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Editorial – Volume 25, Issue 2

Dietmar Kennepohl
Associate Editor

Welcome to our second issue of the year.

In our first paper, **Sanwal** examines study strategies of distance students in India during the pandemic lockdowns, which were influenced by technology access and readiness for online learning. The findings increase our understanding of the role of technology and should inform future teaching-learning approaches.

Given that virtual teaching–learning environments have gained exceptional importance, **Rodríguez-Sabiote**, **Valerio-Peña**, **Batista-Almonte**, and **Úbeda-Sánchez** investigate its perceived utility and learning by higher education students in the Dominican Republic using the extended technology acceptance model (TAM) as the theoretical framework.

In this next study of elementary school teachers in Korea by **Jung**, **Choi**, and **Fanguy**, several digital literacy issues were identified during remote instruction due to COVID-19 isolation. From their analysis, the authors propose a plan for cultivating teachers' digital literacy in anticipation of skills needed in a time of digital transformation.

We continue with the theme of school teachers and technology where **Maro**, **Kondoro**, **Mtebe**, **Proctor**, **Komba**, and **Haßler** explore the feasibility of deploying Raspberry Pi computers and tablets as micro-servers to facilitate professional development activities of teachers via a learning management system (LMS) without Internet connectivity in Tanzania. They argue that this approach is both academically sound and cost effective.

Bae and **Chong** use the technological, pedagogical, and content knowledge (TPACK) framework as a lens of analysis for online cultural exchange in an international learning collaboration between two higher education institutions. They propose a modified version of TPACK incorporating cultural knowledge to potentially afford a more culturally sustainable framework.

In this study, **Akçapınar**, **Er**, and **Bayazıt** focus on actual usage data (rather than self-reporting) to provide evidence-based insights into students' engagement with the lecture capture videos. In particular, measuring active video watching versus more superficial interactions.

The isolation and remoteness of non-traditional doctoral candidates from a community is explored by **Melián** and **Meneses** through an examination of lived experiences. The result is a series of recommendations to both mitigate challenges commonly encountered and to recognize that the doctoral journey is more than just academic.

In our *Literature Review* section **Karabey** and **Karaman** provide a systematic examination of the activities and applications used to conduct synchronous virtual classrooms effectively. They were sorted and classified by themes to eventually serve as a guide or rubric for future instructors.

Finally, in *Book Notes* we have two contributions: The first reviewer, **Loglo**, examines *Research, Writing, and Creative Process in Open and Distance Education: Tales From the Field* edited by Conrad. It provides a wealth of sage advice from experts in scholarly writing. The second book, *Critical Digital Pedagogy in Higher Education* edited by Köseoğlu, Veletsianos, and Rowell was reviewed by **Keshavarz**. The book is a valuable open-access collection for both the public and those interested in the fields of online learning and critical pedagogy.

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Marginalization, Technology Access, and Study Approaches of Undergraduate Distance Learners During the COVID-19 Pandemic in India

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Abstract

The COVID-19 pandemic has led to the disruption of classroom activities and adoption of online teaching-learning in almost all parts of the globe, including India. The sudden switch from classroom blackboards to laptop screens may have influenced students' study approaches, especially with challenges related to technology access and readiness for online learning among Indian students. Since different social and economic factors bring about differences in students' learning, an online survey was conducted with 296 randomly selected undergraduate distance learning (DL) students at Indira Gandhi National Open University to examine how technology access during the pandemic influenced the study approaches of Indian DL students from various marginalized and non-marginalized groups. The research results showed that marginalized students had lower access to technology than did their non-marginalized counterparts, although no gender differences were found in access to technology in both the groups. Lower access to technology was associated with a surface approach to study among the DL students in general and the marginalized students in particular. Females in the marginalized group were found to be at risk in terms of both access to technology and study approaches. The findings were intended to enrich our understanding of the role of technology vis-à-vis distance learners' study approaches during the pandemic and formulate appropriate teaching-learning strategies for the future.

