read and comment, and then report back on their progress to the larger group. To move it online we formed a WhatsApp group where the initial instruction was given for participants to prepare a short goal statement. We then met on Zoom for participants

to present their statements and discuss. Thereafter, instead of a lecture, they were given a link to a YouTube video of the lecture. Then the uninterrupted time started, with the WhatsApp group being used to share information of common interest throughout the day. Participants also used WhatsApp to share their work in pairs for the discussion, and the closing of the day took part, once again, via Zoom. In this example one sees a blend of synchronous and asynchronous participation. Participants had to attend the Zoom sessions at the times when they were presented but could attend to the WhatsApp or YouTube whenever it suited them. The asynchronous time allowed them to work at their own pace and convenience. The synchronous time allowed for the development of social presence, but also created a sense of urgency and a deadline to prevent procrastination.

In their feedback forms undergraduate students showed a preference for asynchronous attendance and tended to work in the afternoons and late evenings. Mature students and lecturers also preferred asynchronous communication and noted that their time was impacted by family responsibilities. Once again though, in both groups it was found that deadlines had to be set to prevent procrastination.

From discussions with lecturing staff, it became clear that, as was shown in the literature, students did not need or spend more time with online learning (Asanov et al., 2021). In fact, many lecturers, including myself, found that we were able to get through the syllabus much more quickly. However, there was an almost universal consensus with lecturing staff that never had they been obliged to put in so many hours of hard work into re-designing the curriculum and then re-developing all their contact material to online materials, resonating with Spector (2005) and with Gous and Roberts (2015). Although staff recognised the fact that they had produced quite a bit of re-usable digital material, they still felt that the need to provide much more support to students would still impact on their time.

5.3 Service

When asked what support they needed staff put *communication* as a priority, second only to data and internet access (Figure 3). Increased communication was provided by creating cascading WhatsApp groups and regular University and Faculty news bulletins.

Staff were given additional data allowances and both government and the institution provided zero rated Internet access to students.

Figure 3: Staff support needs

With the rapid move online of traditional contact institutions the contact class was simply moved online and thus the class size remained the same. Similarly one-on-one supervision of masters' and doctoral students moved from the office to the screen. However, discussions with lecturing staff showed that, to compensate for the inequalities of access (Cesco et al., 2021), lecturers moved to a "big group – small group" format where they would pre-record or present work to larger groups of students, and then move towards small group or even one-on-one interactions to provide a better service to students who required individualised attention. Most lecturers formed WhatsApp support groups for their whole class, while the students themselves spontaneously formed smaller work groups of three to six, also on WhatsApp. Thus flexibility in group size enabled community

engagement, which harnessed social presence to address inequalities and in that way augment the service that the university was struggling to provide (See Aminur Rahman, 2020; Lowenthal and Dunlap, 2020; Wang et al., 2020).

5.4 Flexible technology

To accommodate both technologically enabled as well as technologically challenged students a wide range of technological solutions were employed simultaneously, resonating with the suggestion that media does not influence learning (Clark, 1994). Early in the lockdown staff were asked what new technologies they had learnt to use. The results are shown in Figure 4. Not surprisingly, the three most used technologies include video conferencing software such as Zoom, Blackboard Collaborate and Microsoft teams, resonating with Kaqinari *et al* (2021).

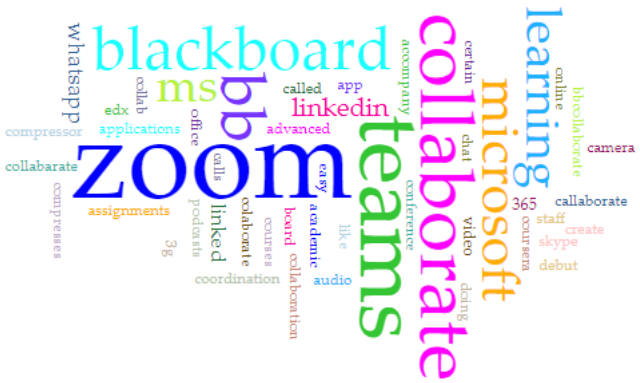

Figure 4: New technologies used by staff

In remote locations with limited internet connectivity printed study packs were couriered to students. Students who had access to technology but not connectivity were send USB drives with pre-loaded materials. Minutes of the emergency command centre meetings showed that, ironically, the distribution of printed packs and USB drives to remote areas was so slow that many students had already returned to campus before the items reached their rural homes.

The university went as far as allowing some students to purchase government subsidized laptop computers on their student accounts. In the spirit of community involvement (Wang et al., 2020) we noticed that some disadvantaged students would WhatsApp their assignments to more privileged students, who would upload it to the LMS on their behalf.

My own experience with my first-year students showed that WhatsApp allowed us to send large amounts of information in video, audio or pdf format to students quite efficiently and they could either download it during cheap hours or go to public areas that had free Wi-Fi to download. For smaller groups, low technology, low bandwidth solutions worked well, but as group sized increased the automation of a learning management system became necessary.

Teaching and learning committee meetings revealed that lecturers realised quite quickly that while many students had limited access to computers and some did not know how to use them, smartphones were almost ubiquitous, and it was easy to supply them to those students without. Lecturers therefore modified their assignments requiring voice notes, photographs, and even video clips instead of written assignments. A mind-set change occurred whereby a smartphone, rather than a tablet or a computer, was seen as the primary technological affordance for teaching and learning, thus supporting the notion that some technologies may be better in certain contexts than others (Kozma, 1994).

A cursory comparison between student results of this year compared to the previous years, moreover, shows very little difference, thus providing at least tentative, support for the *No significant difference phenomenon* (Russell, 1999).

5.5 Flexible pedagogy

When asked what their training needs were, staff requested training in the use of Blackboard, Zoom and Teams, as well as training in online teaching and learning (Figure 5).

Figure 5: Staff training needs

The response of teaching staff to teaching and learning during the pandemic was spread across all four quadrants of Cronjé's (2006) model.

Most instructors simply went the *injection* route, presenting online lectures using various synchronous video platforms, and recording those for use by students who could not attend. We had also purchased a LinkedIn Learning license and trained staff to incorporate it in the Learning Management System. The initial uptake is shown in Figure 6.

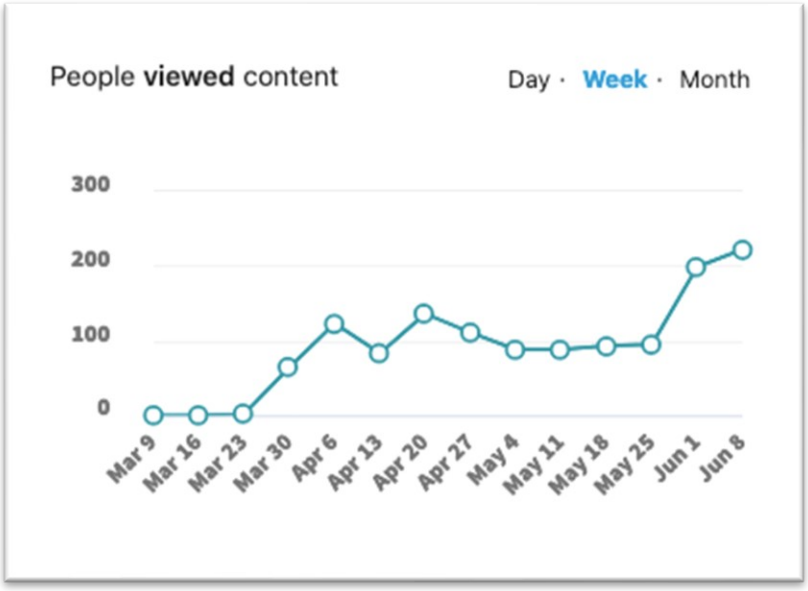

Figure 6: Initial uptake of LinkedIn Learning

In the creative disciplines, however, students were given projects and assignments that align with the *construction* quadrant. The University already supported its work-integrated learning projects via the Learning Management System, which means that there was no change from our side, and students were working in the *immersion* quadrant. Figure 7 shows the LMS uptake in the first semester. The sudden drop in April accounts for recess, and a moratorium placed on online learning until it could be shown that all students had reasonable access, indicating the University's response to addressing social inequalities (See Aminur Rahman, 2020; Lowenthal and Dunlap, 2020; Wang et al., 2020) .

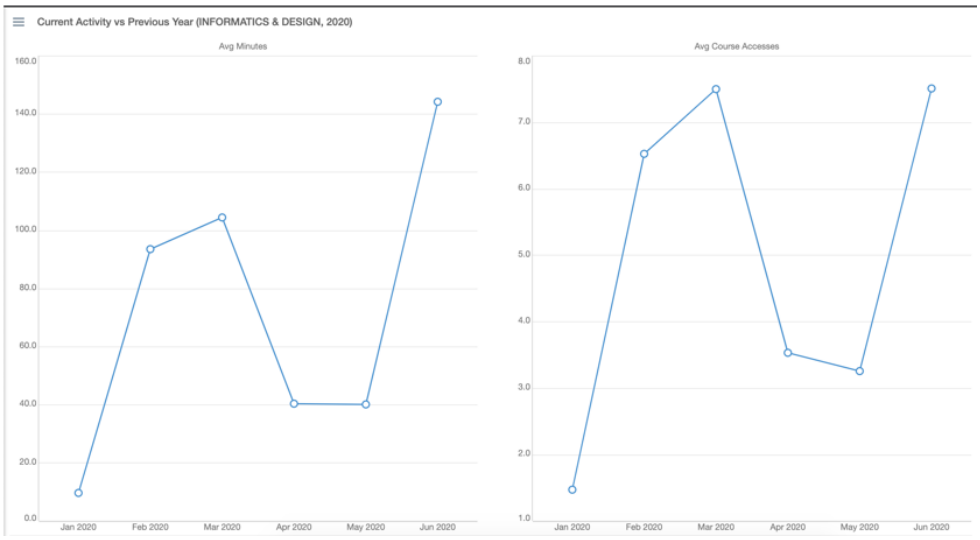

Figure 7: Blackboard Access: First Semester

Work-integrated learning was difficult, during hard lockdown. Employers could not support students working from home. In such cases we developed a "simulated working environment" with lecturing staff pretending to be the employers and assigning simulated work projects to the students. In this way they were combining instruction and construction, effectively working in the *integration* quadrant.

There were, however, teaching staff who took a long-term view and cycled students through the entire four quadrant model. A typical learning event might start in the *injection* quadrant, high in behaviourism, low in constructivism – students may be asked to watch a content-rich video clip, or read a paper, and then to do an online quiz on its content. On that may follow an *immersion* session where students are given a problem to solve based on the information that they had learnt, but with no overt scaffolding or feedback. Once that has been done, they might be asked to discuss their solutions with their peers in smaller groups and, working in the *construction* quadrant, construct a set of heuristics based upon what they had learnt. Finally, there might be a capstone project in which students are given an instruction manual (either printed or on video) as well as an assignment to complete – either individually or in teams, in which all the knowledge and skills are *integrated* and both direct instruction and construction of a final project are required.

A decision framework was developed and presented to the Faculty Board meeting, for lecturing staff to decide on the mode of teaching and learning based on the kind of knowledge outcomes required (See Kurtz and Snowden, 2003).

Knowledge	Methods	Technologies	Platform
Known	Tutorial Drill	Lecture Book/PDF Video PowerPoint	Linked-in Learning Blackboard Collaborate Youtube
Complex	Construction Exploration	Construction kits and tools Spreadsheets	Computer Lab Workshop Studio
Knowable	Puzzle Discussion Debate	Games Discussion tools	WhatsApp Collaborate Kahoot
Chaos	Field trip Work-integrated learning	Blogs Logbooks Assessment tools	Blackboard Linked-in Learning Respondus

Figure 8: Faculty decision framework for multimodal teaching and learning

Figure 8 shows how known knowledge can be presented via tutorials and drill methods through lectures or texts, and that these could be presented in contact, various delivery platforms. Complex knowledge is acquired

through construction and exploration using construction kits (physical, such as jewellery tools, or virtual, such as graphic design software, or programming languages) and delivered via laboratories, workshops, and studios. Knowable information is processed through puzzles, discussion, and debate, facilitated by WhatsApp, Collaborate (or other video conferencing software) and by games such as Kahoot. Chaotic knowledge cannot be taught, since it is the domain of experience, and must instead be recorded and assessed through whatever assessment and record keeping systems are available.

6. Conclusions and recommendations – Five dimensions of blended learning

Where the term "Blended learning" was commonly used to describe systems that "combine face-to-face instruction with computer mediated instruction" (Graham, 2006, p.41), it now becomes clear that there are at least five elements to blend – place, time, size, technology and pedagogy. These elements all need to be considered in making design choices in distance education. The next paragraph shows how each of the elements resonates with the literature.

In terms of *place* the inequalities exposed by the pandemic (Williamson, Eynon and Potter, 2020; Dube, 2020) was addressed by the use of hybrid spaces (Eyal and Gil, 2020). Distance did not impact performance (Russell, 1999). *Time* wise the initial reaction to move the conventional timetable to synchronous video supports the literature about the steep increase in the uptake of video conferencing during the pandemic (Kaqinari et al., 2021). However the social imbalance (Nicola et al., 2020; El-Mohandes et al., 2020; Scott and Aquino, 2020; Cesco et al., 2021) was addressed by moving asynchronous, which in turn led to procrastination becoming a problem. Online learning did not take more student time (Asanov et al., 2021), but did impose much time pressure on lecturing staff (Spector, 2005). *Service* levels had to be increased to compensate for the inequalities of access (Cesco et al., 2021). Using a "big group – small group" approach enabled community engagement through social presence to further address inequalities (Aminur Rahman, 2020; Lowenthal and Dunlap, 2020; Wang et al., 2020). The wide range of *technology* that was used, shows that media does not influence learning (Clark, 1994). WhatsApp groups facilitated community involvement (Wang et al., 2020) which helped address social imbalance. Depending on the context synchronous or asynchronous technologies were preferable, and sometimes high-bandwidth technology such as audio and video was required, while at other times text sufficed, showing that some technologies work better under certain circumstances (Kozma, 1994). The technology used did not affect students' results (Russell, 1999). *Pedagogy* ranged from direct instruction of known knowledge, through construction and exploration of complex knowledge, discussion and debating of knowable information and the acknowledgement of the acquisition of chaotic knowledge through assessment of logs and portfolios, showing that all four paradigms of Cronjé's (2006) model were used in acquiring different sets of knowledge as described by Kurtz and Snowden (2003).

From the conclusions above the following table is recommended as a decision framework to consider when deciding upon elements of a blended learning solution. The table is by no means exhaustive but gives an indication of how such a table could be populated for a given context.

Further research should be conducted to determine the variables to consider within each of the elements in making such decisions.

Table 1: A decision framework for blended learning

Category	Inflexible	Flexible	Implications for blended learning
Place	Formal learning spaces, on campus	Informal, anywhere, hybrid	Moving towards a flexible environment needs closer monitoring of "attendance" Blurring boundary between home and university leads to high complexity
Time	As timetabled	When convenient or possible	Flexibility aligned with social justice Pre-recorded work allows a flexi-time approach, but specific real-time contact allows for greater interaction and reduces procrastination
Service	Fixed: Dictated by student-staff ratio policy	Student:Staff ratio Determined by student's level of competence and type of learning material	Pre-recorded materials and automated delivery and assessment for large groups free up time for individual and small group sessions

Category	Inflexible	Flexible	Implications for blended learning
Technology	Computer laboratory	Mobile devices	Adaptive design is required so that materials can be delivered to any device Some platforms work better for some contexts Media do not influence results
Pedagogy	Direct instruction OR Project-based learning	Serendipitous immersed, integrated	Scaffolded blend of Direct instruction AND project-based learning Selection of pedagogy dependent on context and type of knowledge to be attained

This research has shown that distance learning can occur if the student is in the room next door, or around the globe. Asynchronous learning allows learners to work at their own pace – but is prone to procrastination. Synchronous learning creates urgency to meet deadlines but is hard to schedule. Technology-based online learning need not take longer than contact learning, but allowance might have to be made for increased instructor time. Learning material and learner proficiency can help determine if work can be covered in large groups, or whether individual attention is required. Learning tasks and teaching methods must be adapted to take into consideration the level of technology available to a student and it may be necessary to use more than one platform and more than one design to achieve the same learning outcome for different students. Direct instruction and generative learning tasks can both be facilitated online, and their use need not be mutually exclusive.

Finally, our experience of lecturers' response to the pandemic supports a definition of blended learning that goes beyond a blend of content and technology to include considerations of place, time, size, technology, and pedagogy.

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A Systematic Mapping of E-Learning Research: An Interdisciplinary and Multi-paradigmatic Perspective from the Universitat Oberta de Catalunya

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Abstract: E-learning research is a dynamic and ever-expanding interdisciplinary field. Research in this area is often conducted at the intersection of social science, cognitive science, learning sciences, as well as engineering and computer science. Common concerns in the field include ambiguity and confusion toward how best to approach methodological design as well as tensions around whether the field is coherent or fragmented. E-learning research has been characterized as a multi-paradigmatic knowledge field with distinct theoretical foundations and a horizontal knowledge structure composed of "specialist" languages. There has been a remarkable increase in systematic literature reviews in the field, representing a burgeoning research industry. Although there is a clear division between technical and social scientific approaches, there is a scarcity of literature which attempts to synthesize the evidence on how e-learning research is conducted across disciplines and within distinctive research communities from a multi-paradigmatic perspective. The objective of the current study is to systematically map research done in the field of e-learning in higher education at the Universitat Oberta de Catalunya (UOC) within the frame of an institutional analysis. The aim is to identify key features and distinctive approaches to research across disciplines in this area from a multi-paradigmatic perspective. A systematic mapping review has been conducted, synthesizing research published between 2015-2020 by authors affiliated with the UOC. The study identified 291 articles, the majority of which use quantitative approaches following both design-based research methods as well as design and development research aims across three distinct research areas (a) educational research, (b) discipline-based education research and (c) learning engineering research. Fragmentation was identified across distinct research areas and communities of practice, particularly between research aims and the methods used to achieve these aims. By empirically examining the claims about methodological capacity and coherence in e-learning research, recommendations are offered for reorienting the field by: (a) increasing interdisciplinary collaboration through integrated research agendas; (b) supporting the expanding profession of the 'learning engineer'; and (c) promoting methodological capacity, clarity and innovation.

Keywords: e-learning, educational technology, interdisciplinary, systematic review, research methods

1. Introduction

How research is conducted in the dynamic field of e-learning has been studied extensively in recent years and remains an important and consistent debate within the broader domain of educational technology (EdTech) (Castañeda, Salinas and Adell, 2020, Reeves and Oh, 2017). Identifying and mapping e-learning research patterns has become a lively and well-established research area, aiming to identify priorities for the advancement of knowledge in the field (Bond et al., 2020). EdTech research, in which e-learning is situated, is dominated by the social sciences accounting for roughly half of research output, along with computer sciences and engineering (Bozkurt, 2020). Although there is a clear division between technical and socially oriented approaches, there is a scarcity of literature which attempts to synthesize the evidence on how e-learning research is conducted across disciplines and within distinctive research communities, particularly in the context of online higher education (OHE). A common concern across such communities is the ambiguity and confusion toward how best to approach methodological design in e-learning research from both social science (Bulfin et al., 2014, Castañeda, Salinas and Adell, 2020) and computer science (Caballé, 2019) perspectives, as well as tensions around whether the field is coherent and cohesive or fragmented (Czerniewicz, 2010).

EdTech has been characterized as a multi-paradigmatic knowledge field with distinct theoretical foundations and a horizontal knowledge structure composed of "specialist" languages (Czerniewicz, 2010 p.2). Such languages, as Czerniewicz (2010 p.2) argues, have "specialized modes of interrogation and criteria for the construction and circulation of texts", and are comprised of clusters such as *Instructional Design*, *Learning Science*, *Learning Technology*, *Computer Supported Collaborative Learning* and *Networked Learning*. As the field

evolves with the unceasing development of more powerful and sophisticated technologies, newer clusters emerge with particular relevance for online and distance education, such as *Learning Engineering* (Dede, Richards and Saxburg, 2019), defined as "the application of engineering methodologies to develop learning technologies and infrastructures to better support learners and learning" (Caballé, 2019 p.548). With a diverse and heterogenous knowledge structure, e-learning is a highly varied field of critical inquiry with an ever-expanding scope and scale.

The purpose of the current study is to map the key features and distinctive approaches to e-learning research across disciplinary boundaries and distinct research communities in higher education, through an institutional analysis of the Universitat Oberta de Catalunya (UOC) in Barcelona, Spain. First, we situate this research within current literature about e-learning research within the broader EdTech field. Then, we outline the study context and justification, study aims and research design. Next, we present the main findings followed by a discussion on e-learning research from a multi-paradigmatic perspective, where we make recommendations for the future development of the field, transferable to other research communities and contexts.