Keywords: marginalization, technology access, online learning, approaches to study, distance students, open and distance learning

Marginalization, Technology Access, and Study Approaches of Undergraduate Distance Learners During the COVID-19 Pandemic in India

The literature on students' learning in higher education has confirmed that students adopt different approaches to studying, (i.e., deep, surface, achieving) congruent with their learning motivation, namely intrinsic, extrinsic, and achieving (Biggs, 1987; Entwistle & Waterson, 1988). Students from different cultures and in different social milieu see learning differently (Richardson, 1994, 2000). The sudden outbreak of the COVID-19 pandemic compelled all educational institutions in India to teach and assess online (Mishra et al., 2020). This largely affected students belonging to marginalized communities like the scheduled caste (SC), scheduled tribe (ST), and other backward castes (OBCs) as marginalized people were socially disadvantaged, unable to access resources, economically deprived, and facing inequity and exclusion (United Nations Development Programme, 2019). This has deepened the digital divide between the communities of marginalized and non-marginalized (McBurnie et al., 2020). Online learning calls for devices like smart phones, computers, laptops, and so on, as well as a high bandwidth Internet connection, an uninterrupted supply of electricity, and the knowledge and skills to handle technology to one's advantage. This could be challenging for students who belong to marginalized communities. The World Bank (2020) has reported that these disparities in access to technology can create a digital divide that may restrict online education in developing countries. Olayem et al. (2021) reported that (a) fear of high Internet charges, (b) non-availability or limited access to computers, (c) lack of broadband services, and (d) interrupted electricity were major hindrances to online learning. Further to cultural and socio-economic status variations in students' study approaches, differences also exist in technology access across cultural and social groups. There was a need to examine this scenario in the context of unusual situations like the COVID-19 pandemic.

Literature Review

Phenomenography-based research studies conducted in Britain and Sweden in the late 1970s confirmed the existence of different approaches to study in students. Students adopting a deep approach aimed at understanding for their satisfaction and were engaged in wide reading from different sources to connect different ideas while learning. On the other hand, students who adopted the surface approach saw learning as unrelated bits of information and tried to memorize the learning material and do the minimum required to pass the course (Marton & Saljo, 1976; Pask, 1976). Some students have also adopted an achieving or strategic approach to their studies (Biggs, 1987; Ramsden, 1979). They attained good grades by adopting different achieving strategies such as time management, selective study by reading past year's papers, and cue seeking.

Different personal, social, and contextual factors bring about differences in the way students learn (Vermunt, 2005). Rearing practices, as well as individuals' role and status in society may also be reasons for gender differences in students' learning (Richardson, 2000). Several studies in Western countries confirmed that the study approaches of distance students did not differ from those of on-campus students (Harper & Kember, 1986; Morgan et al., 1980; Richardson, 2005). Even distance students were found to adopt a deeper approach to study as compared to on-campus students (Neroni et al., 2019; Quinn, 2011). In earlier studies, Richardson et al. (1999) and Richardson (2005) found that women studying at a distance adopted a more surface approach to study than did men, but later Richardson

(2013) found this difference had waned, perhaps due to women's changing status in society.

The COVID-19 pandemic, when students were compelled to study online, raised challenges for India, as in other developing as well as low- and middle-income countries in South Asian and sub-Saharan regions, where fewer students in marginalized communities had access to technology (McBurnie et al., 2020). To ensure equity and inclusion, there was a need to explore access to technology especially by marginalized students, while they studied online during the pandemic; the marginalized students may have been more adversely affected than their counterparts. Further, access to technology needed to be examined in terms of marginalization and gender, and their influence on approaches to study.

Context of the Study

Marginalization is a common problem spread globally across different cultures and civilizations, and in different ways with varying degrees (Vinod & Kumar, 2021). These authors pointed out that "two of the most pervasive forms of inequality in the Indian context have been caste and gender" (Vinod & Kumar, 2021, pp. 6–7). India's new National Education Policy (NEP, 2020) has emphasized equity and inclusion in higher education. The policy further recognized gender identity (female and transgender) and sociocultural identity (SC, ST, and OBC) as socio-economically disadvantaged groups (Kumar, 2021). India is largely a patriarchal country; many inequalities such as gender roles and stereotypes, have been socially constructed there (Siddiqui, 2021). "This gender disparity aggravates because of the intersection of other identities, such as caste, religion, region, and tribe, and adds to a much more vulnerable position of women in the field of higher education" (Mathur & Sharma, 2021, p. 245). Goode (2010) also found gender, race, and socioeconomic status associated with access to and use of technology. As Muthuprasad et al. (2021) stated "it is important to note that the learning quality depends on the level of digital access and efficiencies" (p. 2). These prevailing situations aroused my interest in finding gender differences in access to technology and the study approaches of students in marginalized and non-marginalized communities studying online during the pandemic.

This study aimed to investigate access to technology and the study approaches of marginalized and non-marginalized distance learning students in India studying online during the pandemic. The study also intended to investigate how access to technology was related to the study approaches of these students. These were important topics since the study approaches adopted by students in higher education are significant determinants of quality of learning and academic achievement. The study was conducted to answer three key research questions.