1.1 Related Literature

It has become clear that one of the key tensions that define research in this area is methodological capacity across distinct research communities (Bulfin et al., 2014, Caballé, 2019). Computer science and EdTech are relatively young interdisciplinary fields and as Caballé (2019) and Castañeda, Salinas and Adell (2020) note, both face an identity crisis when confronted with how best to approach research problems and methodological design, as well as in making relevant contributions to educational practice. In particular, Caballé (2019) notes there is no clear consensus in the literature about how to conduct quality and rigorous academic work in e-learning from a computer science perspective. This is an increasing concern, particularly given the rise of emerging and interdisciplinary fields of study with specialist approaches such as learning engineering and the rise of specialized sub-fields which engage with big data, data visualizations, learning analytics, machine learning and artificial intelligence. The current study, therefore, raises the question of how a lack of consensus around clear research guidelines across diverse research communities may affect the relevance of research and its capacity to influence educational practice across the many sub-communities which make up the field. Are specialized communities of research practice in e-learning disparate and mutually exclusive paradigms? Or are they different perspectives and approaches on the same object of study with common research problems, aims and themes?

A study on the methodological capacity of researchers within the field reveals a clear preference for basic forms of descriptive research (Bulfin et al., 2014). Moreover, observers have long characterized the study of educational technology as an under-theorized field (Hew et al., 2019), and recent research has revealed that such critiques have some merit corroborating previous claims that there is a clear preference for basic forms of descriptive research and that "explicit engagement with theory is absent in the majority of previous studies" (Hew et al., 2019 p.967), with many studies theoretically agnostic or making ambiguous theoretical positioning. Many of these challenges result in a lack of credibility of educational research and the low transferability of research results on policy formulation and practices (Castañeda, Salinas and Adell, 2020, Gorard and Cook, 2007).

In recent years, a number of EdTech systematic literature reviews have been developed, representing a burgeoning industry (Polanin, Maynard and Dell, 2017, Zawacki-Richter et al., 2020). While EdTech systematic literature review's act as fundamental ways to critically synthesize published research, they can also point toward important and critical directions for identifying the research that is needed (Reeves and Lin, 2020). For example, Ifenthaler and Yau (2020) synthesize evidence on utilising learning analytics to support study success in higher education; Zawacki-Richter and Latchem (2018) review four decades of conceptual and thematic development in EdTech research interrelated with evolving technologies and theories; and Nortvig, Petersen and Balle, (2018) offer a comprehensive systematic review of factors influencing e-learning and blended learning in relation to learning outcome, student satisfaction and engagement.

1.2 Study Context

Although education research is experiencing the rapid growth of a systematic review industry, including fast changing data-driven approaches (Bond et al., 2019, Zawacki-Richter et al., 2020), it is rare that a systematic review has been conducted at one site which covers diverse communities of research practice. We present a case study of e-learning research conducted at the UOC across distinctive research communities and areas, led

by 500 researchers, professors, instructional designers, and learning engineers organised into 51 recognized research groups. The UOC was recently ranked as Spain's leading online university for research (Ranking CYD, 2020).

1.3 Justification and Aim

The UOC is positioned as a unique institutional case which reflects highly varied and diverse research communities of practice. E-learning is one of the core areas in which the UOC has carried out research and researchers have considerable access to large student datasets and virtual learning environments for experimentation, observation and data generation, with 87,000 distance education students. Keeping in mind current debates from a multi-paradigmatic perspective concerning (a) whether the field is cohesive or fragmented, and (b) confusion and ambiguity toward how best to approach methodological design, the UOC case has been selected for its unique character as a site of institutional analysis, providing new insight through an interdisciplinary perspective.

The objective of the current study is to describe distinctive approaches and key features to e-learning research conducted across disciplinary boundaries and distinct research communities and areas. The current study has defined the following research questions:

- Research Question (RQ) 1: How is e-learning research conducted at the UOC across research areas, disciplines, and communities?
- RQ2: What relationships can be identified between aims of and approaches to e-learning research across distinctive research areas and disciplines?
- RQ3: What differences and similarities exist in how researchers conduct e-learning research across research areas and disciplines?

Resolving these questions will bring a cross disciplinary and multi-paradigmatic perspective to the distance education and e-learning field by (a) emphasizing differences in research patterns across disciplines and research communities, (b) deepening our understanding of the relationships between the aims of and approaches to research in this field, and (c) empirically examining the claims made about methodological capacity and coherence.

2. Research Design

This study follows a systematic mapping review and synthesis (Grant and Booth, 2009). E-learning research is characterized as an expansive and interdisciplinary field at the intersection of social science, cognitive science, learning science, and computer science. We use an inclusive definition developed by Sangrà, Vlachopoulos and Cabrera (2012), who define e-learning as:

> *An approach to teaching and learning, representing all or part of the educational model applied, that is based on the use of electronic media and devices as tools for improving access to training, communication and interaction and that facilitates the adoption of new ways of understanding and developing learning* (p.152).

2.1 Search Strategy

Scopus and Web of Science (WOS) were selected as bibliographic databases, since they are considered the most relevant coverage of peer-reviewed, international, and multidisciplinary academic literature (Aghaei Chadegani et al., 2013). The search was restricted to the range from 2015 to February 2020. The search strategies were drafted and elaborated in collaboration with two information scientists from the UOC library team. The search was carried out between February 14-28, 2020. Both databases were searched using the UOC author affiliation search field while adopting the query using the individual keywords and string queries as depicted in Table 1. In each database, lists were compiled with all the results, and duplicates were removed automatically before exportation.

Table 1: Search key words

Dimension	String query	Boolean Operator
Terms related to E-learning	(E-Learn*) OR (eLearn*) OR (Online Learn*) OR (Online Education*) OR (Digital learning) OR (Digital Education*) OR (ICT and Education*) OR (Information* and Communication*) OR (Technolog* and Education*) OR (Education* Technolog*) OR (Ed* Tech*) OR (Technology-Mediated Learning) OR (Online Higher Education*) OR (Distance Education*) OR	AND

Dimension	String query	Boolean Operator
	(Open Education*) OR (Open Education* Resourc*) OR (Learning Technolog*) OR (Technolog* Enhanced Learn*) OR (MOOCs) OR (Massive Open Online Cours*) In TITLE and ABSTRACT and KEYWORDS fields	
Author affiliation	(Universitat Oberta de Catalunya) OR (UOC) in AFFILIATION field	

2.2 Inclusion Criteria

In order to be included in the review, articles needed to report on e-learning focused research published between 2015 and the search date. The inclusion criteria were:

- *Study focus* within the broad domain of e-learning, as defined by Sangrà, Vlachopoulos and Cabrera (2012).
- *Study language* in English or Spanish.
- *Study affiliation* with an author from UOC.
- *Study accessibility* through UOC Library and open databases.

The inclusion criteria was piloted by two independent reviewers who screened a random sample of 20% of the articles in order to establish a common understanding and application of the inclusion criteria, based on title and abstract. Results were compared and disagreements were resolved through discussion. If the discrepancy could not be resolved among the first two reviewers on the application of the inclusion criteria, a third reviewer was used.

2.3 Study Selection

In total, 750 articles were identified for review. After duplicates were removed (n=178), article metadata, including titles and abstracts, were downloaded and imported into an Excel Worksheet used to manage the study selection, while the available full-text manuscripts were downloaded and integrated into Mendeley, for use as a reference manager. In the following step, all articles considered eligible (572) were independently assessed and screened by the primary reviewer and reasons for exclusion of full-text articles were documented. A range of documents were accepted if they met the above inclusion criteria, including systematic reviews, theoretical and methodological papers, and book chapters reporting research. After screening based on defined inclusion criteria using the PRISMA guidelines, 291 publications were selected for final analysis, as shown in the PRISMA workflow (Liberati et al., 2009) in Figure 1.

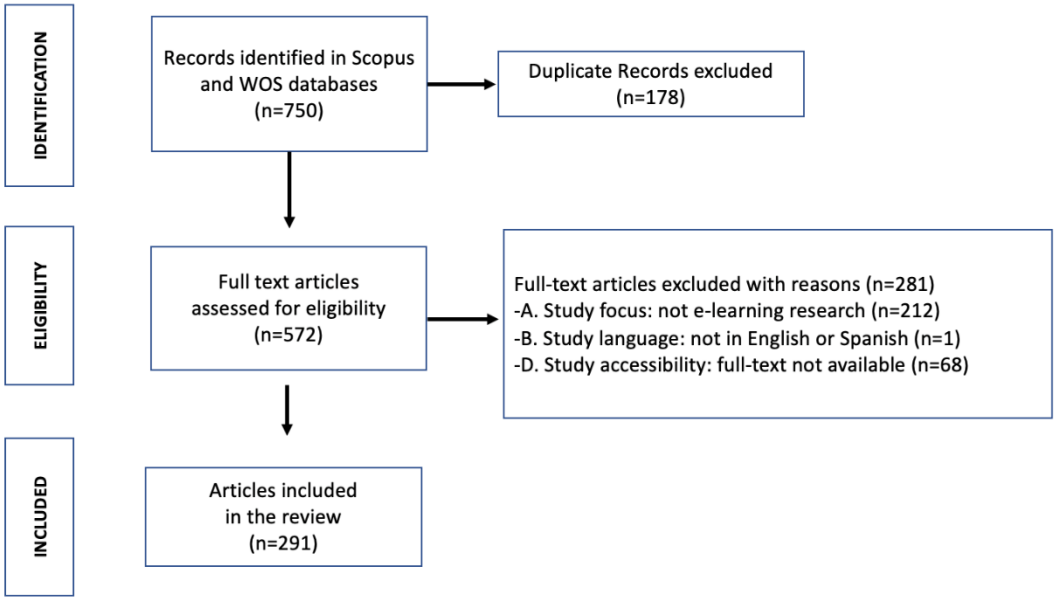

Figure 1: PRISMA Workflow Diagram

2.4 Data Coding

Data coding followed four steps. First, as shown in Table 2, a hybrid coding scheme was developed for data extraction and coding. The hybrid coding scheme allowed for both deductive (closed) and inductive (open) coding to occur in relation to the specific objectives of the study. Except for "theme" and "theory" categories in

Table *2*, the majority of the coding scheme was deductive and based on the methodological literature from previous studies which systematically reviewed e-learning or EdTech research (Hew et al., 2019, Raffaghelli, Cucchiara and Persico, 2015, Reeves and Oh, 2017, Reeves and Lin, 2020). Step two involved both importing the metadata of the selected documents entering the coding scheme into an Excel worksheet used to organize coding and subsequent analysis. Once the coding scheme was complete, the third step involved two independent reviewers applying the coding scheme to a random sample (20%) of the selected articles, managing, annotating and coding the articles using the reference management software Mendeley. This phase of double coding emphasized double-checking for accuracy and reliability to ensure that the coding scheme was being applied consistently. As in the screening phase, discrepancies between reviewers on the application of the coding scheme were resolved through discussion, and with the involvement of a third reviewer when necessary. The fourth step involved the first author coding the remaining articles.

Table 2: Description of the coding scheme

Categories	Description
Discipline	Disciplinary field where the research can be placed, based on Scopus and WOS definitions.
Research Area	Specific area where the research can be placed, based on WOS definitions and adapted from Caballé (2019).
Method	Research method embraced by the author(s) following a common classification: Quantitative, Qualitative, Mixed Methods, Theoretical/Conceptual Development/Synthesis, & Literature Review (Reeves and Oh, 2017).
Design	Design choices made by the authors aligned with research method (i.e., quantitative, qualitative, mixed methods, conceptual, literature review) (Farrow et al., 2020)
Data Collection	Procedures used for data collection, including classical (surveys) and emergent (learning analytics data tracking) (Kiliç-Çakmak et al., 2013, Raffaghelli, Cucchiara and Persico, 2015).
Data Analysis	Procedures used for data analysis, including classical (i.e., statistical procedures, thematic analysis) or more recent (i.e., data mining or data visualisation).
Theme	Relates to the specific thematic subject or research topic addressed in the study
Aim	Guiding research purpose typology from Reeves and Oh (2017).
Theory	Most relevant theories identified to frame research design and analysis, where present.
Study Population	Characterization of the study population based on educational level.
E-Learning Mode	Characterization of the learning processes under study according to mode of e-learning (i.e., online higher education, blended learning, informal online learning,.).

2.5 Data Analysis

Descriptive statistics and crosstabs were used to analyze the coded data. To examine the statistical significance of differences across groups, Fisher's exact test was used, as the sample size of the review corpus (n=291) was too small for a Chi-square test (Everitt, 2019). Common patterns and relationships between the codes were examined for subsequent interpretation and synthesis to respond to the research questions. Analyses were performed using XLSTAT Version 22.5.1.

3. Results

3.1 RQ1: How is e-learning research conducted at the UOC across research areas, disciplines, and communities?

Analysis of the conduct of e-learning research is shown in Table 3 presenting a range of categorical variables to provide as global a view as possible. Two broad disciplinary fields, social science (66.3%) and engineering and computer science (33.7%) and three research areas, education research (ER) (49.1%), learning engineering (LE) (33.7%) and discipline-based education research (DBER) (17.2%) were identified. Most research in the current study was quantitative in nature (46.0%), while the second most common research approach involved theoretical, conceptual, or methodological development (22.7%). Mixed methods (14.1%), qualitative (11%), and literature review (6.2%) research were detected considerably less within the review corpus.

The most common research design included a *design science research framework* (28.1%), while the second most common was correlational (16.4%), emphasizing the examination of association or relationship between factors of interest. The most common thematic domains were (a) design and evaluation of learning resources/tools/spaces (18.5%) and (b) learning analytics and automatization of learning (17.8%).

When considering research goals, two research aim categories presented in Table 3, contributed to just over half (53.8%) of observed research: (a) design/development (31.9%) and (b) exploratory/hypothesis testing (20.9%). This finding characterizes analyzed e-learning research as focused on developing solutions to educational problems with an emphasis on specifying how education works by testing conclusions related to theories and models of teaching, learning, and student performance.

Table 3: Characteristics of the 291 articles featured in the review

Category	Codes	N (%)
1. Discipline	Social Sciences	193 (66.3%)
	Engineering & Computer Science	98 (33.7%)
2. Area	Education Research	143 (49.1%)
	Learning Engineering	98 (33.7%)
	Discipline-Based Education Research	50 (17.2%)
3. Type of Article	Empirical	207 (71.1%)
	Non-Empirical	84 (28.9%)
4. Method	Quantitative	134 (46.0%)
	T-C-M* Development	66 (22.7%)
	Mixed Methods	41 (14.1%)
	Qualitative	32 (11.0%)
	Literature Review	18 (6.2%)
5. Design	Design Science Approach	82 (28.2%)
	Correlational Design	48 (16.5%)
	T-C-M* Development	42 (14.4%)
	Case-study	18 (6.2%)
	Literature Review	18 (6.2%)
	Evaluation Research	15 (5.2%)
	Exploratory/Descriptive	14 (4.8%)
	Education Design Research	13 (4.5%)
	Generic Qualitative Design	13 (4.5%)
	Quasi-Experimental Design	8 (2.7%)
	Causal-Comparative Design	7 (2.4%)
	Experimental Design	7 (2.4%)
	Action Research Design	3 (1.0%)
	Mixed Methods Sequential Design	3 (1.0%)
6. Theme	Design and evaluation of learning resources/tools/spaces	54 (18.5%)
	Learning Analytics and Automatization of Learning	52 (17.9%)
	E-learning adoption	48 (16.5%)
	Innovative Pedagogies & Technologies	48 (16.5%)
	Student/Teacher Learning Practices/Performance	46 (15.8%)
	Assessment & Feedback	23 (7.9%)
	Collaboration & Interaction	20 (6.9%)
7. Aim	Design/Development	93 (32.0%)
	Exploratory/Hypothesis Testing	61 (21.0%)
	T-C-M* Development	53 (18.2%)
	Descriptive/Interpretive	44 (15.1%)
	Action/Evaluation	40 (13.7%)
8. Theory	One or more theories/frameworks used	154 (53.0%)
	Unclear Theoretical Positioning	111 (38.1%)
	N/A Review	26 (8.9%)
9. Study Population	Higher Education	225 (77.3%)
	Mixed Levels	36 (12.4%)
	Primary & Secondary School (K-12)	24 (8.2%)
	Professional Training and Development	6 (2.1%)
10. Mode of E-learning	Online Higher Education	136 (46.7%)
	Mixed Modes (Formal)	90 (30.9%)
	Face-to-face Mediated through Technology	31 (10.7%)
	MOOC	24 (8.2%)
	Mixed Modes (Informal)	10 (3.5%)

*T-C-M Development = theoretical-conceptual-methodological development

Concerning the use of theory in research, just over half (53.0%) implemented one or more theories/frameworks, while a significant amount (38.1%) held ambiguous theoretical positioning. In regards to study population, most research focused on formal education at the HE level (77.3%), indicating the case of the UOC is principally focused on the domain of HE, with a significant focus on the mode of distance and online higher education (OHE) (46.7%), followed by mixed modes of e-learning (30.9%), including blended, hybrid, or other forms of mixed integration of technology mediated learning.

Figure 2 presents the range of data collection techniques used in empirical research, accounting for 71.1% (n=207) of the review corpus. Most empirical quantitative, mixed methods, or qualitative research employed more than one data collection technique. Each article may be coded for more than 1 category as coded data collection categories are not mutually exclusive. Moreover, some studies included up to four techniques (i.e. survey, interviews, student data tracking, and documents collection), while others only used one technique, most commonly survey instruments. The two most common overall data collection procedures were quantitative, including survey technique (61.5%) and student data tracking in virtual learning environments (28.0%), which often includes tracking assessments, forum posts/discussions or other traces of digital learning artefacts. The third most common procedure was qualitative interviews and focus groups, occurring in 21.2% of reviewed research. System data tracking (11.1%), including the use of system log files, was the fourth most used procedure.

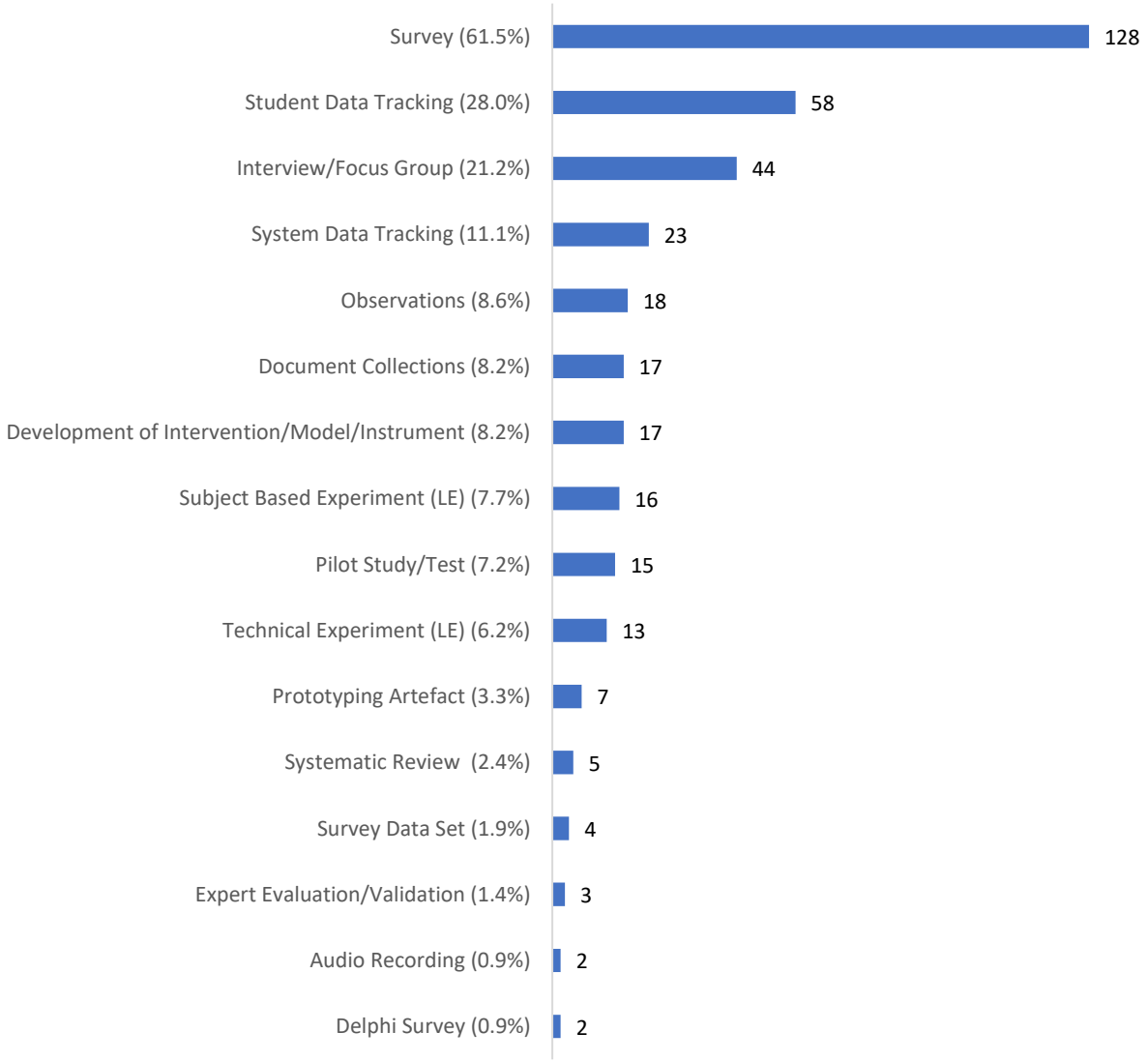

Figure 2: Distribution of data collection procedures within empirical research (n=207)

Note: *Data collection categories are not mutually exclusive and an empirical article may be coded for more than one data collection category

Figure 3 presents the most common techniques for quantitative data analysis procedures (n=175). For example, descriptive statistics (67.4%) was most common, followed by bivariate analysis (36.0%), aiming to identity relations between two variables, while multivariate analysis techniques (32.0%) were less often used. As in the data collection techniques, more than one analytical technique is often used within each study, for example, most advanced statistical techniques (i.e. multivariate analysis, educational data mining, social network analysis) are most often preceded by descriptive statistics and/or bivariate analysis. There is a clear presence of both traditional techniques, which appear most frequently through statistical analysis and quantitative content analysis and more emerging data-driven techniques which appear less frequently yet are rapidly changing approaches to educational research through learning analytics, data visualizations, educational data mining, and social network analysis.

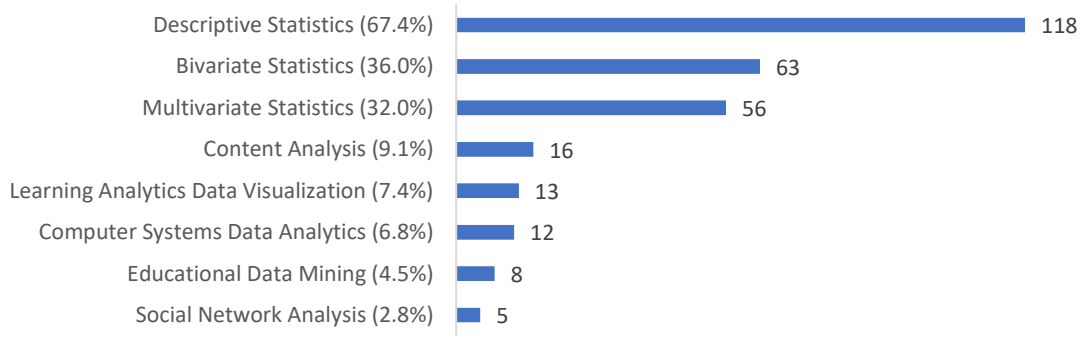

Figure 3: Distribution of research by quantitative data analysis procedure within quantitative or mixed methods studies (n =175)

*Data analysis categories are not mutually exclusive and an empirical article may be coded for more than one data analysis category across quantitative or mixed methods studies

Figure 4 presents qualitative data analysis techniques which appear much less frequently among qualitative and mixed methods studies (n=73), due to the predominance of objectivist-driven research dominated by quantitative approaches. More than one technique can be used within a single empirical study. For example, a thematic analysis can be complemented by a systematic knowledge synthesis. Surprisingly, the most common qualitative analytical procedure among empirical research was a generic qualitative approach, observed in 20.5% of cases, where the research design makes no clear allegiance to an established form of methodological development, followed by a procedure of description of categories and dimensions (16.4%) used for developing frameworks, thematic analysis (17.8%), and basic coding and categorization (16.4%).

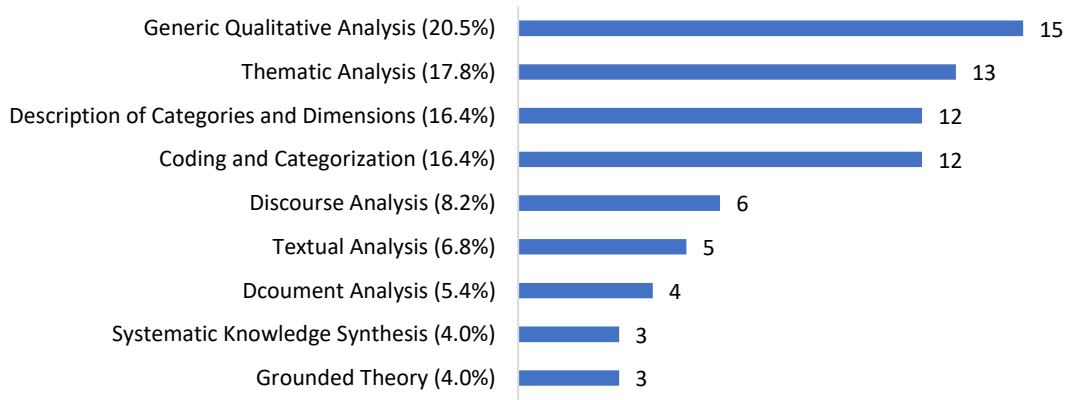

Figure 4 Distribution of research by qualitative data analysis procedure within qualitative or mixed methods studies (n=73)

*Data analysis categories are not mutually exclusive and an empirical article may be coded for more than one data analysis category across qualitative or mixed methods studies

3.2 RQ2: What relationships can be identified between aims of and approaches to e-learning research across distinctive research areas and disciplines?

Figure 5 examines the relationship between study purpose and research methods since these two elements are closely associated. Having clearly established research aims at the beginning of a study enables a greater focus on a research design and allows researchers to make more informed choices of the most appropriate method to achieve that goal (Reeves and Oh, 2017). Predictably, results demonstrate that some research methods are more strongly associated with certain research areas and disciplinary boundaries than others. Quantitative research was the most common method across all research areas, for example, 56% of all DBER, 48.9% of all LE research and 46% of all ER used such a method. The next most common approach was theoretical-conceptual-methodological development, where 31.6% of LE research, 21.6% of ER, and 8.0% of DBER used this method for synthesizing and developing theoretical knowledge.

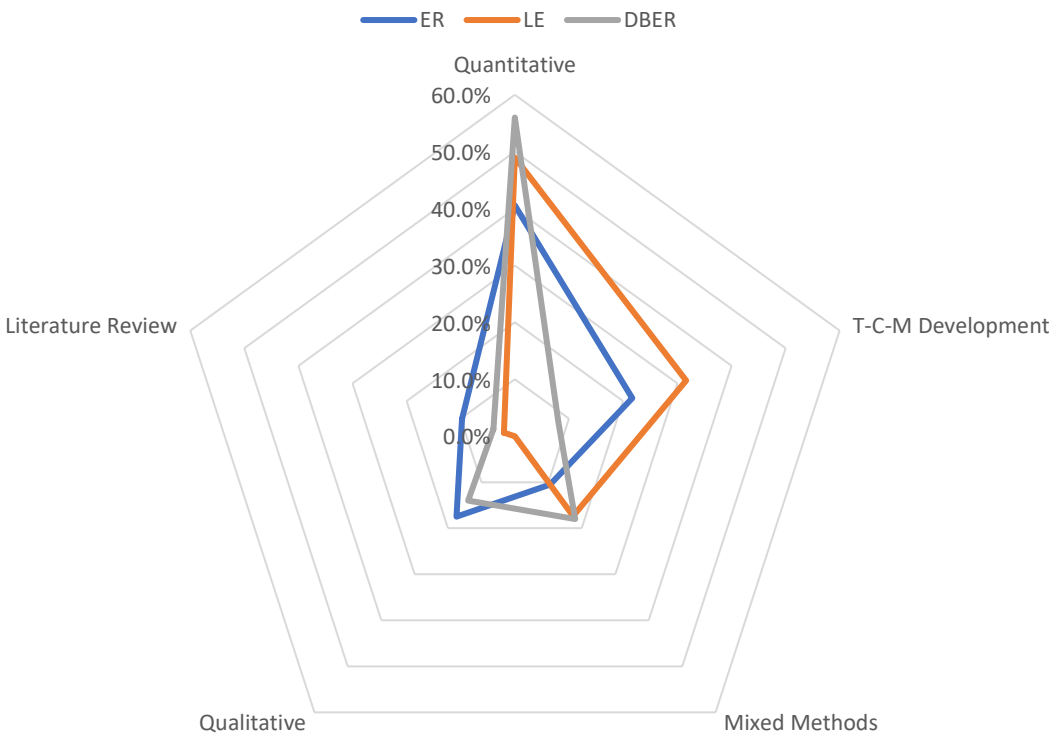

Figure 5: Distribution of research approach X area (relative frequencies)

In Figure 6 research aim categories are correlated to research areas, showing that ER was distributed roughly evenly between four categories (Exploratory/Hypothesis testing, 27.9%; T-C-M Development Synthesis, 25.8%; Descriptive/Interpretive 22.3%; Design/Development 16.0%). In contrast, LE research mostly focused on Design/Development 66.3%. Most DBER research was focused across three research aim categories: Exploratory/Hypothesis testing (32.0%), Action/Evaluation (32.0%) and Descriptive/Interpretive (20.0%).

Comparison of Figures 6 and 7 show some interesting trends. When research approaches are related to research aims, as shown in Figure 7, we see that certain research goals are significantly associated with specific approaches; for instance, 95.0% of research with Exploratory/Hypothesis testing, 82.5% of Action/Evaluation research, and 41.9% of Design/Development research use quantitative methods. Research which follows a theoretical or conceptual development approach is understandably associated with Theory Development/Synthesis (66.0%) and Design/Development (32.2%) goals. In contrast, 34.0% of Mixed Methods and 54.5% of Qualitative research are associated with Descriptive/Interpretive goals.

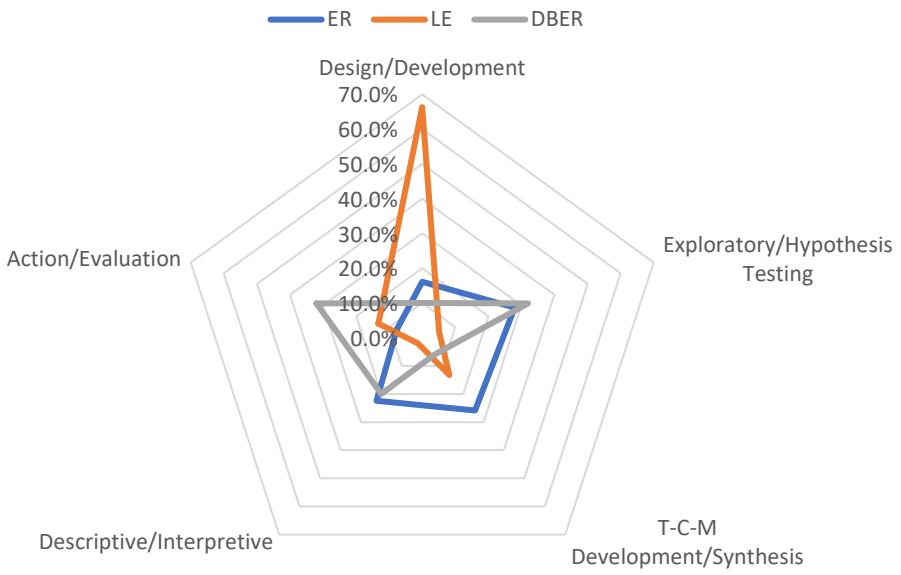

Figure 6: Distribution of research aims X area (relative frequencies)

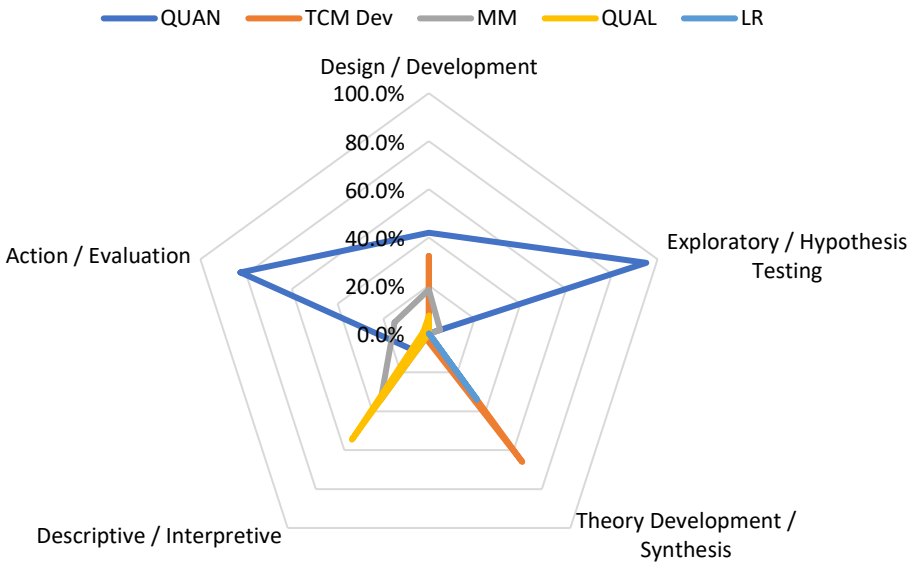

Figure 7: Distribution of research aims X approach (relative frequencies)

As shown in Table **4**, the most common research aim category was *design/development* research (93/291=31.9%), most commonly from computer science (69.8%). In contrast with other research aim categories, *design/development* approaches are dispersed, where the most common approach (QUAN) accounted for only 41.9% of studies. As can be seen, the most common approaches relate to the thematic domain of learning analytics and the automation of learning (38.7%), using a design science framework (68.8%), often unsupported by a clear theoretical positioning (50.5%). The most common data collection technique is survey (35.4%), followed by descriptive statistics (37.6%) as the most common analytical procedure. The most common study context was in HE (80.8%) where the modality of e-learning was OHE (59.1%).

Table 4: Distribution of most common research approaches X research aims (relative frequencies)

Approaches / Aims	Design / Development (n=93)	Exploratory / Hypothesis-testing (n=61)	Theory Development / Synthesis (n=53)	Descriptive / Interpretivist (n=44)	Action / Evaluation (n=40)

Discipline	CS (65/93=69.8%)	SS (56/61=91.8%)	SS (39/53=73.5%)	SS (42/44=95.4%)	SS (27/40=67.5%)
Area	LE (62/93=66.3%)	ER (40=61=65.5%)	ER (37/53=69.8%)	ER (32/44=72.7%)	DBER (16/40=40%)
Method	QUAN (39/93=41.9%)	QUAN (58/61=95.0%)	T-C-M Development (35/53=66.0%)	QUAL (24/44=54.4%)	QUAN (34/40=85.0%)
Theme	Learning Analytics and Automation of learning (36/93=38.7%)	E-Learning Adoption (25/61=40.9%)	Student/Teacher Learning Practices/Performance (15/53=28.3%)	Student/Teacher Learning Practices/Performance (18/44=40.9%)	Design of learning resources and spaces (11/40=27.5%)
Design	Design Science (LE) (64/93=68.8%)	Correlational Design (40/61=65.5%)	T-C-M Dev. (29/53=54.7%)	Generic Qualitative Design (12/44=27.2%)	Design Science (LE) (12/40=30.0%)
Theory	Unclear (47/93=50.5%)	One or More Frameworks Used (42/61=68.8%%)	N/A Lit Review (24/53=45.2%)	One or More Frameworks Used (30/44=68.1%)	Unclear (21/40=52.5%)
Data Collection	Survey (33/93=35.4%)	Survey (61/61=100%)	N/A Review (31/53=58.4%)	Interviews/Focus Groups (20/44=45.4%)	Survey (24/40=60.0%)
Data Analysis	Descriptive Statistics (35/93=37.6%)	Multivariate Analysis (43/61=70.4%)	N/A Review (31/53=58.4%)	Descriptive Statistics (13/44=29.5%)	Descriptive Statistics (16/40=40.0%)
Study Population and Mode of E-Learning	HE (76/93=80.8%) OHE (55/93=59.1%)	HE (44/61=70.9%) OHE (33/61=54.0%)	HE (32/53=60.3%) Mixed Modes (41/53=77.3%)	HE (37/44=84.1%) OHE (20/44=45.4%)	HE (36/40=90.0%) OHE (22/40=55.0%)

*Percentage in each cell represents the most frequent value, based on relative frequency within each research aim category. CS = computer science; SS = social science; LE = learning engineering; ER = educational research; DBER = discipline based educational research; QUAN = quantitative; QUAL = qualitative; T-C-M = theoretical/conceptual/methodological development; HE = higher education; OHE = online higher education

In contrast, research which pursued exploratory/hypothesis-testing aims represented 21% (61/291) of all reviewed research, mostly from a social science perspective (91.8%) from an educational research area (65.5%) using quantitative approaches (95.0%). The most observed thematic domain was E-Learning Adoption (40.9%) where a correlational design (65.5%) was most often used. It is noteworthy that within this category there was a significant tendency to use one or more theoretical frameworks (68.8%%), data collection procedures which rely on survey collection (100%) while using more advanced statistical techniques through multivariate statistical procedures (70.4%). In research which pursed exploratory/hypothesis-testing, the most common study population was also HE (70.9%) commonly examining OHE (54.0%).

Theory development/synthesis-based research represented 18.2% (53/291) of the review corpus, with most studies coming from social science (73.5%). Research which pursues theory development goals typically rely on theory focused methods (66.0%) and research designs (54.7%). Research which pursued descriptive/interpretivist goals represented 15.1% (44/291) of all reviewed research. A significant majority was from social science (95.4%), conducting ER (72.7%) using a qualitative approach (54.4%). Like theory-oriented research, the thematic domain most common in descriptive/interpretivist aimed research was student and/or teacher learning practices/performance (40.9%). A wide range of designs were used, however the most common was generic qualitative design (27.2%).

3.3 RQ3: What differences and similarities exist in how researchers conduct e-learning research across research areas and disciplines?

In Table 5 an alignment between the research variable categories and research areas is displayed. A significant and exclusive relationship between disciplines and research areas is shown according to Fisher's exact test. ER and DBER were associated with social science, while engineering and computer science were exclusively associated with LE. When considering research method in relation to research area, Fisher's exact test rejected the null hypothesis that methods are equally likely to be present in the same research area, with LE being associated with T-C-M development and ER with qualitative methods. Overall, 98.0% of LE research is highly concentrated in quantitative, T-C-M development and mixed methods approaches.

When examining the relationship between research aim and research area, results reveal that studies with design and development goals have a significant relationship (p<0.001) with LE (66.0%) and ER (16.0%). Over one third of the review corpus reported an unclear theoretical positioning and a significant relationship was identified with the LE (52.4%) research area. Fisher's exact test also rejected the null hypothesis that research areas are equally likely to implement theory, with DBER implementing one or more theoretical frameworks in 66.0% of observations.

In relation to the distribution of research themes across research area, Fisher's test shows a significant relationship between the thematic domain of Learning Analytics and Automatization of Learning (45.9%) and LE. Similarly, Student/Teacher Learning Practices/Performance (26.7%) was significantly related to ER, while Innovative Pedagogies and Technologies (28.0%) was associated with DBER.

Table 5: Distribution of research approaches and procedures X research area

	Research Area	ER	LE	DBER	Total
Discipline, n(%)	Social Science	143 (100)[a]	0 (0)[a]	50 (100)[a]	193 (66.3)
	Engineering & C.S.	0 (0)[a]	98 (100)[a]	0 (0)[a]	98 (33.7)
Method, n(%)	Quantitative	58 (40.6)	48 (48.9)	28 (56.0)	134 (46.0)
	T-C-M Development	31 (21.7)	31 (31.6)[b]	4 (8.0)[c]	66 (22.6)
	Mixed Methods	15 (10.5)	17 (17.3)	9 (18.0)	41 (14.0)
	Qualitative	25 (17.5)[d]	0 (0)[a]	7 (14.0)	32 (10.9)
	Literature Review	14 (9.7)[e]	2 (2.0)[f]	2 (4.0)	18 (6.18)
Aim, n(%)	Design/Development	23 (16.0)[a]	65 (66.3)[a]	5 (10.0)	93 (31.9)
	Exploratory/Hypothesis Testing	40 (27.9)	5 (5.10)[a]	16 (32.0)	61 (20.9)
	T-C-M development	37 (25.8)	13 (13.2)	3 (6.0)	53 (18.2)
	Descriptive/Interpretive	32 (22.3)	2 (2.0)[a]	10 (2.0)	44 (15.1)
	Action/Evaluation	11 (7.6)	13 (13.2)	16 (3.0)	40 (13.7)
Theory, n(%)	One or More Theories Used	80 (55.9)	41 (4.)[d]	33 (66.0)	154 (52.9)
	Unclear Theoretical Positioning	47 (32.8)	51 (52.0)[g]	13 (26.0)[d]	111 (38.1)
	N/A Review	16 (11.1)	6 (6.1)	4 (8.0)	26 (8.9)
Theme, n(%)	Design and evaluation of learning resources, tools and spaces	25 (17.6)	17 (17.3)	12 (24.0)	54 (18.5)
	Learning Analytics and Automatization of Learning	4 (2.8)[a]	45 (45.9)[a]	3 (6.0)	52 (17.8)
	E-learning adoption	29 (20.4)	12 (12.2)	7 (14.0)	48 (16.4)
	Innovative Pedagogies & Technologies	23 (15.4)	11 (11.2)	14 (28.0)[i]	48 (16.4)
	Student/Teacher Learning Practices/Performance	38 (26.7)[a]	2 (2.0)[a]	6 (12.0)	46 (15.8)
	Assessment & Feedback	12 (8.4)	10 (10.2)	1 (2.0)	23 (7.9)
	Collaboration & Interaction	12 (8.4)	1 (1.0)	7 (14.0)	20 (6.8)
	Total	143 (100)	98 (100)	50 (100)	291(100)

Values displayed are significant at the level alpha=0.05. a. p <0.0001; b. p=0.012; c. p=0.005; d. p=0.001; e. p=0.014; f. p=0.040; g. p=0.009; h. p=0.044; i. p=0.021

4. Discussion

The purpose of the current systematic mapping review was to describe how e-learning research is conducted across distinct research areas and communities of practice through an institutional case-study in order to offer recommendations and critical analysis for future directions in the field. The current move to remote, emergency online education provoked by the global COVID 19 pandemic has only amplified and intensified the critical role of e-learning, particularly in higher education. The outlook for the coming decade is that EdTech will continue to grow in significance with on-going developments and issues. In the current study, a clear picture emerged of e-learning research with a majority focus on HE, nearly half which examines the modality of OHE, in line with recent research (Bozkurt and Zawacki-Richter, 2021). Clear fragmentation was identified between social scientific research, encompassing ER and DBER research areas, and computer science-oriented research approaches. This finding is consistent with the observations of Daenekindt and Huisman (2020), who claim higher education research is a highly specialized and fragmented domain, where research communities tend to inhabit their own islands. Finding synergies between and across disciplines and research areas could be a way to develop innovative approaches to e-learning research, as well as a way to detect inefficiencies in the field across research communities who may address the same theme, but use different conceptual, theoretical and methodological approaches.