1. Are there any significant differences in access to technology and study approaches between marginalized and non-marginalized distance learning students?

2. Are there any significant differences in access to technology and study approaches between male and female distance learning students within marginalized and non-marginalized communities?

3. What is the relationship between access to technology and study approaches of marginalized and non-marginalized distance learning students?

Methods

Research Methodology

The survey research method was used in this study. Quantitative surveys have been used by many researchers to assess the study approaches of students across institutions and cultures (Hermann et al., 2017; Ullah et al., 2016; Yin et al., 2018). Quantitative data was collected through two questionnaires—the revised two-factor study process questionnaire (R-SPQ-2F) to examine study approaches, and a self-made questionnaire measuring students' access to technology. The questionnaires were administered online through Google Forms to students selected randomly.

Participants/Samples

The study was conducted at the Indira Gandhi National Open University (IGNOU) headquartered in New Delhi, India, with regional centers as well as study centers spread across the country and in about 15 countries overseas. A center in the Delhi region was conveniently selected by the researcher; and 296 undergraduate students studying in their final year undergraduate program were randomly selected from a population of 1,000 students enrolled in arts/humanities, science, and social sciences. Of the 296 students, 133 belonged to marginalized groups and 163 belonged to non-marginalized groups (Table 1). The two questionnaires were administered online to all the randomly selected students.

Table 1

Selected Sample from Indira Gandhi National Open University (Total Population 1,000)

Group	Male	Female	Total
Marginalized	95	38	133
Non-marginalized	94	69	163
Total	189	107	296

Instruments

The revised two-factor study process questionnaire developed by Biggs et al. (2001) in English was used to get responses on students' study approaches. The questionnaire contained 20 questions and comprised two scales, the deep approach and the surface approach. Each scale was divided into two subscales—deep motive and deep strategy, and surface motive and surface strategy. There were five questions for each subscale; examples of questions from each subscale are given in Table 2.

Table 2

Example Items From Each Subscale of the R-SPQ-2F Questionnaire

Subscale	Example statement
Deep motive	I work hard at my studies because I find the material interesting.
Deep strategy	I find most new topics interesting and I often spend extra time trying to obtain more information about them.
Surface motive	I aim to pass the course with as little effort as possible.
Surface strategy	I find the best way to pass an examination is to try to remember answers to likely questions.

A second questionnaire was developed by the researcher to measure students' access to technology

during the pandemic. There were four questions for assessing students' access, and one additional question regarding students' satisfaction with access to technology during the pandemic. The five questions (given below) were measured on a three-point Likert scale (i.e., high access, medium access, and low access to technology).

1. I had access to either a smart phone, laptop, tablet, or computer while studying online during COVID-19 pandemic.

2. The software used by the university for online teaching was compatible with my device.

3. I had a broadband Internet facility at home for online study during the pandemic.

4. Many times, my online classes were disrupted/disturbed due to electricity failure.

5. Overall, I was satisfied with my access to technology while studying online during the pandemic.

Reliability and Validity of the Instruments

The R-SPQ-2F is a short and validated inventory. It measures the deep and surface approaches universally adopted by students across different cultural and linguistic contexts. It has been derived from the original study process questionnaire (Biggs, 1987) which had 64 items. The revised inventory has been validated in Japan (Fryer et al., 2012) and the Netherlands (Stes et al., 2013) and has recently been used in China and Chile (Yin et al., 2018; Yin et al., 2016) to assess the study approaches of undergraduates. The inventory has also been used to assess the study approaches of students in different contexts, such as a flipped classroom environment (Jeong et al., 2019) and a blended learning environment (Ellis et al., 2009) in Australia. The inventory has recently been used in India to assess students' engagement while studying online during the pandemic (Bhuria et al., 2021). To check its reliability for participants in this study, a pilot was conducted by the researcher with 40 randomly selected undergraduates at IGNOU. The Cronbach alpha (α) of R-SPQ-2F was found to be 0.81, which showed high reliability of the scale in the Indian context. The reliability of the different subscales is given in Table 3, as compared to Biggs et al. (2001). A strong association was found between the surface motive and surface strategy subscales with the surface approach scale, and the deep motive and deep strategy subscales with the deep approach scale. This confirmed the criterion validity of the R-SPQ-2F. The Cronbach alpha of the self-made questionnaire was found to be 0.75. The mean score of the access to technology scale was found strongly related to learners' satisfaction with access to technology during the pandemic. This showed reasonably high construct-validity of access to technology scale.