In regard to RQ1, a majority of research in the current study was quantitative in nature, in line with objectivist research trends reported in other reviews (Baydas et al., 2015, Kiliç-Çakmak et al., 2013). Bozkurt (2020) identifies the strong belief in a positivist paradigm as an Achilles heel of the EdTech movement, linked to a "never-ending quest to prove whether educational technology is effective" (p.12). The most common research design included a *design science research framework*, which involves interdisciplinary approaches from a learning engineering and computer science perspective, appropriate for optimizing the impact of distance and online HE. Design/Development was the most frequent research aim reflecting the significant growth of design-based research in recent decades across many areas of educational inquiry (Reeves and Oh, 2017). Educational design research is a genre of research that shows promise in developing iterative solutions to complex educational problems while also engaging with and advancing theory (Reeves and Lin, 2020), and should be continued to be supported at institutional levels. Because design-based research approaches where used in both social scientific and computer science disciplines, this could be an obvious focus for developing trans-disciplinary synergies and advancing the e-learning field.

With regards to RQ2, the relationship between study aim and research methods have been examined since these two elements are closely aligned through research design. Results revealed that research methods are closely associated to research aims across distinct research communities, seeing the LE research community drawn to design/development approaches closely associated with quantitative techniques, while ER pursues broader research aims such as hypothesis testing, theoretical development or descriptive/interpretive objectives through quantitative, qualitative and mixed methods traditions. As e-learning and EdTech continue to grow in scale, reach, and significance in the 2020´s, and as new areas of technical capabilities and expertise emerge (Castañeda and Williamson, 2021) greater understanding of research aims, and the methods used to pursue them, can contribute to developing well-defined research guidelines, methodological capacity, and impact in the field.

4.1 Increase interdisciplinary collaboration using an integrated research agenda

With respect to RQ3 results demonstrated that research across distinct areas and communities of practice was fragmented. An example is the patterns observed between research aims and research areas, and the methods used to achieve these aims. Increasing interdisciplinary collaboration using an integrated research agenda across distinctive communities on an institutional level could be one directive for building more cohesion and clarity in the field. Building interdisciplinary collaboration can help mitigate fragmentation across research areas and designs, where common objects of research, including shared aims and thematic domains, are often pursued. Coordinated and intentional efforts are required to build multi-faceted partnerships across the islands of HE research, developed through years of specialized research training. Some of the most interesting and innovative new ideas in EdTech research form at the boundaries of social science and computer science scholarship, and thus bridges should be attempted to be built in order to reimagine the field in new directions (Selwyn et al., 2020). Progress in this regard would be reflected in building multi-disciplinary research teams and projects. Universities and research institutions must therefore challenge themselves to develop substantial, cross-institution efforts committed to integrated research agendas aiming to solve complex research problems (Wilcox and Sarma, 2016). Researchers, for their part, must continue to develop new methods while advancing theoretical frameworks in the pursuit of building their "theoretical and methodological toolboxes required to

examine educational technology as they (*EdTech*) continue to mutate, evolve, extend to new settings and expand in their (un)intended uses¨(Castañeda and Williamson, 2021 p.11).

4.2 Support the expanding profession of the learning engineer

As reflected in the results of this study, the scope and scale of e-learning research from a computer science perspective is a call for supporting the expansion of the learning engineer as an emerging field of critical inquiry. The design and optimization of current and future e-learning experiences will be supported through the role of the learning engineer, among many other actors, which requires developing well-defined methods to conduct systematic and rigorous research (Caballé, 2019). Solving current and future educational problems in online and distance education will often require expertise in a range of fields such as instructional design, discipline-based knowledge, pedagogy/andragogy, learning sciences, data science, and systems engineering. Such problems often exceed any one researcher's or discipline's ability to solve, requiring integrated research teams across disciplinary boundaries. Many institutions are leading the movement toward Learning Engineering as an emerging profession and academic discipline (i.e., Stanford, Harvard and Carnegie Mellon University). A core thread through all of these programs is the belief that learning engineers should have a solid foundation in the learning sciences, be fluent in educational technology, and have a strong understanding of design principles in both research and practice (Wilcox and Sarma, 2016). It is clear then, to support such a specialized professional profile, strategic institutional support is essential.

4.3 Promote methodological capacity, clarity, and innovation

In the last 10 years, the field of EdTech has seen notable growth in methodological innovations related to the sophistication of digital computing technologies. At the same time, many observers have lamented the general inadequacy and irrelevance of research in relation to both methodological capacity and theorization practices (Bulfin et al., 2014, Castañeda, Salinas and Adell, 2020, Hew et al., 2019). Ambiguity and confusion continue to endure as to how best to approach and theorize research problems, and basic forms of descriptive research continue to prevail (Hew et al., 2019). Authors should be explicitly clear in research conduct and reporting to avoid ambiguity in methodological design and to promote quality and rigor. An emphasis on methodological innovation and professional development initiatives to support and expand methodological capacity among e-learning researchers should be prioritized and incentivized. Both bottom-up and top-down approaches can exist in this regard, fostering research communities of practice which sustain activities such as methodological seminars, sharing of best practice, and opportunities to present research in-process with the goal of receiving critical feedback to improve the quality and rigor of the work. Finally, mixed methods approaches should be considered, combining the strengths of quantitative and qualitative methods, as dependence on narrow research methods may restrict our understanding of certain e-learning research problems.

5. Conclusions

In the current study, a systematic mapping and synthesis of the key characteristics and features of e-learning research (2015-2020) conducted at the UOC has been presented as an institutional case-study. The objective was to offer a contemporary vision of e-learning research through cross disciplinary and multi-paradigmatic perspectives, emphasizing differences in research patterns across disciplines and research communities. The results have several implications for the development of e-learning research with a view toward a post-pandemic reality which will see a continued, amplified and intensified role for EdTech, particularly in the higher education context. We present a critical analysis which supports an integrated and multi-paradigmatic view on e-learning research, particularly relevant for online and distance education research and development. We hoped to deepen our understanding of the relationship between the aims of and approaches to research in this field while emphasizing the importance of researchers continuously assembling their methodological toolboxes. By empirically examining the claims about methodological capacity and coherence in EdTech research, we have been able to offer a critical analysis for reorienting the field by: (a) increasing interdisciplinary collaboration through integrated research agendas; (b) supporting the expanding profession of the 'learning engineer'; and (c) promoting methodological capacity, clarity and innovation.

Despite an abundance of recent systematic reviews in EdTech, rarely has research been synthesized through a multi-paradigmatic perspective. Systematic reviews can generate new knowledge and insightful implications for researchers aiming to navigate the field and predict and shape its future by critically examining its recent past. We have hoped to contribute to the development of the field of e-learning by informing the design of future research initiatives and institutional policies, transferable to wider e-learning research contexts. Future

systematic reviews could continue to develop multi-paradigmatic perspectives across socially oriented and computing approaches and employ different techniques of analysis, such as visualizing bibliometric networks. Lastly, we hope the results and discussion emphasise the need to critically reflect on methodological capacity and relevance of e-learning research and the role of institutions in supporting systematic and rigorous research conduct using well-defined research methods when resolving complex research problems.

Availability of data and material

The authors wish to report that their data is currently not openly published, but is available upon request.

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Exploring Interdisciplinary Collaborative Online Learning Spaces through Sociomateriality in Cape Town, South Africa

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Abstract: With the rapid adoption of online learning spaces since the advent of COVID-19, more and more calls are being made in higher education to move from emergency remote teaching and learning to appropriate online education. Although much has been written about the designing of online learning from both a technological and pedagogical perspective, limited contemporary literature is available to understand the complexity of interdisciplinary collaborative online learning. This limitation is investigated in this paper that reports on the first iteration of a Design-Based Research (DBR) study. Within this iteration, a qualitative exploratory research design that applies an inductive approach between researchers from Information Systems (IS) and Urban Planning (URP) is discussed. The aim was to develop design principles for interdisciplinary collaborative online learning spaces. This paper reports on the data generated during a semester-long, inter-institutional, interdisciplinary student project that was embedded in co-creating social digital innovations for pressing environmental problems faced by marginalised communities in Cape Town, South Africa. The participants for this study are 38 Honours degree IS students and 22 Advanced Diploma URP students (N=60). Participants, individually and in groups, completed a total of three reflective structured questionnaires using Google Forms during the semester that generated the dataset for this paper. The theoretical framing that underpins this research study is sociomateriality. The attraction to sociomateriality is its ability to not merely shift attention from the human to the non-human but rather a focus on entanglements and the interrelated nature of components that constitute the learning space. This focus on entanglements is needed for an understanding of the complexities associated with interdisciplinary collaborative online learning. Engaging this complex learning space through the data has revealed four design principles namely: (1) creating immersive context-sensitive learning experiences, (2) designing opportunities to collaboratively (co)-construct knowledge, (3) focusing on the intra-action of socio-technical and socio-cultural entanglements and (4) foregrounding relationality as a tool to foster agency. It is argued in this paper that the aforementioned design principles are necessary for developing interdisciplinary collaborative online learning spaces that afford students a complex learning experience. Complex learning is considered fundamental in developing abilities in students to appropriately respond to the myriad 21st-century societal challenges that await.

Keywords: Interdisciplinary collaborative online learning, online learning design, sociomateriality, agency, intra-action, entanglement

1. Introduction and Background

Covid-19 brought with it unprecedented challenges in the teaching and learning space at higher education institutions with a major shift from predominantly in-person to emergency remote teaching and learning. Emergency remote teaching and learning have been criticised for being hurried and pedagogically weak (Hodges et al 2020) and to be replaced by more substantive online learning interventions. A closer exploration of the concept of online learning revealed a significant shortcoming as highlighted by the Networked Learning Editorial Collective (2021, p. 312) "Online learning has always been an awkward term—not least, because, like 'digital', 'distance' and 'virtual', it can obscure the embodied and physically situated nature of learning….. Students live in a complex social-material-digital world".

Although much has been discussed in the literature on the shifts in learning pedagogy (Cubric and Söbke, 2021), fewer scholars are focussing on the sociomaterial aspects of relationality, the agency of technology and the intra-active entanglements within online pedagogy. Sociomateriality (Mousavi Baygi, Introna and Hultin, 2021; Hultin, 2019; Scott and Orlikowski, 2013, 2014; Fenwick, Jensen and Nerland, 2012 and Barad, 2007) and its associated philosophical and theoretical positionings provided the needed recognition of the multitude of complex dimensions within online learning spaces or the "complex social-material-digital world" (Networked Learning Editorial Collective, 2021, p.312) mentioned above. The broad banner of sociomateriality presented the opportunity to acknowledge the interconnected nature of technology artefacts and their influence on humans, and vice versa, to examine how actions and relations are materially constituted in practice (Scott and Orlikowski, 2013, 2014).

The study addresses the research question: *What are the sociomaterial-inspired design principles for interdisciplinary collaborative online learning spaces?* It draws on data from 60 post-graduate students that formed interdisciplinary student teams within the first quarter of 2021. Student teams engaged with local communities to identify pressing urban environmental problems that were framed by the sustainable development goals (SDGs). They followed a design thinking methodology (Brown, 2008) to suggest digital innovations to address the systemic urban environmental problems.

This paper firstly engages theme-specific literature to frame the learning space and thereafter sociomateriality is positioned as a theoretical lens. An argument is made for an analysis of the data with an emphasis on key sociomaterial concepts of agency, intra-action and entanglement. The methodology section provides context about the DBR study and more specifically the interdisciplinary collaborative student projects as part of iteration one of the study. The data were collected - or co-created as is the custom in a sociomaterial context (Pischetola et al. 2021) - from student reflections, researcher field notes and project artefacts. The data exploration concludes this paper with four design principles for interdisciplinary collaborative online learning spaces through a sociomaterial lens.

2. Literature Analysis

The analysis of relevant literature forms part of the DBR process as an element of Phases 1 and 2 (see Figure 1).

2.1 Interdisciplinary and transdisciplinary learning spaces

There is a different approach to studies within a single discipline and those that are drawing from multiple disciplinary stakeholders. A multidisciplinary approach normally gathers contributions from different disciplines without actual synthesis, while interdisciplinarity integrates knowledge from several disciplines (Bernstein, 2015). The integration of perspectives from different disciplines provides a systemic outcome (Lawrence, 2010). The difference between an interdisciplinary and a transdisciplinary approach is the widening of focus to more complex heterogeneous domains that include stakeholders from academia, government and civil society (Lawrence, 2010; Dorst, 2018; Kroeze, Travica and van Zyl, 2019).

Within the academic environment, different professions tend to operate within the confines of their own disciplines leading to deep specialisation within a closed philosophy (Bernstein, 2015). This siloed approach is not conducive to the understanding of complex or wicked problems encountered in an interconnected digital world. Wicked problems transcend a single discipline such as pressing problems around the Sustainable Development Goals (SDGs) that are multi-dimensional and non-linear and should be addressed by a combination of theories and approaches (Kroeze, Travica and van Zyl, 2019). This prompted the engagement with the properties of interdisciplinary perspectives within student projects that explore the complexities of systemic problems within communities. Within the complex entanglements of this environment, further compounded by a switch to online-only learning, the affordances of sociomaterial learning theories were further explored. As a sociomaterial-focus recognise the complex entanglements between the human and non-human, devices, objects, digital and analogue texts, spaces and time, to create fluid assemblages of practice (Gourlay and Oliver, 2018).

Fenwick, Edwards and Sawchuk (2011), affirm that interdisciplinary studies require a shift to the development of collective and sociomaterial learning theories. Within such practices, the emphasis shifts to the collective where social collaborative networks and material artefacts become entangled in knowledge production. The application of an interdisciplinary, project-based approach to teaching and learning is conducive to this mode. Collaborative projects within communities ultimately require a shift from an interdisciplinary to a transdisciplinary understanding that allows for human and non-human entanglements within a complex setting involving multiple actors. To understand the implications of such a collective network, it is necessary to understand the concept of networked learning as situated within the sociomaterial framing of this study. The next section will summarise networked learning within the bigger framing of interdisciplinary collaborative online learning.

2.2 Collaborative, participatory, networked (online) learning

Networked learning researches the complexities that reside in the interconnected nature of "students, teachers, ideas, tasks, activities, tools, artefacts, places and spaces'' (NLEC, 2021, p. 313). Deeper engagement with these connections will combat the dissonance that resides in the disconnect between design intent and unfolding learning activities (Carvallo & Yeoman, 2021).

Learning in networks opens up collaboration and collective action in the process of knowledge creation in an unbiased attempt to not privilege any one form of knowledge or learning. There needs to be a strong dependence on relationality that opens up the space for trust and reciprocity to enhance the network's activities for a larger purpose that matters to the collective. An important part of networked learning is that technology is an integral part of the network to facilitate connectivity (NLEC, 2021). Digital technologies cannot be viewed as tools that will automatically enhance learning for the users (students) but rather as part of the interdisciplinary network of human and non-human actors (Gourlay et al., 2021). As such, we engaged with the framing of our collaborative, participatory, networked (online) learning using a sociomaterial approach. The following section positions the theoretical underpinning of sociomateriality as a way to open the space for human and non-human entanglements.

2.3 Theoretical framing: A sociomaterial approach

In this paper, a sociomaterial position is taken as a relational materialist theoretical stance to frame the complexity and creativity of interdisciplinary collaborative online learning spaces. Notable sociomaterial scholars such as Orlikowski (2007); Scott and Orlikowski (2013) and Hultin (2019) influence and shape understandings of an onto-epistemological position that foregrounds the interrelatedness of the social and material worlds. A shift in understanding is called for because of the contextual changes from face-to-face teaching and learning to an online environment. A need exists to pivot and recognise that experiences for both lecturers and students in face-to-face teaching and learning do not necessarily translate to the online learning space.

Sociomateriality has frequently been adopted as an onto-epistemological framework for various studies as Fenwick et al. (2011) claim, humans should be understood not as holding a privileged status in the world but rather as being part of it. To this point, practice theory (Schatzki, Knorr-Cetina and Von Savigny 2001; Rouse, 2007) and more specifically a posthumanist practice theory (Gherardi in Hui et al., 2017) provides an initial disruptive lens to explore how the dualism between the social and the material may be overcome by considering the practice as the space where complexity and creativity play out. Gherardi in Hui et al. (2017, p. 38) provides a useful understanding by explaining that "the materialities of bodies, technologies, discourses could not be separated from the society that formed them, and vice versa the social cannot be considered external or separate from materialities." Similarly, Kemmis, Wilkinson, Edwards-Groves et al. (2014, p. 4) caution that people interpret other people within a group or community based not only on face value but their perceptions that are already shaped by "a lifetime of inhabiting the social world." This needs serious consideration, especially when engaging with a diverse society such as South Africa.

This understanding of practice affords an opening to engage with the complexity of interdisciplinary collaborative learning where the social is made up of differing disciplines underpinned by differing onto-epistemological foundations. Over and above the disciplinary difference, differing socio-eco-cultural backgrounds make up the student body which represents yet another onto-epistemological position. The diversity of onto-epistemology brings with it the potential for conflict and complex engagement in the online learning space but also the opportunity for creative and shared learning and the potential for co-creating a practice. Barad (2007) in Hultin (2019, p. 91) offers that "[a] relational and performative sociomaterial approach operates with a different ontology. Its underlying assumption is that there are no beings, social or material, no subjects and objects, no research and researched. Rather, all assumed actors, entities and categories are understood as relational enactments or material configurations of the world's becoming."

To formulate a theoretical lens within sociomateriality is a complex endeavour. The work of Mousavi Baygi, Introna and Hultin (2021), is valuable in clarifying the position taken in this paper to focus on "relational enactment" as a move to decenter human actors by advancing attention on "ongoing processes" of phenomena. By "foregrounding the ongoing relational enactments of entities in practices" (Mousavi Baygi et al., 2021, p. 427) the focus shifts not merely from the human to the non-human but rather to the relationality and interrelatedness that typically exist in the background. It is argued that the nature of collaboration exists in this

domain and therefore the focus of this paper is on collaborative enactments. The next section highlights some key elements that constitute the collaborative enactments within the online learning space.

2.4 An understanding of agency, intra-action and entanglement as foundational to sociomateriality

The entanglement of the technical or material and the social can be understood through the notion of constitutive entanglement (Orlikowski and Scott, 2008). Within the context of interdisciplinary collaborative online learning, the ordinary relations between human, material and other elements can be seen as mutually constituted or inextricably related and therefore inseparable (Latour, 2005). Actor-Network Theory developed by Latour (2005), reviews the symmetry between human and non-human elements as actors in a heterogeneous network in which they both have the same power of agency. Therefore, it does not give special privilege to human actors over technologies (or the non-human) but recognises humans and technologies as ontologically inseparable components (Cecez-Kecmanovic, Galliers, Henfridsson et al., 2014).

This assumption allows Barad (2007) to reformulate the notion of agency and in particular to transcend the duality of human versus technological. Barad's conception of agency is the "enactment of iterative changes to particular practices through the dynamics of intra-activity" (2007, p. 827). Intra-action can thus be understood as the "mutual constitution of entangled agencies" (Barad 2007, p. 33). For Barad (2007, p. 33) "the notion of intra-action is a key element of my agential realist framework" where intra-action "signifies the mutual constitution of entangled agencies". This recognises that individual agencies do not precede the interaction but "rather emerge through their intra-action". This would mean that you cannot and should not separate the human and non-human actors in contributing to knowledge creation. There is no prior understanding that is not influenced and shaped by intra-action, stipulating the importance of working within an interdisciplinary environment where there is no discipline-specific knowledge creation but a mutual entanglement of new learning.

The idea of agency opens up possibilities for creating alternative views within an online learning environment. It can be developed and nurtured as an enactment rather than something that someone already has (Norris, 2016, p. 178). This then has the potential to overcome possible inequalities within higher education by considering agency as continuously starting afresh. Mousavi Baygi et al. (2021, p. 440) pose a central question by asking "do they [actors] get to sense and actualise certain possibilities for action?" which foregrounds the empowering ability to consider agency as entangled and inseparable. This is summarised by Ewalt's (2016, p. 139) eloquent statement that "agency emerges from the arrangement-in-relation-to-each-other that is the result of there being a multiplicity of [human and non-human, discursive and nondiscursive] modalities of moving matter." The rapid move under COVID-19 conditions from the traditional face-to-face to online learning and teaching spaces, opens up the possibility of sociomaterial perspectives, specifically, agency, intra-action and entanglement to consider complexity and creativity anew.

3. Methodology

The researchers followed a qualitative exploratory research design that applied an inductive approach to study observations and theories in search of patterns to reach conclusions (Saunders, Lewis and Thornhill, 2019). The application of Design-Based Research (DBR) was deemed to be the most suitable for the larger research study because it encourages collaboration between stakeholders (e.g., researchers, IS and URP students, community members) which is a central premise of the research. Within a DBR study, both new theoretical insights and practical solutions to teaching and learning challenges can be developed (McKenny and Reeves, 2020). Furthermore, the application of DBR is ideal for the research and design of a learning environment in which technology plays a major role, as is the case in this study (Wang and Hannafin, 2005). A four-phased DBR approach as adapted from Reeves (2006) was applied (see Figure 1).

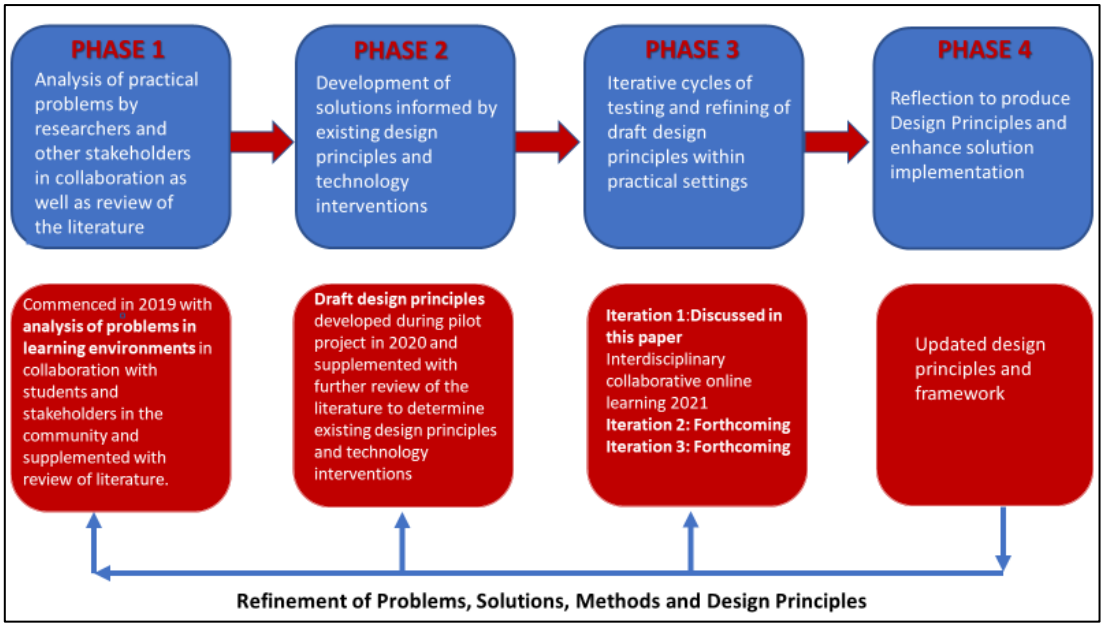

Figure 1: Design-based research phases in blue and the phases of this research study in red. Source: Reeves (2006).

A DBR study is longitudinal and consists of a collection of sub-studies that are reported separately, with this paper discussing the first iteration as part of Phase 3 of the overall DBR study. As seen in Figure 1, in the first phase of a DBR study practical problems within the learning environment are explored in a process of collaboration with other practitioners and stakeholders as well as a review of the literature. The study was initiated in 2019 with the identification of problems in the learning environments and ways of incorporating interdisciplinary collaborative student projects to address systemic problems in communities (van den Berg and Verster, 2020). The consultation and collaboration included a pilot project that resulted in pedagogical propositions and design principles to be continuously tested and refined (Verster and van den Berg, 2021).

The draft principles formulated in Phase 2 were constructed for a blended learning environment and a shift to online-only during the first iteration added more complexity to the learning environment. This presented the problem of how to stimulate interdisciplinary collaboration within an online environment? The shift resulted in a review of theories and as such, the possibilities of sociomateriality were explored by the researchers leading to the research question: What are the sociomaterial-inspired design principles for interdisciplinary collaborative online learning spaces?

3.1 Iteration 1: Interdisciplinary Collaborative Online Student Project 2021

3.1.1 The student project was rolled-out as follows:

- **Pre-Production Phase**: Collaborative workshops to identify pressing environmental problems in local communities. The workshops were in a blended learning format consisting of Zoom sessions with the IS students where online tools such as Jamboards were used for brainstorming ideas within groups of five students each. The URP students collaborated via a face-to-face session in groups made up of two to three students. The themes identified by the individual groups within the different disciplines were used as a guide to form seven interdisciplinary groups. The interdisciplinary groups then identified a single problem within one of their local communities, derived from the broader theme and the output was a problem statement informed by a deep dive into the relevant literature. Table 1 contains information on the group names and the problem areas focused on per group.

Table 1: The range of environmental community problems as identified by student groups.

Group Name	Problem Area
Eco Team	Illegal dumping and mismanagement of solid waste
Eco Warriors	Rapid urbanisation and its pressure on biodiversity
Group 6	Dumping of domestic waste
Removal Approval	Litter and waste at public transport interchanges
System 740	Poor community waste management
Waste Junkies	Improper disposal of urban waste
Water Gate	Water pollution within communities

- **Phase 1**: Empathise and Define: Authentic understanding of the problem from the community perspective. The output was interviews with respondents in student communities and the responses were captured as digital stories. From the digital stories, groups had to develop two personas to be used within the roll-out of the rest of the project (See Figure 2).
- **Phase 2**: Ideate and Prototype: The teams were aided to brainstorm ideas during an online session using Jamboards (See Figure 3). This was followed by a process where teams utilised a decision matrix to determine potential ideas to be prototyped. Prototypes were created and pitched to other groups for feedback.
- **Phase 3**: Test and design. Prototypes were tested by a wider audience and one prototype was selected to be designed and presented to a panel consisting of representatives from communities and local government (See Figure 4).
- **Post-Production Phase**: Individual and group reflections after the completion of the project and the compilation of e-portfolios that showcased the final projects.

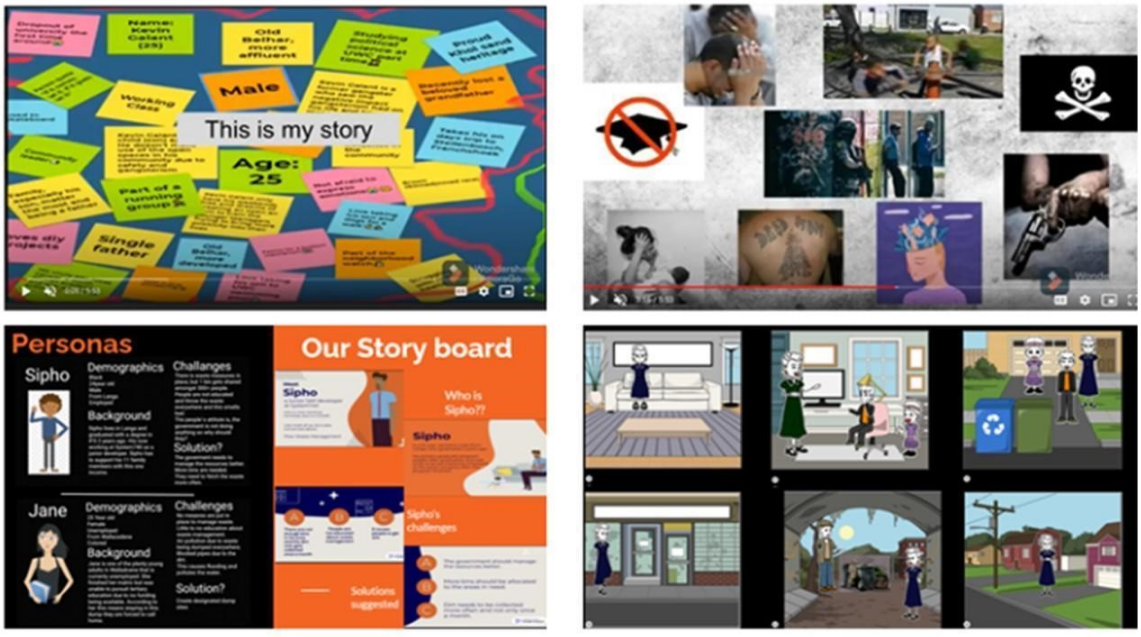

Figure 2: A sample of digital stories and personas that student groups developed to continuously consider the community voice.

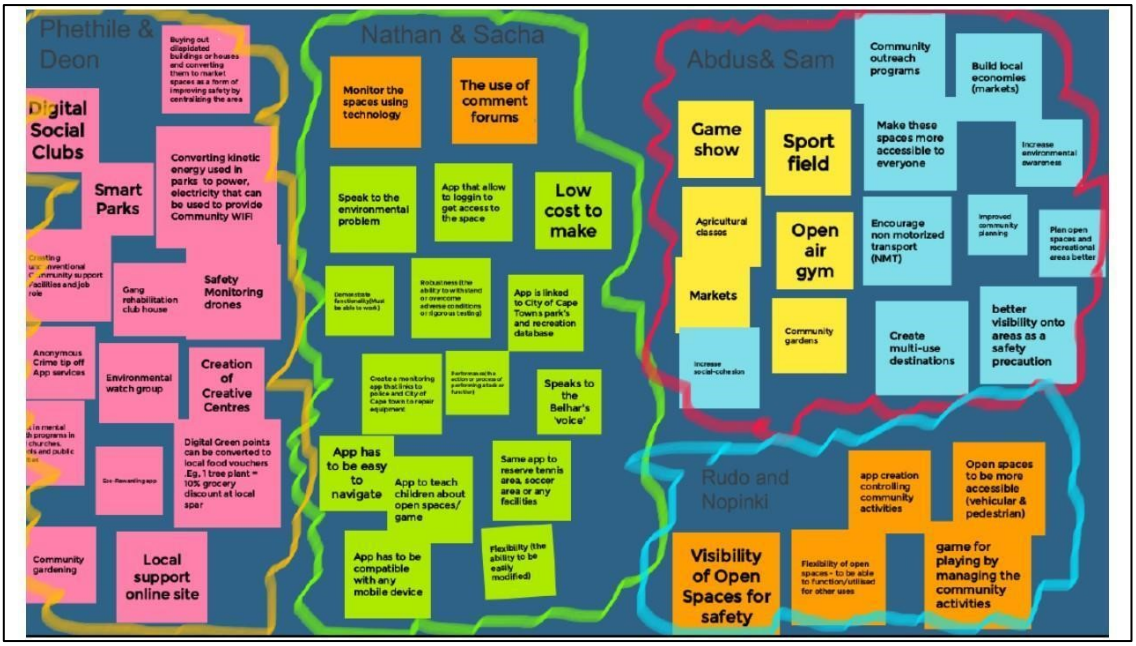

Figure 3: Jamboard with group ideas to co-construct for and with a community.

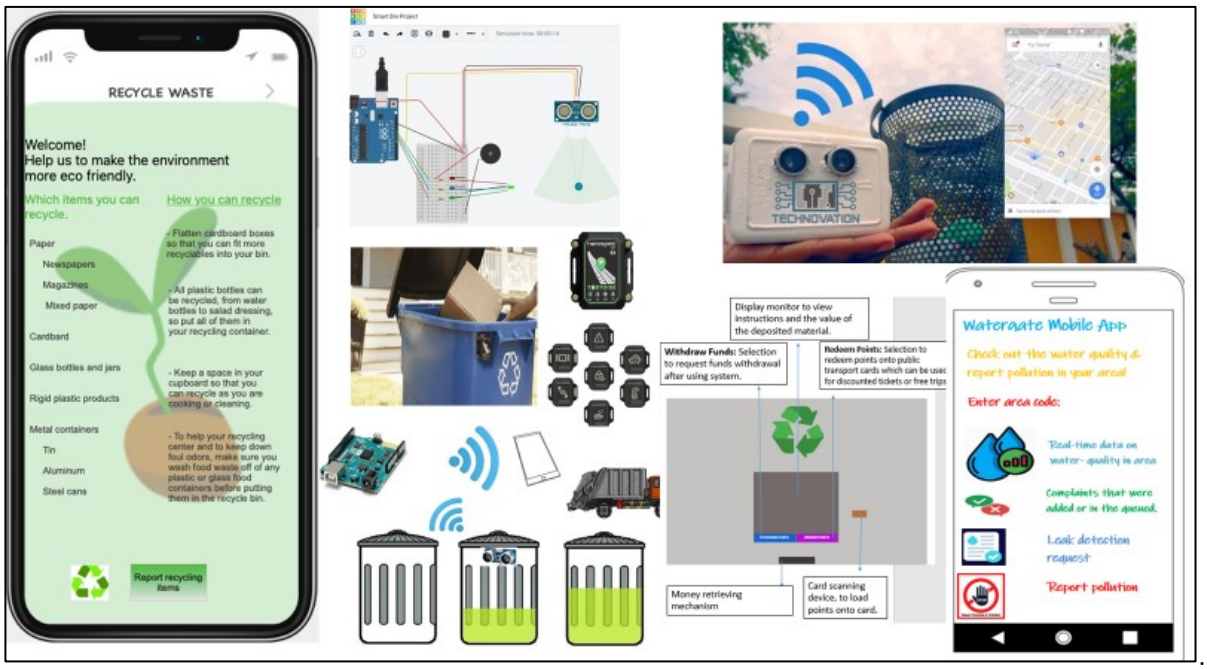

Figure 4: Examples of prototypes developed by student groups.

3.2 Sampling and Participants

The first iteration took place in 2021 during a joint project consisting of 38 students from the Honours group in IS at one university and 22 URP students doing the Advanced Diploma at another university. The two groups represented the full student complement enrolled for these courses. The interdisciplinary group project formed part of the overall learning outcomes and assessments of the modules. Permission to have their findings and reflections, during the roll-out of their group project, included in the data was obtained from students via a signed information sheet that contains details about the study. The participants were students of the researchers and the inclusion of individual findings and reflections in the data was voluntary. Their participation or non-participation had no beneficiary nor negative implications. As such, the researchers applied convenience sampling that included all the students registered for the two modules. Permission and ethical clearance were obtained from both universities.

Table 2: Participation summary

Student Reflections	*Before Project*	*During Project*	*After Project*
Population	*60*	*60*	*60*
Response Rate	*87%*	*83%*	*85%*
Number of URP students	*22*	*18*	*20*
Number of IS students	*30*	*32*	*31*

3.3 Data Collection and Instruments

The researchers participated in the data-gathering efforts and ensured that the data remained as close as possible to the actual events. An access-controlled Google Drive folder was used to store all information gathered from students during the semester. This included:

- A pre-and post-course reflective questionnaire using Google Forms was made up of open and closed questions that tested students' perceptions of the learning environment. The questionnaires were specifically designed to address the objective of the study to test the students' perceptions of interdisciplinary collaborative online learning. The first section tested their perceptions on interdisciplinary knowledge creation, section two focused on the learning environment created, and the third section on collaboration. The fourth section tested students' perception of the development of critical thinking and problem-solving and the final section contained their biographical information.
- A reflective questionnaire on Google Forms about the students' perceptions of the interdisciplinary project· during the project activities to reflect on the positive and negative aspects of interdisciplinary collaboration in online environments was a further data collection instrument.
- Field notes and reflections made by the researchers during the project rollout were also consulted.
- Data from the artefacts produced during the interdisciplinary project was also consulted. All course work was saved in folders per group (seven assignments with all responses, comments, artefacts and e-portfolios (See Figure 5).

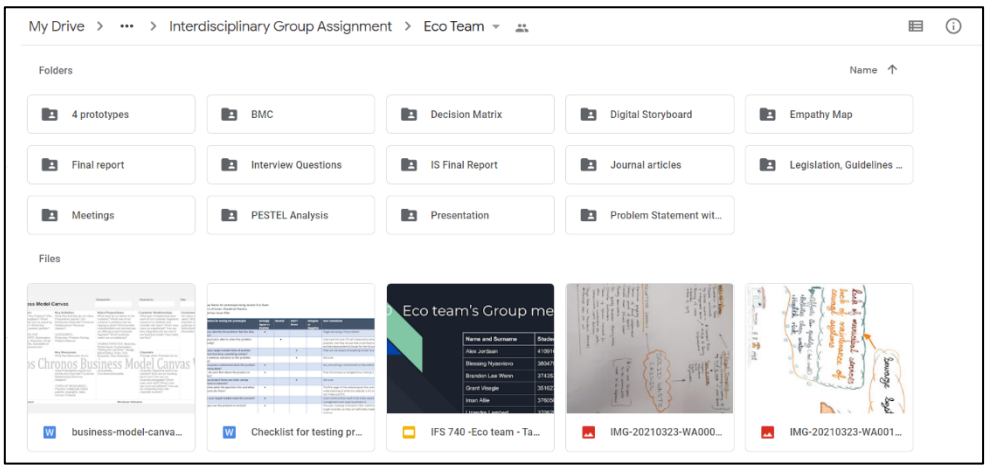

Figure 5: An example of a student group folder in Google Drive.

3.4 Data analysis through sociomaterial concepts

The analysis of findings required "creative and analytical flexibility to support the optimisation of the human and material resources available in ways that remain aligned with the goals of the instruction" (McKenny and Reeves, 2020, p. 90). Within a sociomaterial setting, we shared Hultin's (2019, p. 92) struggle in this research of "becoming entangled with" the research project "rather than being positioned outside it." This proved to be especially challenging within the interdisciplinary space where differing positionalities of understanding the world collided.

Researchers are referred to in the first person because they are positioned 'inside' the research event and in line with the sociomaterial approach.

In our engagement with the data sources, our key objective was to focus attention on those manifestations of complex and creative agency and entanglements within the interdisciplinary collaborative online learning space. The interest in agency and entanglements emerged through our reading of sociomaterial theory as positioned by Gaskin, Berente, Lyytinen et al. (2014, p. 849) as the "study of the entanglement of human activities and digital capabilities" to describe a sociomaterial inquiry position. With this in mind, we explore a sociomaterial informed method by drawing on sociomaterial scholars as those "who seek to understand social phenomena as the product of interaction between humans and non-humans" (Moura and de Souza Bispo, 2020, p. 351) and their understanding of a selection of key concepts.

Saunders, Lewis and Thornhill (2016, p. 142) note that the researcher's philosophical positioning represents the "ways of seeing the world and carrying out research." To this point, St Pierre (2014, p. 3) warns "that methodology should never be separated from epistemology and ontology (as if it can be) lest it becomes mechanised and instrumental and reduced to methods, process, and techniques." Being conscious of the limiting nature of predetermining and following a single method, resulted in us following an organic, iterative process of engaging data to ensure a natural unfolding and emergence of meaning. In this organic, iterative process we draw on several key concepts that influenced our engagement with data.

One such concept is offered by MacLure (2013) as 'data that glow' or data hot-spots. In our repeated reading and listening to our data, we sought to tune into those moments of data that 'jumped out at us'. MacLure (2013, p. 228) speaks of data hotspots as data that seem to 'glow' and 'glimmer', which stay in your mind, touch your heart and spark off connections with other instances. Another concept we found useful to think with, is Barad's (2007) 'intra-acting' "which argues that agency is not possessed by individual things or beings, but emerges through relationships" (Verlie, 2020, p. 1266). This concept provides an opportunity to engage with data relationally instead of categorically (Nordstrom, 2013). This means that we are attentive to the relationality and entanglements in the data as it unfolds and evolves.

Because sociomateriality is so deeply rooted in relational onto-epistemology, we propose exploring and engaging with the data by way of 'emergence' as our final concept. Springgay and Truman's (2018, p. 205) concern rings true that "the idea that data is a thing that sits in the world and can be isolated and extricated by a method but as separate from that method is impossible." Letting meaning emerge calls for a move away from the typical measurability of data elements such as coding or affordances. It further shifts focus from verification and recognizable sameness to focus attention on the seemingly insignificant and mundane in the data. Hultin (2019, p. 91) refers to "inviting materiality into" to explain how meaning can be allowed to emerge authentically.

4. Discussion: Sociomaterial-inspired design principles for interdisciplinary collaborative online learning

Due to the fast-changing landscape of ICT, technological innovations now facilitate the interconnection and interaction of large numbers of people, artefacts and organisations. These changes have also impacted Higher Education Institutions (HEIs) and particularly since the outbreak of the COVID-19 pandemic, enforced a move to online learning. The result is that the online learning space has presented new functionality and materiality within the teaching and learning environment for many actors within HEIs. The sudden shift to online learning imposed a review of online pedagogy that prompted a deeper engagement with the social and material entanglements. What was sought in this paper was what Pischetola et al. (2021, p.400) recognised as "a sociomaterial approach might…offer emergent and creative ideas for what might be the future of education and the role of digital technologies within it."

Sociomaterial concepts are not easily quantifiable and provide a way of thinking-with and engaging-with data rather than the more traditional categorising of data in groups of sameness and difference. The datasets are used to understand how sociomaterial qualities of online learning can facilitate interdisciplinary collaboration.