Table 3

Reliability of R-SPQ-2F Subscales: Cronbach Alpha of Biggs et al. (2001) and Current Study

Subscale	Biggs et al. (2001)	Current study
Deep motive	0.62	0.57
Deep strategy	0.63	0.54
Surface motive	0.72	0.53
Surface strategy	0.57	0.41
Deep approach	0.73	0.72
Surface approach	0.64	0.60

Findings

To begin, the quantitative data from the two questionnaires (i.e., R-SPQ-2F and access to technology survey) was checked for normal distribution in the total sample and selected sub-samples from different groups. Kolmogorov-Smirnov tests showed significance levels greater than .08 in different cases, indicating data did not deviate significantly from normal distribution.

The statistical technique, *t*-test, was applied to determine group differences (i.e., gender, marginalized, and non-marginalized students) concerning access to technology and study approaches. Pearson's correlation coefficient was used to determine the relationship between students' access to technology and their study approaches.

Access to Technology

Marginalized and Non-Marginalized Distance Students

The five-question self-made questionnaire assessed 296 distance students' access to technology. The difference in access to technology of 133 marginalized and 163 non-marginalized students was measured using a *t*-test technique at .05 and .01 levels of significance. Overall, a significant difference was found in the average scores for access to technology by marginalized and non-marginalized students (Table 4).

Table 4

Measures of Access to Technology: Marginalized and Non-Marginalized Students

Measure	Marginalized (n = 133)	Non-marginalized (n = 163)	t-value
Mean	1.82	2.06	-3.59
SD	0.54	0.59	$p < .01$

Table 5 shows that the non-marginalized students had better access to smart phones, laptops, and so on than did the marginalized students (p <.01). The non-marginalized students' devices were also found to be more compatible with the university software for online teaching (p <.01). There was also a significant difference in the speed of broadband Internet between the marginalized and non-marginalized students. The marginalized students were found to have lower speed Internet facilities as compared to their non-marginalized counterparts (p <.01) and were found to be less satisfied with their access to technology during the pandemic (p < .01). In both groups, no significant difference was found concerning the disturbance of online classes due to electricity failure. A Cohen's (1988) d value of 0.58 in terms of the difference in speed of broadband Internet showed a medium to large part of the marginalized population was affected due by this and thus needs consideration. Meanwhile, a small to medium part of the marginalized population (Cohen's d = 0.33) was affected even in terms of access to devices and compatibility. A small to medium population (Cohen's d = 0.32) of the marginalized students were found to be less satisfied with their access to technology during the pandemic.

Table 5

Measures of Access to Technology Variables: Marginalized and Non-Marginalized Students

Variable	Parameter	Marginalized (n = 133)	Non-marginalized (n = 163)	t-value
1. Access to laptop, tablet, or smart phone while studying	Mean	1.82	2.07	-2.80
	SD	0.78	0.74	$p < .01$
2. Compatibility of device with university's software for teaching	Mean	1.76	2.01	-2.84
	SD	0.72	0.74	$p < .01$
3. Speed of broadband Internet	Mean	1.64	2.02	-4.14
	SD	0.76	0.78	$p < .01$
4. Disruption of online classes due to electricity failure	Mean	2.03	2.17	-1.48
	SD	0.78	0.76	n. s.
5. Students' satisfaction with access to technology	Mean	1.75	1.98	-2.59
	SD	0.75	0.74	$p < .01$

Note: n. s. stands for not significant.

Marginalized and Non-Marginalized Males

In the case of technology access among male students, those from non-marginalized groups were found to have better access to technology and the difference was statistically significant ($p < .01$). Though no significant difference was found in access to smart phones, laptops, and so on by students from both the groups, a significant difference was found in device compatibility with IGNOU's software and students' speed of Internet (Table 6). Marginalized male students' devices were less compatible and they had lower Internet speeds than did their non-marginalized male counterparts.

These differences were found to be statistically significant at .05 and .01 levels, respectively. However, no significant difference was found in satisfaction with technology access among males in both groups. Cohen's d value of 0.52 showed a medium to large effect size, which means a medium to large number of marginalized males were affected by lesser speeds of broadband Internet and compatibility of devices as compared to non-marginalized males.

Table 6

Access to Technology: Values for Male Students, Marginalized and Non-Marginalized

Variable	Parameter	Male (M) (n = 95)	Male (NM) (n = 94)	t-value
1. Access to laptop, tablet, or smart phone while studying	Mean	1.86	2.08	-1.91
	SD	0.78	0.74	n. s.

2.	Compatibility of device with university's software for teaching	Mean	1.81	2.07	-2.44
		SD	0.72	0.74	$p < .05$
3.	Speed of broadband Internet	Mean	1.67	2.07	-3.44
		SD	0.80	0.78	$p < .01$
4.	Disruption of online classes due to electricity failure	Mean	2.07	2.14	-0.66
		SD	0.78	0.76	n. s.
5.	Students' satisfaction with access to technology	Mean	1.86	2.02	-1.39
		SD	0.79	0.76	n. s.

Note: n. s. stands for not significant, M stands for marginalized, NM stands for non-marginalized.

Marginalized and Non-Marginalized Females

The marginalized females were found to have less Internet speed than their non-marginalized counterparts (Table 7). They were also found to be less satisfied than were the non-marginalized females. These differences were statistically significant at a .05 level (Table 7). A Cohen's *d* value of 0.50 showed a medium effect size; neither a large nor small population of marginalized females was affected by lesser speeds of broadband Internet during the pandemic as compared to non-marginalized females. Further, the medium-sized population of marginalized females (Cohens' *d*: 0.42) was found to be less satisfied with their access to technology during the COVID-19 pandemic.

Table 7

Access to Technology: Values for Female Students, Marginalized and Non-Marginalized

Variable		Parameter	Female (M) (n = 38)	Female (NM) (n = 69)	t-value
1.	Access to laptop, tablet, or smart phone while studying	Mean	1.78	2.07	-1.89
		SD	0.73	0.72	n. s.
2.	Compatibility of device with university's software for teaching	Mean	1.71	1.91	-1.34
		SD	0.72	0.76	n. s.
3.	Speed of broadband Internet	Mean	1.60	1.95	-2.40
		SD	0.67	0.79	$p < .05$
4.	Disruption of online classes due to electricity failure	Mean	1.94	2.24	-1.70
		SD	0.80	0.74	n. s.
5.	Students' satisfaction with access to technology	Mean	1.63	1.92	-2.12
		SD	0.67	0.70	$p < .05$

Note: n. s. stands for not significant, M stands for marginalized, NM stands for non-marginalized.

Males and Females From Marginalized and Non-Marginalized Groups

A *t*-test was used to determine the gender differences between male and female students of both

communities. No significant difference was found in access to technology for both populations within both communities (Table 8).

Table 8

Measures of Access to Technology for Male and Female Students in Marginalized and Non-Marginalized Groups

Variable	Parameter	Male (NM) (n = 94)	Female (M) (n = 38)	t-value and signif.	Male (M) (n = 95)	Female (NM) (n = 69)	t-value and signif.
1. Access to laptop, tablet, or smart phone	Mean	1.86	1.78	0.50	2.08	2.07	0.10
	SD	0.80	0.73	n. s.	0.78	0.72	n. s.
2. Compatibility of device	Mean	1.81	1.71	0.71	2.07	1.91	1.34
	SD	0.72	0.72	n. s.	0.74	0.76	n. s.
3. Internet speed	Mean	1.67	1.60	0.49	2.07	1.95	0.93
	SD	0.80	0.67	n. s.	0.78	0.79	n. s.
4. Disruption due to electricity failure	Mean	2.07	1.94	0.82	2.14	2.21	0.56
	SD	0.77	0.80	n. s.	0.77	0.74	n. s.
5. Satisfaction with access to technology	Mean	1.86	1.63	1.69	2.02	1.92	0.80
	SD	0.79	0.67	n. s.	0.76	0.70	n. s.

Note: n. s. stands for not significant, M stands for marginalized, NM stands for non-marginalized.

Study Approaches

Marginalized and Non-Marginalized Distance Students

The study approaches of 296 IGNOU students was assessed using the R-SPQ-2F, and the differences between the study approaches of 133 marginalized and 163 non-marginalized students was measured using the *t*-test (Table 9). No significant difference was found for any subscale of the study approach inventory, except the surface motive subscale. Marginalized students were found to have higher scores on surface motive than non-marginalized students. Cohen's *d* value of 0.30 showed a small to medium effect size; a small to medium population of marginalized students had more surface motives towards their study as compared to the non-marginalized group while studying online during the pandemic.

Table 9

Study Approaches: Scores for Marginalized and Non-Marginalized Students

Variable	Parameter	Marginalized (n = 133)	Non-marginalized (n = 163)	t-value
Deep motive	Mean	3.84	3.79	0.70
	SD	0.50	0.56	n. s.