In the data analysis, the sociomaterial concepts of 'data that glow', 'intra-action' and 'emergence' provided the analytical lenses. The following four principles are proposed as considerations when engaging in an

interdisciplinary collaborative online learning pedagogy. A selection of student quotes as well as artefacts are used to illustrate the principles.

4.1 Create immersive context-sensitive learning experiences

It is important to set the context that structural inequalities, societal exclusion and/or poverty are experienced by the majority of our students. The first design principle focuses attention on creating opportunities in the interdisciplinary collaborative online learning space for students to immerse themselves in diverse perspectives and contexts. In an online learning environment, this can be facilitated by opening up the space to experiment with a range of different digital tools to assist group members in authentically expressing themselves. Students groups used a range of tools such as MS Teams, Zoom, Google Meet or WhatsApp for online discussions and could also experiment with tools such as Jamboards or Padlets for brainstorming sessions. These tools were available within the learning management system (LMS) or could be accessed with a Virtual Private Network (VPN) and they did not incur any data charges. Students were encouraged through the above interactive tools to express differing viewpoints and their own cultural understanding of the environmental problems within their communities. The benefits of a context-sensitive learning experience as expressed by students:

> *It helped me to have a positive mindset and see different perspectives objectively. I realised there are so many more different platforms to reach people and people have vastly different perspectives which relate a lot to their education and upbringing as well as their circumstances* (Student).

> *I got a deeper insight into how people really felt about the problem, what the government was actually doing about it and also [encountered] different ideas that could assist in solving the problem (Student). It broadened my understanding of the complexity of solutions to problems in society in this generation. Given the interrelatedness of the different sciences and ideologies, it is important to approach problems in society from multiple disciplines* (Student).

The data also revealed some challenges experienced at the beginning of the project such as the complexity of power dynamics when students are meeting online. In a face-to-face environment, a more structured approach can be introduced by facilitators to ease students into the complexities of an interdisciplinary group project, which is not the case in the online learning space:

> *At the start, the problem was that not every individual was given an equal footing and some members may overpower others in a virtual setting* (Student).
> *In the beginning, we had a clashing of ideas from the different disciplines, a lack of communication and the absence of some team members due to connectivity issues* (Student).

To circumvent the issues experienced at the beginning, the project was redesigned to allow more time to be spent on understanding and formulating the community problem and to enable participation from all students in the groups. Participation through creating, narrating and recording stories from their communities in the form of digital stories and personas, provided students with an opportunity to have their voices heard and to engage with different perspectives.

Higher Education is facing growing uncertainty and complexity that requires creative solutions and new ways of doing and being. This complexity is further amplified by the switch to online learning as a result of the COVID-19 pandemic. There is a growing need to tolerate uncertainty and to function in ambiguous and unpredictable circumstances (Sinha and Sinha, 2020). As such, students need exposure to diverse content, techniques, and views on problems within society that combine multiple knowledge areas (van den Berg and Verster, 2020). Therefore, by designing learning spaces that intentionally create awareness of diverse perspectives and contexts, students are better prepared for the complexity in a ubiquitous world.

4.2 Design opportunities to collaboratively (co)-construct knowledge

For an immersion in diverse perspectives and context to successfully be enacted in interdisciplinary groups, the learning space needs to facilitate a collaborative approach to the co-constructing of knowledge. Within the online space, this requires the use of multiple platforms for engagement, regular peer and facilitator feedback and the pacing of project deliverables to allow enough time for groups to collaboratively consider and incorporate feedback. We used Google Drive with folders for each group that contained the different stages of the project. Student groups were requested to specify the type of feedback they required to be active participants in the learning. Feedback was also provided on each milestone during the project roll-out.

At the beginning of the project, students experienced uncertainty because of the rapid shift to online learning and the additional complexity posed by an interdisciplinary learning environment.

> *At first, nothing made sense to me and I had no idea of where we were heading with our project. But completing each activity, collaborating with the Urban Planning students, and also having discussions with members of my community gave me a clearer picture of where we are heading. It was quite interesting to see how everything came together and how IS, URP as well as the community could be intertwined to create something really extraordinary* (Student).

> *The feedback provided allowed the team to look through different lenses, angles and approaches to the various [project] stages* (Group Watergate).

> *Online learning is very new to me, so is working from home so I had a lot to adjust to, but it also made it a lot easier to keep in touch with my peers and message them whenever I was struggling with anything related to our assignment* (Student).

> *I also liked the fact that we had small deliverables that build-up to the big project such as using Jamboards the whole time to brainstorm and focus our ideas* (Student).

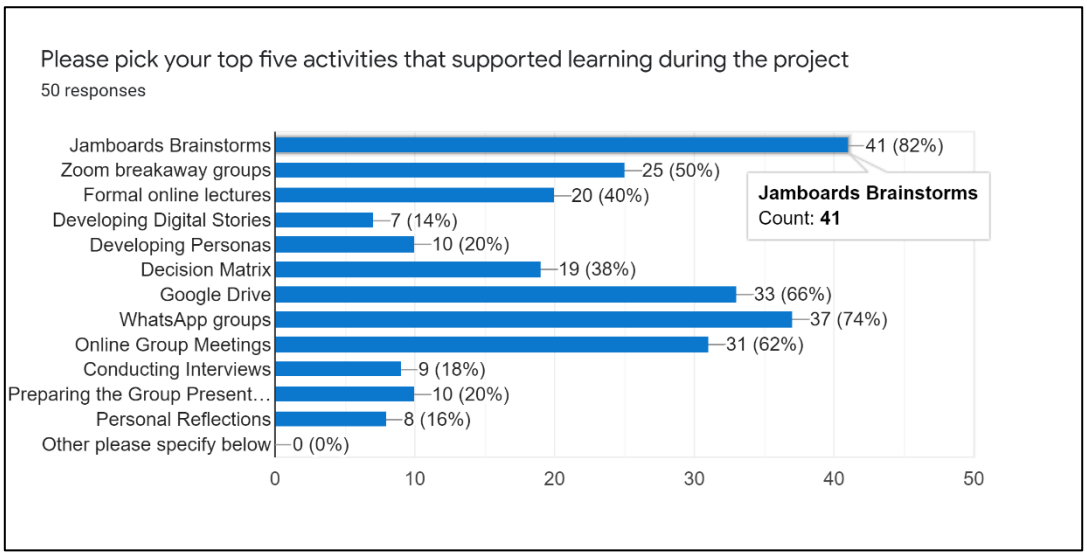

Figure 6: The activities that students regarded as most supportive of their learning. The top 4 - Jamboards, WhatsApp groups, shared Google Drive and Online group meetings - are activities to co-construct knowledge.

To collaboratively (co)-construct knowledge, a space for sharing agency is needed as Sobko, Unadkat, Adams et al. (2020, p. 51) postulate "The key is to neither dismiss nor over-emphasise the role of any actant—be it the instructor, students, or digital tools—but to interrogate the dynamic ways these come together." The coming together of the actants or what Barad (2007) referred to as "intra-action" enables human and non-human actors to collaboratively (co)-construct knowledge within the online learning space. Moreover, the online learning space needs to incorporate several digital tools to stimulate multiple ways of collaborating and creating group cohesion. Also recognised by both facilitators at the onset of the project and the student groups during the project rollout was the value of offering continuous feedback to provide enough scaffolding that enables students to navigate between the complex and the creative.

4.3 Focus on the intra-action of socio-technical and socio-cultural entanglements

Socio-technical refers to the intra-action between the human and technology within the learning space whereas socio-cultural refers to the complex human and socio-economic-cultural setting. We recognise that both facilitators/lecturers and students are intrinsically linked to their social standing, traditions and beliefs. As such, we created a learning space that enabled the student groups' time to experiment with and explore different ways of working collaboratively. The focus on experimenting within the learning space created an opportunity for students to develop confidence and strong group cohesion was detected.

> *The different technologies allowed each student to not only learn from one another but also gave a comprehensive overview of inclusivity through differences in opinions, views etc. (Student).*

> *I enjoyed making use of other technological applications and work ethics such as finding new applications to work together as a group, I have never been involved in such [a] collaboration before. It is exciting to see how well we engage with each other and how we use the knowledge we have acquired and try to use it to achieve the same goal (Student).*

How knowledge and agency emerge in complex learning spaces, requires designing with matters of space, time, different digital tools and other artefacts in mind (Leibowitz and Naidoo, 2017). Students were given the freedom to experiment with a variety of digital tools and ways of working as a response to the complexities within their different socio-technical and socio-cultural realities.

> *Many of the lessons learned were outside an academic perspective, but more on a personal level - learned to accommodate differing cultural-religious social spaces...We also learned that the religious beliefs of people are important. For example, the month of Ramadan for the Muslim students. We had to work around the times of breaking the fast to ensure everyone is available for meetings, for instance (Group EcoWarriors).*

> *People from different backgrounds have very different ways of doing things and different approaches to solv[ing] a common problem (Student).*

A further very practical socio-technical consideration, specifically in the South African context, is the added complexity of regular electricity outages referred to as "load shedding" that impacted the delivery of online lectures and student engagements during the roll-out of the project. Furthermore, the cost of data is high in South Africa - South Africa ranks 136th for the average cost of 1GB of mobile data as measured in 230 countries (Cable, 2021). These issues are further exacerbated by the fact that the majority of the students at our two HEIs come from poor and marginalised communities.

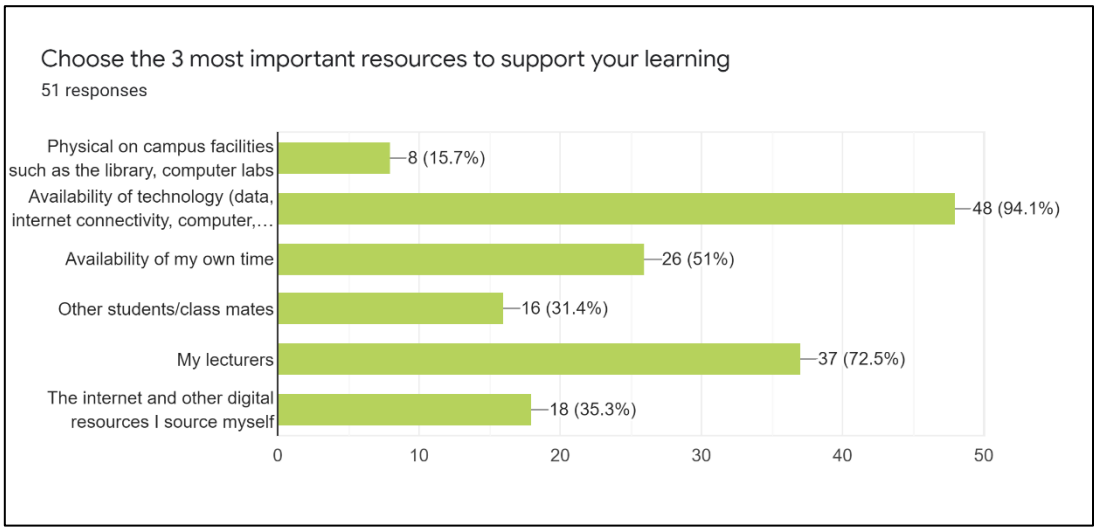

Figure 7: The availability of technology in the form of data, connectivity, devices and digital tools were considered fundamental in supporting student learning.

> *Some of my group members did not have sufficient data to attend every meeting, some could not connect to any network and this created standstills in some parts of the project* (Student).

> *I consider myself privileged to have working devices and an active internet connection. Some do not have working devices or connectivity which makes it more difficult to be an active student in the online working environment* (Student).

Within the context of these 'impediments', a sociomaterial turn enabled us to be open to unpredictable flows of action that can cause unforeseen outcomes. Therefore, our focus shifted to the entanglement of students, facilitators and other non-human materials such as Virtual Private Networks (VPNs) in a process of becoming together (Lebowitz and Naidoo, 2017). Students were sensitised to sharing the responsibility of the learning processes and not only the learning outcomes. The idea of 'learning in the moment' became important to expose students to new experiences and ways of thinking, acting and co-creating.

> *One of the things I realised is that non-linear learning is essential to truly understand a concept (Student). I enjoyed the opportunity to express ourselves in a unique way* (Student).
>
> *The ability to not be as serious as I normally am about work. I feel like I am allowed to explore outside the box and be creative which is fun* (Student).

Students recognise the opportunities a non-linear responsive learning experience creates by being creative and flexible and as such provide more openings for students to develop their learning strengths and weaknesses.

We find it useful to think with Kemmis et al. (2014) when they propose "cultural-discursive arrangements" as ways in which to transform our understanding of the intra-action of technology, culture and social opinions. Cultural-discursive arrangements focus attention on the agency that exists within the socio-technical and socio-cultural entanglements and how knowledge cannot and should not be attributed to any one component. This requires an awareness of relationality as discussed in the next section.

4.4 Foreground relationality as a tool to foster agency

Both facilitators have had past success with face-to-face collaborative learning but found the challenge of adapting to an online learning environment daunting when trying to simulate a rich collaborative space. This challenge initiated our interaction with sociomateriality which acknowledges that human and non-human entities are performed and continuously brought into being within a web of relations (Cecez-Kecmanovic et al., 2014). We shifted our thinking about the influence of technology on learning to rather examine the entanglements of the social and the material where learning takes place intra-actively in time and space amongst screens, digital tools, facilitators, students, and other material arrangements. As one student group commented that the *"ownership of the learning space was of our own doing and very empowering"* (Group EcoTeam).

Designing a learning space that focuses attention on recognising the agency of all human and non-human actors through a relational engagement is complex and time-consuming. Examples of engaging student groups included polls, breakaway groups and brainstorming activities that fostered the relational interplay between the social and material worlds.

Students were able to learn from each other and share already existing skills and knowledge sets, be it discipline-specific, technological or lived community knowledge, and thus created the potential to upskill the whole group. A student reflected on the entangled transfer of skills by stating *"this was a steep learning curve, being old school and used to face-to-face lectures and working on hardcopies... I learned so much from the group engagements and other things like the online interviews and apps that we created as a group"* (Student). The potential for a relational awareness to have a lasting impact is recognised by a student who commented that *"it opened up my mind to so much more and shifted my way of thinking not just for the module but for everything else I do"* (Student).

To foster agency within student groups is a highly complex task mainly because of the power dynamics that are at play. Agency is anonymous with empowerment and sharing power in a group. The data revealed this as a major issue with a student commenting on *"leadership and power being subverted by the digital space in the way that our group glossed over issues of conflict"* (Student). This is a major concern as highlighted by Feldman and Orlikowski (2011, p. 1246) when the authors referred to "power is understood to have both constraining and enabling implications for everyday action". If students then experience the subvergence of power in the online learning space, it might indicate a lost learning opportunity. Exposing students to the constraining and enabling nature of power relations is central to developing their relations with each other and with the environment in which they learn.

A further challenge to agency that we experienced in this project was the limited voice given to community members because of the lack of technology available at a grassroots level. Students had to rely heavily on their own experiences as community members and only had access to a direct family member or friends because of COVID-19 restrictions as well as the low availability of technology such as smartphones and data to access and capture the community voice. Although students were able to embrace the interdisciplinary collaborative online learning experience and drew high levels of learning from it, they were also aware of one inadequacy in particular: *"we missed the embodied experience, being present, and the subtleties you only get from in-person classes"* (Group EcoTeam).

In concluding the engagement with data, we refocus attention on the learning space by drawing on Kemmis et al. (2014, p. 4) and their concept of "intersubjective spaces [as] always already arranged in particular ways, so that people receive one another in these spaces in ways already shaped for them by the arrangements that are already to be found there - and sometimes by new objects that are brought there. These intersubjective spaces 'lie between' people. They are not mysterious; they are palpable and even tangible."

Although we agree that these intersubjective spaces are not mysterious, they are in many instances hidden and assumed and as such do not receive the necessary attention when designing interdisciplinary collaborative online learning spaces. Another takeaway from Kemmis et al. is the tension between the "already shaped" quality of the learning space and the freedom of what Mousavi et al. (2021, p. 424) refer to as the "temporal flow of action" to create spaces or pauses for the natural emergence of those learning opportunities that cannot be pre-designed. Here we are thinking of essential learning opportunities such as developing an appreciation for multicultural perspectives or experiencing unexpected creativity and joyfulness.

5. Conclusion

In this paper, sociomateriality provided the lens to unpack the data generated in a semester-long student project to identify design principles that can guide future complex online learning experiences. A theoretical framing through sociomateriality was deemed appropriate as it does not favour either the social (human) or the material (non-human) elements within the online learning space.

The four design principles that were developed in this paper are proposed as a way of engaging with complexity within the interdisciplinary collaborative online learning space. The following is a summary of the main insights from each of the proposed design principles.

1. Create immersive context-sensitive learning experiences by incorporating different interactive tools to open up the learning space to divergent viewpoints and cultural perspectives about problems in communities. The timing and pacing of project deliverables need to be carefully monitored to facilitate continuous and active participation.
2. Designing opportunities to collaboratively (co)-construct knowledge, focuses attention on the agency that both the human and non-human agents have, for example, the activity of continuous feedback. The human actors (facilitators, individual student and student groups, the community members), and the non-human actors (digital tools and artefacts) all have a responsibility to contribute to the feedback cycle's success. This requires the use of multiple platforms for engagement, and the pacing of project deliverables to allow enough time for groups to collaboratively consider and incorporate feedback.
3. Focusing on the intra-action of socio-technical and socio-cultural entanglements by recognising the emergence of knowledge and agency in a learning design that allows for matters of space, time, different digital tools and other artefacts to co-evolve. This provides an opportunity to engage with the full scope of complexities associated with, amongst others, differing technical skills, access to technology as well as the nuances of different socio-cultural backgrounds of group members.
4. Foregrounding relationality as a tool to foster agency, acknowledges that different entities within the learning environment perform within a web of relations between people, tools and the collective activities that take place. This is an exceptionally challenging design principle for the online learning space because of the absence of the embodied-whole person experience. By continuously creating opportunities for human and non-human actors to be put in relation to each other, for example, skills transfer between IS and URP disciplines, empowerment and thus agency is fostered.

It should be noted that the four design principles are not offered as a how-to guide, but rather as a proposed way of thinking about the complex and creative possibilities that exist within interdisciplinary collaborative online learning spaces. That being said, the next iteration of the larger DBR research study will focus on practical ways in which the four design principles can manifest in the online learning space and more importantly how such complex principles can be translated to 21st-century learning skills and objectives.

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An Approach to Measure the Pedagogy in Slides with Voice-Over Type Instructional Videos

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Abstract: E-learning provides a more suitable learning environment for educators and learners. Hence, the e-learning community has rapidly increased over the years. At present, e-learning environments use several materials to transfer knowledge to learners. Out of various types of materials, instructional videos have become the prominent source of information in popular e-learning environments. Instructional videos in e-learning can be categorised into many types based on the content presentation method. Voice-over slides are popular instructional videos at present. Since the instructional materials are a key component of an e-learning environment, maintaining the required quality of these materials is vital. Using proper pedagogy in instructional materials mainly enhances the quality. There are many pedagogical principles proposed over the years, and these principles address different features of all instructional materials. Therefore, it is necessary to derive the applicable pedagogical principles based on the features available in the instructional video to analyse the pedagogy in an instructional video. The investigation related to this paper aims to derive an approach to analysing and quantifying the pedagogy in slides with voice-over type instructional videos. In this study, a thorough literature review first identified the pedagogical principles applicable to slides with voice-over type instructional videos. Next, the prominence of the identified pedagogical principles was derived from a Likert-scale survey conducted by several Information Technology undergraduates. The survey response assigned a rank to each identified pedagogical principle. The rank was derived by the mean score obtained for each pedagogical principle. Next, one-way ANOVA tests were performed for the mean score of pedagogical principles to derive their prominence levels. The ANOVA tests were conducted by adding adjacent pedagogical principles with a non-identical rank until the ANOVA results claimed a significant difference in variances. A new level was defined when the ANOVA results showed a significant difference. This study proposed a pedagogical score calculation formula using these levels (derived from the statistical analysis) to derive a qualitative measure of the use of pedagogy in slides with voice-over type instructional videos. The pedagogical evaluators and content developers can use the proposed scoring method to quantify and compare the pedagogy in slides with voice-over instructional videos.

Keywords: Pedagogy, Pedagogical Principles, Pedagogical Analysis, Instructional Videos, Online Learning

1. Introduction

The increased dependency on e-learning has enforced the development of quality e-learning materials. Applying proper pedagogy or teaching methods generally helps improve the quality of any learning material. Thus, focusing on the pedagogical aspects is vital in preparing e-learning materials (Kim and Ko, 2017). Several pedagogical aspects of e-learning environments have been discussed over the years (Hubackova, 2014), which are proposed by focusing on various features of e-learning materials. Hence, a content developer must thoroughly analyse different pedagogical principles and identify the applicable once before implementing them in learning material. Alternatively, there is a difference in the impact level of implementing different pedagogical principles in an instructional video. Implementing a particular pedagogical principle may highly enhance the learning experience, whereas implementing another pedagogical principle may not have much impact on the learning experience. Therefore, a content developer must first focus on the pedagogical principle, which significantly influence on enhancing the learning experience. To achieve this, the content developer must clearly understand the impact level of different pedagogical principles on the quality of an instructional video. In addition, quantifying the application of pedagogical principles and deriving a pedagogical score will aid a content developer in further analysing and comparing the pedagogical implementations in an instructional video.