Deep strategy	Mean	3.86	3.74	1.77
	SD	0.56	0.58	n. s.
Deep approach	Mean	3.85	3.77	1.37
	SD	0.50	0.52	n. s.
Surface motive	Mean	2.77	2.59	2.42
	SD	0.61	0.64	$p < .05$
Surface strategy	Mean	2.92	2.77	1.89
	SD	0.68	0.66	n. s.
Surface approach	Mean	2.84	2.71	1.37
	SD	0.58	1.09	n. s.

Note. n. s. stands for not significant.

Female Students From Marginalized and Non-Marginalized Groups

No significant difference was found for any subscale except the deep motive (Table 10). Between the female students of both the groups, those in the non-marginalized groups were found to have higher scores on deep motives than were the marginalized female group ($p < .05$). The Cohen's *d* value of 0.42 indicated that a small to medium population of marginalized females was affected and was less deeply motivated for online study during the pandemic as compared to non-marginalized females.

Table 10

Study Approaches: Scores for Female Students

Variable	Parameter	Female (M) ($n = 38$)	Female (NM) ($n = 69$)	*t*-value
Deep motive	Mean	3.65	3.89	-2.11
	SD	0.57	0.48	$p < .05$
Deep strategy	Mean	3.66	3.76	-0.80
	SD	0.60	0.60	n. s.
Deep approach	Mean	3.66	3.82	-1.51
	SD	0.54	0.50	n. s.
Surface motive	Mean	2.72	2.48	1.77
	SD	0.62	0.64	n. s.
Surface strategy	Mean	2.88	2.71	1.20
	SD	0.73	0.70	n. s.
Surface approach	Mean	2.80	2.60	1.59
	SD	0.64	0.61	n. s.

Note. n. s. stands for not significant, M stands for marginalized, NM stands for non-marginalized.

Male Students From Marginalized and Non-Marginalized Groups

The marginalized male students were found to adopt a deeper approach to study than their male counterparts in the non-marginalized groups ($p < .05$; Table 11). Marginalized males were found to have more deep motives and apply more deep strategies than did non- marginalized males while learning online ($p < .05$). A Cohen's *d* value of 0.4 indicated a small to medium effect size; a small to medium-sized population of marginalized males applied the deep approach to study as compared to the non-marginalized males. This population of marginalized males was more motivated to study deeply and applied more deep strategies while learning online during the pandemic.

Table 11

Study Approaches: Scores for Male Students

Variable	Parameter	Male (M) (n = 95)	Male (NM) (n = 94)	t-value
Deep motive	Mean	3.91	3.73	2.28
	SD	0.46	0.60	$p < .05$
Deep strategy	Mean	3.94	3.74	2.49
	SD	0.52	0.56	$p < .05$
Deep approach	Mean	3.93	3.74	2.60
	SD	0.45	0.53	$p < .05$
Surface motive	Mean	2.79	2.67	1.27
	SD	0.61	0.61	n. s.
Surface strategy	Mean	2.93	2.81	1.29
	SD	0.67	0.64	n. s.
Surface approach	Mean	2.86	2.75	1.31
	SD	0.55	0.57	n. s.

Note. n. s. stands for not significant, M stands for marginalized, NM stands for non-marginalized.

Males and Females From Marginalized and Non-Marginalized Groups

Marginalized male students were found to adopt a deeper approach to study than did marginalized females (Table 12). They had more deep motives and applied more deep strategies while learning online ($p < .05$). No gender differences in study approaches were seen in the non-marginalized group of students. Cohen's d values of 0.51, 0.52, and 0.53 indicated a medium to large effect size; a medium to large population of marginalized females adopted less deep approaches and deep strategies while learning online during the pandemic as compared to marginalized male students.

Table 12

Study Approaches for Male and Female Students in Marginalized and Non-Marginalized Groups

Variable	Parameter	Male (NM) (n = 94)	Female (M) (n = 38)	t-value and signif.	Male (M) (n = 95)	Female (NM) (n = 69)	t-value and signif.
Deep motive	Mean	3.91	3.65	2.44	3.73	3.89	-1.82
	SD	0.46	0.57	$p < .05$	0.60	0.48	n. s.
Deep strategy	Mean	3.94	3.66	2.50	3.74	3.76	-0.16
	SD	0.52	0.60	$p < .05$	0.56	0.60	n. s.
Deep approach	Mean	3.93	3.66	2.65	3.74	3.82	-1.02
	SD	0.45	0.54	$p < .05$	0.53	0.50	n. s.
Surface motive	Mean	2.79	2.72	0.58	2.67	2.48	1.81
	SD	0.61	0.62	n. s.	0.61	0.67	n. s.
Surface strategy	Mean	2.93	2.88	0.35	2.81	2.71	0.94
	SD	0.67	0.73	n. s.	0.64	0.70	n.s.
Surface approach	Mean	2.86	2.80	0.50	2.75	2.60	1.50
	SD	0.55	0.64	n. s.	0.57	0.62	n. s.

Note. n. s. stands for not significant, M stands for marginalized, NM stands for non-marginalized.

Relationships Between Access to Technology and Study Approaches

The study approach and access to technology scores of 296 distance education students were assessed through the R-SPQ-2F inventory with a self-made additional questionnaire on access to technology, respectively. The Pearson coefficient of correlation was calculated for these students, 133 of whom were from marginalized groups and 163 who were non-marginalized. The results are summarized in Tables 13, 14, and 15.

Table 13

Results of Pearson Test for 296 Undergraduates at IGNOU

Variable	Technology access	*t* statistic	*df*	*p*-value
Deep approach	0.08	1.37	294	0.171
Surface approach	0.18*	3.16	294	0.0017

Note. * indicates that correlation is significant at a .01 level of significance.

The value of the coefficient of correlation r (294) of - 0.18, p = 0.0017 showed a weak negative but statistically significant correlation between technology access and surface approaches to study by students generally (Table 13). Gignac and Szodorai, (2016) described a small to medium effect size as represented by Pearson's r of magnitude 0.18. A small to medium population of undergraduate students were more inclined to adopt a surface approach due to less access to technology during the COVID-19 pandemic.

Table 14

Results of Pearson Test for 133 Marginalized Students

Variable	Technology access	*t* statistic	*df*	*p*-value
Deep approach	-0.09	1.03	131	0.304
Surface approach	-0.22*	2.57	131	0.0092

Note. * indicates that correlation is significant at a .01 level of significance.

The value of the coefficient of correlation r (131) of -0.22, p = 0.0092 showed a weak negative but statistically significant correlation between technology access and surface approach to study adopted by the marginalized students (Table 14). A Pearson value of 0.22 indicated a medium to large effect size (Gignac & Szodorai, 2016). A medium to a large population of marginalized students were more oriented towards a surface approach due to lesser access to technology as compared to their non-marginalized counterparts.

Table 15

Results of Pearson Test for 163 Non-Marginalized Students

Variable	Technology access	*t* statistic	*df*	*p*-value
Deep approach	-0.054	0.63	161	0.529
Surface approach	-0.110	1.40	161	0.163

Note. * indicates that correlation is significant at a .01 level of significance.

The *r* value of -0.054, $p = 0.52$, and *r* value of -0.11, $p = 0.16$ showed no significant correlations between technology access and study approach for non-marginalized students (Table 15).

Discussion and Implications

The COVID-19 pandemic enforced online teaching and learning for all educational delivery modes including distance education. Before the pandemic, distance courses were taught primarily through self-learning materials (SLMs) and by organizing counseling sessions on weekends. These were supplements by audio or video programs. During the pandemic, SLMs were uploaded onto the e-Gyan Kosh (IGNOU's online resource repository), counseling was held online by designated academic counselors or tutors, and assignments were submitted online at the designated portal. For online learning, students needed a suitable device compatible with the platform used by the teaching university, a broadband Internet connection, and uninterrupted electricity. This was challenging for Indian distance learners since they represented diverse social groups in terms of economic status, family background, geographical area, and Internet facility, among others.

The situation of the marginalized communities in India was not on par with that of the non-marginalized communities, and different personal, social, cultural, and economic factors affected students' learning. There was a need to study the access to technology and study approaches of students, especially the marginalized students, since the latter may have been more adversely affected than their counterparts while studying online during the pandemic. The present study aimed to ascertain the access to the technology of marginalized and non- marginalized distance learning students and how this influenced their approach to study during the COVID-19 pandemic. The important findings of this study are discussed below as per the objectives of this study.

First, an average score of 1.82 on the access to technology scale for the marginalized students represented lower to moderate access to technology for those students, while an average score of 2.06 for the non-marginalized students represented moderate to high access to technology for those students. A significant difference was found in access to technology for marginalized and non-marginalized students. Marginalized students were found to have lower access to digital devices, less compatible devices, and lower speed of broadband Internet as compared to non-marginalized students. Those in the marginalized groups were also found to be less satisfied with access to technology during the pandemic as compared to their non-marginalized counterparts. The results of this study aligned with Kimble-Hill et al. (2020) who reported that marginalized students (in terms of lower income level, color, and rural background) struggled with access to technology. Since online education has been promoted by the government of India when it announced that up to 40% of credits could be earned through online courses, such a significant difference in access to technology could lead to marginalized distance students lagging behind. This digital divide can widen the gaps in online learning between marginalized and non- marginalized students.