This study aims to derive a pedagogical standards model for evaluating the pedagogy of instructional videos with presentation slides and voice. Section 2 explains the different studies that have been analysed to identify pedagogical principles which apply to a content-independent pedagogical analysis of presentation slides with voice-type instructional videos. Further analysis of this study used the feedback obtained by undergraduates. They have followed slides with voice-over instructional videos as the primary learning medium to follow semester work during the second quartile in the year 2020. These undergraduates were from all four levels of Information Technology, Software Engineering, Interactive Media, Data Science, Computer System Engineering, Cyber Security, and Information System Engineering.

This study conducted a preliminary literature survey to identify pedagogical principles proposed in different research articles. The identified pedagogical principles were filtered only to select the standards commonly applicable for the domain of selected instructional videos in the study. A set of pedagogical standards were chosen from this literature survey to evaluate the pedagogy of presentation slides with voice-type instructional videos.

Next, the selected pedagogical standards were ranked by considering the result of a survey conducted using the set of undergraduates. The survey was designed to identify the importance of considering the pedagogical standards in presentation slides with voice-type instructional videos. The pedagogical standards model, *Pedaxonomy*, is defined using the ranking derived by analysing survey results. The main intention of the proposed Pedaxonomy model is to provide clear guidance for pedagogy evaluators to evaluate the pedagogy and derive a quantitative measure for the pedagogy in presentation slides with voice-type instructional videos.

2. Research Background

2.1 Popularity of e-learning

The rapid increase of advantages in information technology significantly enhances many fields such as business, health, finance, and education. Education is one of the main fields that have greatly improved by incorporating information technology (Al-fraihat et al., 2020). E-learning, or the learning conducted through electronic media, primarily using the internet, is implementing information technology in education (Welsh et al., 2003). In the study (Zhang *et al.*, 2004) quoted e-learning as the "modern learning in the era of the Internet". Over the years, several research studies have designated the educational advantages of e-learning, using many factors such as the effectiveness of the learning environment, the flexibility of time and resources, cost-effectiveness, higher consistency, and convenience for the learners (Al-fraihat et al., 2020) (Welsh et al., 2003) (Dongsong et al., 2004)(Javier et al., 2020)(Hayashi et al., n.d.)(Docebo, 2016)(Sirisuriya et al., 2018). The global COVID-19 pandemic during the year 2020 further confirmed the importance of e-learning (Agarwal and Kaushik, 2020)(Li, 2020)(Lin and Johnson, 2021). Most countries were locked down during this period, and none of the educational organizations could conduct traditional face-to-face learning. Thus, almost all educational organizations depend on e-learning materials (Gleason, 2021), further proving the prominence of flexibility and effectiveness of e-learning.

2.2 Role of instructional videos in e-learning

E-learning platforms are enriched with multiple learning materials to provide an effective learning environment for the learners. These materials include instructional videos, documented tutorials, presentation slides, forums, quizzes, and games. Out of these many learning materials, instructional videos are crucial in almost all well-known e-learning platforms such as Coursera, Udacity, edX, Khan Academy, etc. The research study by Javier et al. confirms that learning via instructional videos is more effective than learning via traditional face-to-face lectures (Expósito *et al.*, 2020). This study further claims that an instructional video increases learners' motivation, improves their memory and learning potential and offers a higher level of effectiveness through flexibility. The survey of Brecht (Brecht, 2012) shows that the use of instructional videos provides portability and control of learning to the learner, which improves the learning experience and reduces the dropout rates. Another study (Mendoza, Caranto, and David, 2015) shows that instructional videos generate creativity and motivate learners to explore the knowledge. This study also states that instructional videos create a stronger memory for learners, further describing the prominence of instructional videos. Hansch and co-workers (Hansch et al., 2015) confirmed that instructional videos are the primary content delivery method in e-learning environments. This study further discusses how instructional videos can be categorised based on the style or approach used in presenting the content. Some instructional video styles defined in this study are presentation slides with voice-over, talking-head, screencast, animation, conversation, and live videos. Among these

instructional videos, presentation slides with voice-over (also known as PowerPoint-narration) are one of the most popular instructional video styles in e-learning (Chen and Thomas, 2020).

2.3 Pedagogy of instructional videos

Knowledge transfer in an e-learning environment primarily depends on the quality and effectiveness of instructional materials provided in the background. Thus, in an e-learning environment, it is vital to maintain the proper quality of instructional materials to ensure the learners have a practical and smooth learning experience.

There are two key aspects to define the quality of instructional material: *The level of accuracy and relevancy* is one of the quality aspects which depends on the content of instructional material. *The quality level of pedagogy* is the other way of defining the quality of instructional material. Pedagogy can be defined as the techniques used in instructional material to transfer knowledge to the learners efficiently. Over the years, several studies have proved the importance of pedagogy in any learning environment (Hubackova, 2014)(Imbulpitiya, Kodagoda, Gamage, et al., 2019)(Watson, 2005)(Veniegas, 2006)(Mukti et al., 2000)(Seale and Cooper, 2010). These studies have emphasised the importance of proper pedagogy in a learning environment. Pedagogical aspects used in e-learning materials play a vital role in enhancing learners' learning experience. Several pedagogical evaluation techniques have been proposed to measure the pedagogy in a traditional learning environment. The majority of these pedagogical evaluation techniques are applicable to e-learning environments. In addition, few techniques are specifically proposed to evaluate the pedagogy in an e-learning environment (Govindasamy, 2001). Typically, a pedagogical expert must perform a thorough pedagogical evaluation and ensure that the e-learning material is up to adequate pedagogical standards before publishing any e-learning material. An appropriate pedagogical assessment is a challenging and time-consuming task. Thus, providing clear guidance for the pedagogical evaluation of e-learning materials is vital.

3. Analysis of literature on pedagogical principles for slides with voice-over type instructional video

Pedagogy of a learning environment has been a prevalent domain in the learning industry for several years. Over the years, studies have attempted to highlight various aspects of pedagogy. The majority of these pedagogical aspects focus on a traditional classroom learning environment. Pedagogy of the e-learning environment is an upcoming topic that has gained several researchers' attention. As a result, studies have proposed some pedagogical standards to concentrate on the aspects of an e-learning environment specifically. The current research focused on literature, mainly selected by considering the relevance of the proposed pedagogical aspects for slides with voice-over instructional video. Furthermore, the literature analysed in the current study has chosen well-established sources such as Mayer's multimedia principles and Gagne's nine instructions. In addition to these factors, the number of citations for the sources was also noted in selecting the most established literature for the current study.

Richard Mayer's "Multimedia Learning" and "Research-Based Principles for Designing Multimedia Instruction" have defined twelve principles to classify different pedagogical aspects in instructional multimedia content (Mayer, 2009a) (Mayer, 2009b). Most pedagogical standards defined for e-learning materials are based on these twelve principles. Mayer has researched to justify each of the twelve principles to confirm their validity. In (Mayer & Moreno, 2002), Mayer and Morena experimented with these principles, and the statistical analysis of this experiment further claimed the effectiveness of Mayer's multimedia principles. Multimedia principles proposed by Mayer are one of the most popular and well-established pedagogical guidelines for multimedia instructional content. The current study selected the seven best-suited principles for slides with voice-over instructional videos from Mayer's proposed multimedia principles. Other studies have also discussed most of these principles. Many of the other seven studies considered in the current survey discuss the concept of all six principles except the image principle. The Image Principle proposed by Mayer discusses a unique pedagogical aspect of instructional videos.

Robert Gagne's nine instructions are well-known guidance for instructional designing. This guidance mainly focuses on the behaviours of instructions used in a learning environment (Gagne & Wager, 1992). Gagne proposed these instructions in the early 90s when electronic media was not common in a learning environment. Although these instructions are proposed for a traditional learning environment, some selected aspects in these instructions are relevant for the pedagogical aspects in an e-learning environment. The two Gagne's instructions specified in the current study are two main pedagogical concerns in many studies. The signalling principle of

Mayer's principles discusses the same pedagogical aspect as the gaining attention of students. Informing objectives for the learners is similar to the elements discussed in Mayer's pre-training principle. Another study discussed here (i.e., Teoh & Neo, 2007) has also reported that informing the objectives for learners is an essential pedagogical aspect.

Brame's proposed principles for designing instructional videos is one study that discusses several principles in developing compelling instructional videos for learners (Brame, 2016). These principles have focused on different aspects of an instructional video. The first three principles, 3.1, 3.2, and 3.3 (refer to Table 1), are three of the most commonly discussed aspects among eight studies selected for this study. However, this study uniquely presents 3.4, 3.5, and 3.6 principles (refer to Table 1) as critical pedagogical aspects of an instructional video.

In a study (van der Meij & van der Meij, 2013), Hans and Jan have also proposed guidelines for developing instructional videos. This study has derived a set of detailed guidelines by addressing multiple sources in determining instructional quality. Other studies (considered in the literature of the current study) also discuss all five pedagogical aspects addressed in this study.

The online course design checklist of Minnesota State University (Minnesota, 2018) states some prominent pedagogical aspects of e-learning material. These aspects are directly applicable to slides with narration-type instructional videos. The pedagogical aspects of this study aim more at the fonts used in an instructional video. Although maintaining a standard style throughout the video has been discussed in some other studies, this study uniquely proposes the two principles, 5.2 and 5.3 (refer to Table 1).

The literature review (Stemler, 1997) has examined several elements that contribute to the effectiveness of multimedia instructions. This study has reviewed multiple quality aspects of any instructional material in an e-learning environment. Out of the nine pedagogical principles proposed in this study, 6.6 and 6.9 (refer to Table 1) are unique principles that discuss pedagogical aspects that are not captured by other studies considered in this literature review.

The study of Theo and Neo (Teoh & Neo, 2007) identified essential characteristics to maintain a positive mindset towards an online course. Other studies considered in the literature review have discussed all principles proposed in this study. Thus, none of the principles in this study can be claimed as unique pedagogical aspects of an instructional video.

Berk's research study on multimedia teaching with video clips (Berk, 2009) has discussed techniques and guidelines to design effective instructional video clips that can be used as a tool to invoke multiple intelligences in the audience. The pedagogical aspects focused on these techniques are familiar with the pedagogical aspects discussed in other studies of the literature review.

Table 1 presents a summary of pedagogical principles selected for the current study by analysing the aforementioned eight different sources.

Table 1: Pedagogical Principles from the Literature

#	Pedagogical Principle	Source Reference
1.1	Coherence Principle: Eliminating extraneous information provides a better learning experience	(Mayer, 2009a), (Mayer, 2009b), (Mayer & Moreno, 2002)
1.2	Signalling Principle: Organising learning material using a highlighting technique to emphasise important facts will provide an efficient learning environment	
1.3	Redundancy Principle: Having the learner focus on a single presentation through each channel, visual and verbal, will provide an efficient learning environment	
1.4	Pre-training Principle: An initial introduction to names and features of the key concepts in a learning material helps learners focus on the content casually	
1.5	Personalisation Principle: Using conversational style sentences in the learning material helps a learner understand the content easily	
1.6	Voice Principle: Use of a human voice rather than a machine voice provides a more effective learning experience for the learners	

#	Pedagogical Principle	Source Reference
1.7	Image Principle: Avoid using a static image of the speaker on each screen provides a more focusable learning environment for the learners	
2.1	Gain students' attention	(Gagne & Wager, 1992)
2.2	Inform students of the objectives Inform	
3.1	Use a proper signalling mechanism to highlight important information in the content	(Brame, 2016)
3.2	Maintain a short duration for a single video to not more than six minutes	
3.3	Use a conversational language in the video	
3.4	Use an enthusiastic tone and maintain a proper speaking rate in the narration	
3.5	Include interactive questions in the video	
3.6	Avoid using distractive background music	
4.1	Use a human voice for the narration	(van der Meij and van der Meij, 2013)
4.2	Use conversational style for descriptions	
4.3	Provide learners with a set of clear and simple tasks	
4.4	Use a good highlighting technique to emphasise essential facts	
4.5	Control the duration of the videos on average 3 minutes	
5.1	Consistent font sizes and styles throughout the video	(Minnesota, 2018)
5.2	Maintaining sufficient contrast between text and background	
5.3	Consistent design format throughout the video	
6.1	Maintain the simplicity in each screen by presenting only limited information from a single screen	(Stemler, 1997)
6.2	Limit the number of texts on the screen by having a maximum of three lines per screen	
6.3	Use a single font style on a screen	
6.4	Highlight text to emphasise points that require special attention	
6.5	Use a bright colour to highlight important information	
6.6	Use a significant contrast between the background colour and the text colour	
6.7	Use animations to demonstrate points on the screen	
6.8	Make the narration simple and in a conversational style	
6.9	Avoid pausing a screen for a long time for an extended narration to be over	
7.1	Use animations, images, sound effects, text information, and contrasting background colours to gain learner attention	(Teoh and Neo, 2007)
7.2	Dedicate a section to demonstrating objectives	
7.3	Use simple and clear language	
7.4	Explain the point	
8.1	Maintain a short duration without exceeding it to be 3 minutes	(Berk, 2009)
8.2	Use simple language in the context	
8.3	Use a limited number of characters on the screen	

This literature review discovered several pedagogical principles applicable to instructional videos. It was recognised that several studies have commonly discussed some pedagogical principles, such as using proper highlighting techniques to emphasise important factors, controlling the density of information, and using simple language to convey the information. In addition, some studies have also proposed some unique pedagogical aspects to be considered in maintaining the quality of instructional material. In the next stage of this study, the identified pedagogical principles were methodically analysed for designing and developing the Pedaxonomy model.

4. Methodology

4.1 Deriving an integrated and unique pedagogical principles list to analyse the pedagogy of slides with voice-over type instructional video

The literature review of this study identified the pedagogical principles related to instructional videos discussed in several studies. It revealed that multiple sources had discussed some of these identified principles. Thus, as the next step, all recognised pedagogical principles were clustered by considering how the addressed factor of each principle can be applied for a pedagogical analysis of slides with narration-type instructional video. This step aimed to develop a set of unique pedagogical principles by deriving an integrated code for each cluster with similar principles. Figure 1 describes all activities performed in this step.

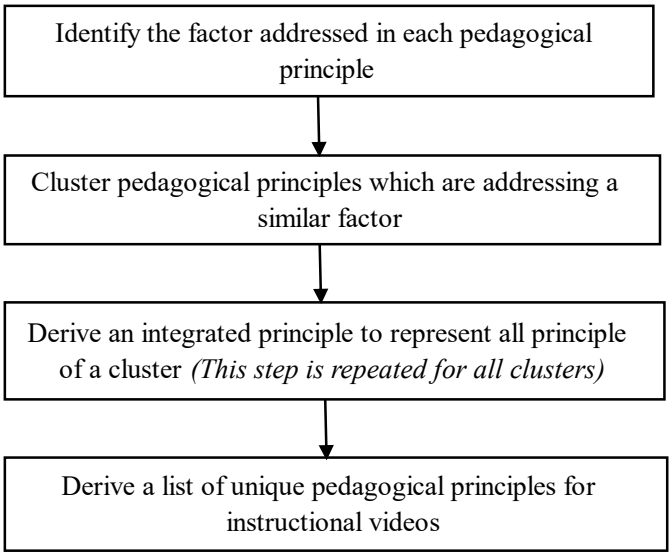

Figure 1: Steps involved in deriving the list of integrated pedagogical standards

Table 2 shows the clustering derived from this step, along with the integrated principle for each cluster. The list of the integrated principles is the list of unique principles derived from this step.

Table 2: Clustering of pedagogical principles and integrated pedagogical principles

Cluster			Integrated Principle
#	Principle	Reference	
1.1	Eliminating extraneous information provides a better learning experience	(Mayer, 2009)	An instructional video has limited content to control the information density at a given time
4.3	Provide learners with a set of clear and simple tasks	(van der Meij and van der Meij, 2013)	
6.1	Maintain the simplicity in each screen by presenting only limited information from a single screen	(Stemler, 1997)	
6.2	Limit the number of texts on the screen by having a maximum of three lines per screen	(Stemler, 1997)	
7.4	Keep the explanation to the point	(Teoh and Neo, 2007)	
8.3	Use a limited number of characters on the screen	(Berk, 2009)	
1.2	Organising the learning material using a highlighting technique to emphasise important facts will provide an efficient learning environment.	(Mayer, 2014)	An instructional video has used proper highlighting to gain the learner's attention and emphasise important information
2.1	Gain the attention of the students	(Gagne and Wager, 1992)	
3.1	Use a proper signalling mechanism to highlight important information in the content	(Brame, 2016)	
4.4	Use a good highlighting technique to emphasise important facts	(van der Meij and van der Meij, 2013)	
6.4	Highlight text to emphasise points that require special attention	(Stemler, 1997)	
6.5	Use a bright colour to highlight important information	(Stemler, 1997)	
1.3	Having the learner focus on a single presentation through each channel, visual and verbal, will provide an efficient learning environment	(Mayer, 2014)	The instructional video uses only one medium to be processed by each channel of the learner at a time
1.4	Providing a prior introduction to names and features of the key concepts in a learning	(Mayer, 2014)	

Cluster			Integrated Principle
#	Principle	Reference	
	material helps learners to focus on the content casually		The instructional video includes a list of objectives to guide the learner at the beginning
2.2	Inform students of the objectives Inform	(Gagne and Wager, 1992)	
7.2	Dedicate a section to demonstrating objectives	(Teoh and Neo, 2007)	
1.5	The use of conversational style sentences in the learning material helps a learner to easily understand the content	(Mayer, 2014)	The instructional video uses simple language and conversational style
3.3	Use conversational language in the video	(Mayer and Moreno, 2002)	
4.2	Use a conversational style for the descriptions	(van der Meij and van der Meij, 2013)	
6.8	Make the narration simple and in a conversational style	(Stemler, 1997)	
7.3	Use simple and clear language	(Teoh and Neo, 2007)	
8.2	Use simple language in the context	(Berk, 2009)	
1.6	Using a human voice rather than a machine voice provides a more effective learning experience for the learners	(Mayer, 2014)	An instructional video has a human voice in narration
4.1	Use a human voice for the narration	(van der Meij and van der Meij, 2013)	
1.7	Avoiding using a static image of the speaker on each screen provides a more focusable learning environment for the learners	(Mayer, 2014)	Instructional video does not include an image of the speaker continuously throughout the content
3.2	Maintain a short duration for a single video to not more than six minutes	(Brame, 2016)	Instructional video does not exceed the duration on which a learner can concentrate continuously
4.5	Control the duration of the videos to average 3 minutes	(van der Meij and van der Meij, 2013)	
8.1	Maintain a short duration without exceeding it to be 3 minutes	(Berk, 2009)	
3.4	Use an enthusiastic tone and maintain a proper speaking rate in the narration	(Brame, 2016)	An instructional video has an appropriate tone and a speaking rate
3.5	Include interactive questions in the video	(Brame, 2016)	The instructional video includes interactive questions
3.6	Avoid using distractive background music	(Brame, 2016)	Instructional video does not contain distractive background music
5.1	Consistent font sizes and styles throughout the video	(Minnesota, 2018)	The instructional video is designed with a consistent style
5.3	Consistent design format throughout the video	(Minnesota, 2018)	
6.3	Use a single font style on a screen	(Stemler, 1997)	
5.2	Maintain sufficient contrast between text and background	(Minnesota, 2018)	The instructional video has used the proper contrast between background and text
6.6	Use a significant contrast between the background colour and the text colour	(Stemler, 1997)	
6.7	Use animations to demonstrate points on the screen	(Stemler, 1997)	The instructional video uses animations, images, and sound effects to gain learners' attention
7.1	Use animations, images, sound effects, text information and contrasting background colours to gain learner attention	(Teoh and Neo, 2007)	
6.9	Avoid pausing a screen for a long time for an extended narration to be over	(Stemler, 1997)	Instructional video does not use the same screen without any change for a long time

A list of integrated unique pedagogical principles was defined as the result of this step to analyse the pedagogy of slides with voice-type instructional videos. The next stage of this study is to sort the list of unique pedagogical principles by ranking each item in the list.

4.2 Instrument Design

A survey was conducted using 145 undergraduates following an Information Technology degree to sort the unique pedagogical principles list. These undergraduates were engaged at different levels of diverse computing degree programmes such as Information Technology, Software Engineering, Interactive Media, Data Science, Computer System Engineering, Cyber Security, and Information System Engineering. The institute has used slides with voice-type instructional videos as the main scheme of lecture delivery during the stringent lockdown period due to the Covid-19 pandemic in 2020.

The undergraduates were provided with a survey towards the end of the semester, where they underwent several slides with voice-type instructional videos to learn the content. This survey was designed to determine the effectiveness level by considering the unique pedagogical principles identified. Due to the disparity of the content covered through the subject instructional videos in the survey, the pedagogical principles in the survey were carefully analysed to ensure that all principles focus on content-independent aspects.

4.3 Survey Implementation

The survey was structured using the Likert scale to get the undergraduates' individual opinions regarding the pedagogical principles. See the *Additional Files* section for the questions included in the survey alongside pedagogical principles focused on each question in the survey.

The questions on the survey addressed the aspects focused on the pedagogical principles list. The undergraduates were asked to give their opinion on the importance of these aspects using a Likert scale based on their experience in following slides with voice-type instructional videos. The Likert scale used in the survey had five options: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree.

Each survey response was a collection of these five options selected by an undergraduate as the level of importance addressed through each question. A rating for each option is given to analyse responses: Strongly Agree is 5, Agree is 4, Neutral is 3, Disagree is 2, and Strongly Disagree is 1. Depending on these ratings, all survey responses were converted into quantitative values. The next step of this study is to derive a statistically significant method for ranking the pedagogical principles based on the survey responses. The mean value of each pedagogical item in the survey result was selected to perform this ranking, where the higher mean value gets the highest ranking. Figure 2 shows the steps in the analysis of survey responses.

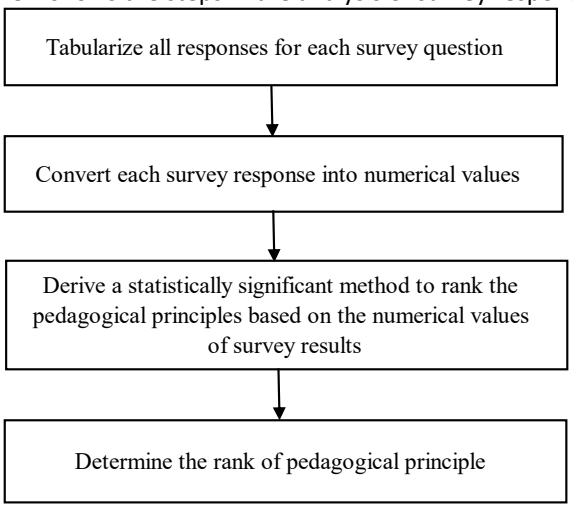

Figure 2: Steps used to analyse survey responses

5. Result and Analysis

Fig 3. illustrates the frequency distribution of numerical survey response values for each pedagogical principle.

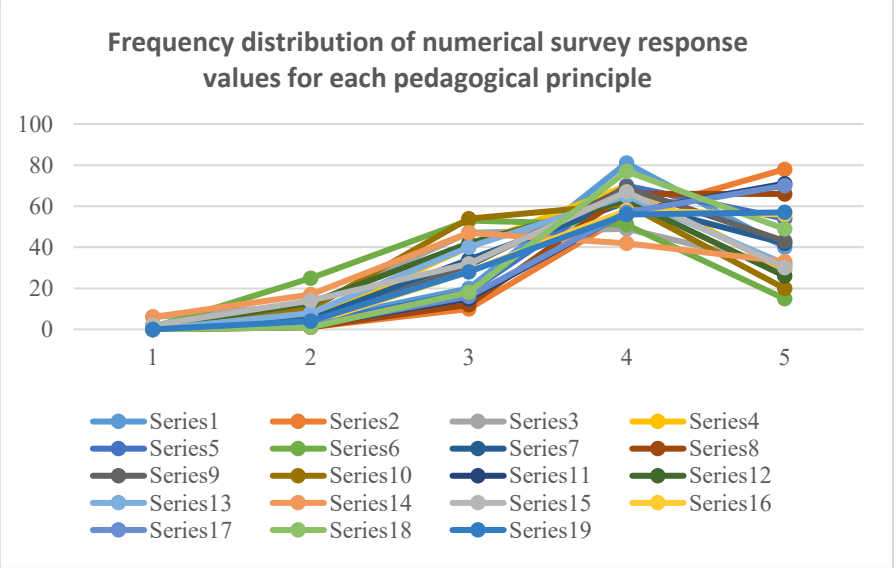

Figure 3: Frequency distribution of numerical survey response values for each pedagogical principle

Figure 3 concludes that all numerical data in survey responses do not have a normal distribution. Table 3 presents the series numbers and corresponding pedagogical principles, along with the mean score and rank based on the mean score.

Table 3: Series numbers and corresponding pedagogical principles with the ranking from the survey results

Series	Pedagogical Principle	Mean	Rank
Series 1	An instructional video includes a list of objectives to guide the learner at the beginning	4.08	P9
Series 2	An Instructional video has used proper highlighting to gain learners' attention and emphasise important information	4.46	P1
Series 3	An instructional video has a single visual to be focused on at a time	3.60	P17
Series 4	An instructional video does not include animation and a text to be focused on at the same time	3.37	P19
Series 5	An instructional video has a single topic to be focused on at a time	3.83	P12
Series 6	An instructional video has limited content to control the information density at a given time	4.21	P5
Series 7	Instructional video does not contain distractive background music	3.94	P11
Series 8	The instructional video uses images to gain learner attention	4.36	P2
Series 9	The instructional video uses animations to gain learner attention	4.06	P10
Series 10	The instructional video uses sound effects to gain the learners' attention	3.63	P16
Series 11	An instructional video uses proper contrast between background and text	4.36	P2
Series 12	An instructional video is designed with a consistent style	3.69	P15
Series 13	An instructional video does not use the same screen without any change for a long time	3.83	P12
Series 14	An instructional video does not include an image of the speaker continuously throughout the content	3.54	P18
Series 15	An instructional video includes interactive questions	3.75	P14
Series 16	An instructional video has a human voice in narration	4.15	P7
Series 17	The instructional video uses simple language and a conversational style	4.34	P4
Series 18	An instructional video has a proper tone and a speaking rate	4.20	P6
Series 19	Instructional video does not exceed the duration on which a learner can concentrate continuously	4.14	P8

The next step of this study defined a clustering for pedagogical principles. This clustering aimed to determine different levels of the pedagogical principles based on the significance claimed through survey results and ranking. The pedagogical principles were sorted according to rank to determine the most significant clusters initially. A distribution-free test, ANOVA, or analysis of variance by Kruskal-Wallis (Kruskal and Wallis, 1952) was selected to perform the statistical analysis in this step. The one-way ANOVA tests were conducted by adding adjacent pedagogical principles with a non-identical rank *(if the mean value difference of two ranks is less than 0.03, then the two ranks are considered identical*) until the P-value < α (0.05) and F > F crit in the ANOVA test.

When P-value < α and F > F crit in an ANOVA test, a cluster is defined by selecting all pedagogical principles with a higher rank compared to the lowest rank considered in the ANOVA test. Figure 4 illustrates the steps in clustering pedagogical principles.

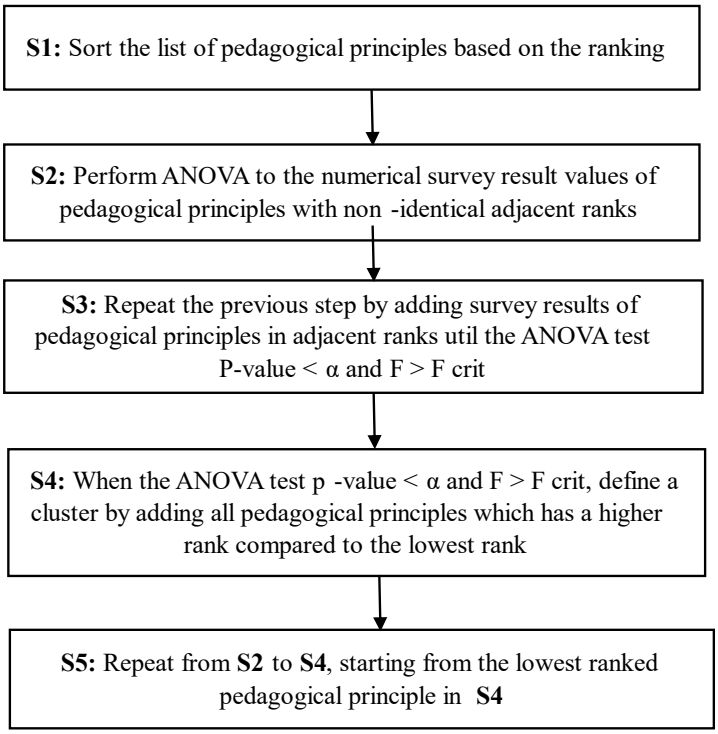

Figure 4: Steps used to cluster pedagogical principles

Table 4 shows the summary of results obtained in each ANOVA test, including the result of P-value, F and F-crit and the conclusion of each test *(Refer to the Additional Files section for the subjected pedagogical principles of each ANOVA test along with the result of P-value, F and F-crit, and the conclusion of each test).*

Table 1: ANOVA Tests and results with the conclusion

ANOVA Test No.	F	P-Value	F crit	F-F crit	Conclusion
01	0.7828	0.5038	2.6204	-1.8376	P-value > α and F < F crit. Therefore, cannot define a cluster
02	**2.9239**	**0.0126**	**2.2245**	**0.6995**	**P-value < α and F > F crit. Therefore, can define a cluster**
03	0.2580	0.8556	2.6204	-2.3624	P-value > α and F < F crit. Therefore, cannot define a cluster
04	0.9563	0.4438	2.2245	-1.2682	P-value > α and F < F crit. Therefore, cannot define a cluster
05	2.0753	0.0536	2.1076	-0.0322	P-value > α and F < F crit. Therefore, cannot define a cluster
06	**5.0499**	**3.38E-06**	**1.9455**	**3.1044**	**P-value < α and F > F crit. Therefore, can define a cluster**
07	0.4453	0.6409	3.0166	-2.5713	P-value > α and F < F crit. Therefore, cannot define a cluster
08	0.9495	0.4163	2.6204	-1.6709	P-value > α and F < F crit. Therefore, cannot define a cluster
09	1.6188	0.1676	2.3843	-0.7655	P-value > α and F < F crit. Therefore, cannot define a cluster
10	1.8615	0.0986	2.2245	-0.3630	P-value > α and F < F crit. Therefore, cannot define a cluster
11	**2.2191**	**0.0392**	**2.1076**	**0.1115**	**P-value < α and F > F crit. Therefore, can define a cluster**
12	2.1268	0.1458	3.8740	-1.7472	P-value > α and F < F crit. Therefore, cannot define a cluster

Four clusters of pedagogical principles were the result of the ANOVA tests in this step, as shown in Table 5.

Table 2: Pedagogical principles, clusters, and mean scores

Pedagogical Principle	Mean	Rank	Cluster
An instructional video uses proper highlighting to gain the learner's attention and emphasise important information	4.46	P1	1
The instructional video uses images to gain the learner attention	4.36	P2	
An instructional video uses proper contrast between background and text	4.36	P2	
The instructional video uses simple language and a conversational style	4.34	P4	
An instructional video has limited content to control the information density at a given time	4.21	P5	2
An instructional video has a proper tone and a speaking rate	4.20	P6	
An instructional video has a human voice in narration	4.15	P7	
An instructional video does not exceed the duration on which a learner can concentrate continuously	4.14	P8	
The instructional video includes a list of objectives to guide the learner at the beginning	4.08	P9	
The instructional video uses animations to gain the learner attention	4.06	P10	
Instructional videos do not contain distractive background music	3.94	P11	
An instructional video has a single topic to be focused on at a time	3.83	P12	3
An instructional video does not use the same screen without any change for a long time	3.83	P12	
The instructional video includes interactive questions	3.75	P14	
An instructional video is designed with a consistent style	3.69	P15	
The instructional video uses sound effects to gain learner attention	3.63	P16	
An instructional video has a single visual to be focused on a time	3.60	P17	
An instructional video does not include an image of the speaker continuously throughout the content	3.54	P18	4
An instructional video does not include animation and text to focus on at the same time	3.37	P19	

As a result of the comprehensive analysis conducted in this study, a set of pedagogical principles were ranked and clustered based on the significance of these principles in slides with voice-type instructional videos. Pedaxonomy is a pedagogical analysis model designed by considering these derived clusters. This model is built for instructional video developers or pedagogical analysers as guidance to achieve and verify important pedagogical aspects in slides with voice-type instructional video. The model consists of four levels: Level 1 includes the most fundamental pedagogical principles identified through the survey results. Principles in level 1 can be defined as the most important pedagogical aspects that have to be implemented in slides with a voice-over type instructional video. Thus, a content developer or pedagogical analyser must initially focus on level 1 pedagogical principles. After verifying the initial level pedagogical principles, a content developer or a pedagogical analyser can focus on the higher-level pedagogical principles. The significance level of pedagogical principles gradually decreases with the increased levels in the Pedaxonomy model.

Figure 4 is the Pedaxonomy model with four levels of pedagogical principles and pedagogical principle reference values (from P1 to P19) according to the REF column in Table 5.

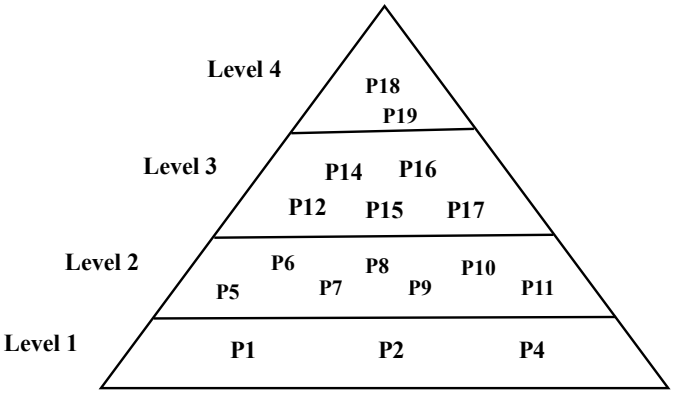

Figure 4: Pedaxonomy Model

The Pedaxonomy model evidently demonstrates an effective approach to implementing and analysing pedagogical principles in slides in a voice-over instructional video.

The next result of this study is an equation to derive a pedagogical score for presentation slides with voice-type instructional videos. Thus, weights (W_{L1}, W_{L2}, W_{L3} and W_{L4}) are allocated for each level in the Pedaxonomy model. These weights are allocated by considering the difference between the lowest mean score value at a lower level with the largest mean score value at a higher level.

Level 1 lowest mean score = 4.34
Level 2 highest mean score = 4.21
} Mean Difference = 4.34 – 4.21 = 0.13

Level 2 lowest mean score = 3.94
Level 3 highest mean score = 3.83
} Mean Difference = 3.94 – 3.83 = 0.11

Level 3 lowest mean score = 3.60
Level 4 highest mean score = 3.54
} Mean Difference = 3.60 – 3.54 = 0.06

The survey results proved that all pedagogical principles selected in this study significantly influence the learners' learning experience. Thus, the implementation of all these pedagogical principles must increase the pedagogical value. For altering this factor for all principles, the pedagogical principles in the lowest level of the model (level 4) were given the weight of 1. Weights of the next levels were given as the summation of the weight of the previous level and the mean difference between the current level and the previous level.

$W_{L4} = 1$ *(Weight of the highest level is assigned as 1)*
$W_{L3} = W_{L4} + 0.06 = 1.06$
$W_{L2} = W_{L3} + 0.11 = 1.17$
$W_{L1} = W_{L2} + 0.13 = 1.30$

Using the derived weights, a content developer of slides with voice-type instructional videos can derive the pedagogical score and the percentage of pedagogy by using the below equations to define the level of pedagogy implemented in the instructional video.

$$\text{Pedagogical Score} = \begin{aligned}&[W_{L1} \times (\text{No. of pedagogical principles implemented in level 1})] + \\ &[W_{L2} \times (\text{No. of pedagogical principles implemented in level 2})] + \\ &[W_{L3} \times (\text{No. of pedagogical principles implemented in level 3})] + \\ &[W_{L4} \times (\text{No. of pedagogical principles implemented in level 4})]\end{aligned}$$

$$\text{Maximum Pedagogical Score} = [1.30 \times (4 - 0)] + [1.17 \times (7 - 0)] + [1.06 \times (6 - 0)] + [1 \times (2 - 0)] = 21.75$$

$$\text{Percentage of Pedagogy} = (\text{Pedagogical Score} / \text{Maximum Pedagogical Score}) \times 100\%$$

6. Discussion

Voice-over slides are a commonly used instructional video style in many e-learning platforms. The authors in this study have focused on deriving an approach, specifically by analysing slides with voice-over type instructional videos. The comprehensive literature review conducted in the study could identify several pedagogical principles applicable for slides with voice-over type instructional video.

As the next step, a rank for the identified pedagogical principles was derived using a survey conducted for 145 undergraduates who followed several slides with voice-type instructional videos. The resulting ranks were

statically proven to be significant, hence used to determine the levels of pedagogical principles based on the importance of the learner's perspective. Using the derived levels of pedagogical principles, the Pedaxonomy model is proposed to define the values of distinct pedagogical principles in slides with a voice-over type instructional video. Level 1 of the Pedaxonomy model encompasses the fundamental and most prominent pedagogical aspects in slides with a voice-over type instructional video. Thus, violating the Level 1 principle may highly impact the quality of an instructional video.

In general, pedagogical principles become more specific with the increase of levels in the Pedaxonomy model. A content developer or a pedagogical analyser of slides with a voice-over instructional video can mainly focus on the lower-level pedagogical principles, as they are the most prominent pedagogical aspects derived through the survey. Through prioritising pedagogical principles demonstrated in the Pedaxonomy model, a content developer can gradually implement pedagogical aspects by initially focusing on the lower-level principles. Initial focusing on and implementing the lower-level principles will significantly improve the quality of slides with voice-over type instructional videos. Secondly, the content developer can aim at the upper-level pedagogical principles in the Pedaxonomy model. These principles will further enhance the quality of slides with voice-over type instructional videos.

A pedagogical analyser can use the Pedaxonomy model as guidance in evaluating the pedagogy in slides with voice-over type instructional videos. The Pedaxonomy model will aid pedagogical analysers to prioritise the aspects they focus on when evaluating an instructional video. It will be useful for a pedagogical analyser to compare different pedagogies used among slides with voice-over type instructional videos and define the instructional video with better implementation of pedagogy.

The model is defined purely based on the survey responses. Thus, having a fundamental pedagogical principle such as "including interactive questions in the instructional video" in the third level of the Pedaxonomy model might have happened due to the lack of experience of the subjected learners in having interactive questions. The model can be further enhanced by choosing learners for the survey, experienced in all pedagogical aspects.

The final result of this study has proposed an equation using the Pedaxonomy model, which the pedagogical analysers can use to derive a quantitative pedagogical score for slides with voice-over type instructional videos. The equation is derived by assigning different weights to the pedagogical principles at different levels. The highest-level weight (W_{L4}) was defined as 1 to ensure that each pedagogical principle implemented in an instructional video will contribute at least 1 to the final pedagogy value. The weight values of other levels (W_{L3}, W_{L2}, W_{L1}) are derived by getting the difference between the lowest mean score value in a lower level with the largest mean score value in the higher level and adding this difference to the weight of the higher level. Therefore, the equation captures the depth of difference from a lower level to a higher level in the Pedaxonomy model. Once the weights are derived, the pedagogical score equation is generated by assigning the derived weights for pedagogical principles. The pedagogical score equation can be used by the pedagogical analyser to effortlessly derive a pedagogical for slides with voice-over type instructional video. Pedagogical analysers can use the percentage of pedagogy to get a more precise and fully Pedaxonomy model-based value of the pedagogy implemented in slides with voice-over type instructional video. It is defined by dividing the pedagogical score of an instructional video from the maximum pedagogical score that can be gained from the pedagogical score equations, i.e. the pedagogical score obtained if all pedagogical principles in the Pedaxonomy model are implemented in the instructional video. From the pedagogy percentage, a pedagogical analyser can easily compare the pedagogy of slides with voice-over type instructional videos. The equations proposed in this study are entirely derived from values obtained through the analysis of survey responses. Thus, the survey itself can be considered a verification of the equations proposed in this study.

The Pedaxonomy model and the scoring methods proposed in this study are expected to assist pedagogical analysers in analysing slides with voice-over instructional videos. The Pedaxonomy model and the scoring method are designed by focusing only on slides with voice-over type instructional videos. Future versions of the Pedaxonomy model are expected to be designed by focusing on other types of instructional videos.

7. Conclusion and Future Work

A suitable pedagogical analysis is essential to ensure the quality of instructional material (Bhowmik, Roy, and Banerjee, 2013). Although several studies have focussed on the pedagogy of instructional materials, the majority

of these studies have not considered specific pedagogical factors in instructional videos. With the rapid popularity of e-learning, instructional videos have become a key source of instruction for learners. Thus, instructional video developers have identified many styles of instructional videos, such as talking heads, slides with voice, animation, and whiteboards (Hansch et al., 2015). Each of these styles uses different approaches and techniques to transfer knowledge to the learners. Even though some pedagogical aspects are common among all these instructional videos, there are many specific pedagogical aspects based on the instructional video style. Hence, identifying the specific pedagogical aspects suitable for the relevant video style is essential to performing a most suitable pedagogical analysis.

Focusing only on a single video style was a successful approach in deriving the precise and specific pedagogical principles model for slides with voice-type instructional videos. Learners are the primary users of instructional videos. Hence, these identified pedagogical principles were ranked based on a survey conducted by instructional video learners. The pedagogical principles model and pedagogy score calculation were derived based on this ranking. The content developers can successfully use the proposed results in this study to evaluate the pedagogy in slides with voice-over type instructional videos.

The future work of this study should use a similar approach to design future versions of the Pedaxonomy model to cover other instructional video styles. Violating some of the pedagogical principles in this study could have a negative impact on the pedagogical quality. The equation proposed here can be further enhanced by factoring in the negative effect of violating these pedagogical principles. The authors expect to adapt this enhancement via a second survey to determine the degree of negative impacts of violating the pedagogical principles.

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