Second, no gender difference concerning access to technology was found in the groups of marginalized and non-marginalized students. These findings were consistent with Bhandari (2019) who conducted a study of 51 countries and found no significant gender difference concerning access to technology and information and communication technology (ICT) use in many of them. Our results relating to gender were found inconsistent with Pande and van der Weide (2012) and Nsibirano (2009) who found significant gender differences in access to and use of ICT devices.

The marginalized students were found to have higher scores on surface motives as compared to non-marginalized students. In particular, marginalized female students were found to have fewer deep motives for online study as compared to non-marginalized females. Access to technology during the pandemic could have been an important factor contributing to the motivation of marginalized students; the lower the technology access, the higher the surface motives for study.

Despite having no significant gender difference in access to technology in either group, a significant gender difference was found concerning the study approach among marginalized students. The marginalized female students were found to adopt a less deep approach to study than the marginalized male students. Fewer deep motives and deep strategies used by marginalized female students as compared to their male counterparts during online study may have been due to less access to technology alongside other social and cultural factors that adversely affected their deep approach to study. A lesser use of a deep approach and less access to technology for marginalized females studying online could be cause for concern among educators. As Vagishwari (2021) pointed out "women are yet to cross this digital divide to be an integral part of the digital world in India" (p. 234). The situation becomes more critical in the case of marginalized women as this adds on to other social and cultural barriers thereby making online learning challenging for this vulnerable sector.

Third, one unexpected result was found in this study, that the marginalized male students (despite having lesser access to technology than the non-marginalized males) were found to adopt a deeper approach to study than their male counterparts in the non-marginalized group. The marginalized males were also found to have higher scores on deep motives and deep strategies as compared to the non-marginalized males. These findings underline that marginalized males have achieved a better position in society through education even with fewer resources and less access to technology. This should be a measure of concern for both policymakers and educational administrators in the country.

Fourth, although distance students' deep approach to study was not associated with their access to technology, lesser access to technology was found associated with the surface approach to study. This association was also found in the marginalized students. This suggested that better access to technology can reduce the surface approach to study by distance education students in general, and by marginalized students in particular, as far as online learning is concerned. However, on the contrary, poor access to technology enhanced the surface approach to study (rote learning and memorizing essential pieces to pass the course) in distance students, as well as in marginalized distance students.

This study had two major implications. First, to reduce the digital gap and promote online and blended learning between the marginalized and non-marginalized students, there is a need to facilitate special institutional support to the marginalized students in terms of free access to smart phones, tablets, and so on with high-speed Internet connectivity as well. Second, female students in marginalized groups need more support in terms of both technology access and courses on study skills, as they were found to adopt a less deep approach to study than did their counterparts (marginalized males and non-marginalized females). As a general conclusion, to ensure equity and inclusion in higher education, the needs of the marginalized sectors of society in terms of access to ICT and the competencies to use these tools effectively for study should be the basis of designing online teaching-learning where learner support forms an integral part of curriculum design itself (Panda, 2022).

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Perceived Utility and Learning by Dominican University Students in Virtual Teaching–Learning Environments: An Analysis of Multiple Serial Mediation Based on the Extended Technology Acceptance Model

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Abstract

The global pandemic caused by the SARS-CoV-2 virus brought about a true revolution in the predominant teaching–learning processes (i.e., face-to-face environment) that had been implemented up to that point. In this regard, virtual teaching–learning environments (VTLEs) have gained unprecedented significance. The main objectives of our research were to define an explanatory theoretical model and to test a multiple serial mediation model with four variables in series (one independent variable plus three mediators) to relate perceived utility (independent variable) in the use of a VTLE and perceived learning (dependent or criterion variable) in such contexts, taking into account the mediation of subjective norm (mediator 1), ease of use (mediator 2), and intention to use behavior (mediator 3), and using the extended technology acceptance model as the theoretical framework. Additionally, we aimed to analyze the direct and indirect relationships and effects among the variables that constituted the proposed model. Methodologically, the research can be classified as a cross-sectional causal ex post facto design. A representative sample of students enrolled in higher education institutions in the Dominican Republic was used as the research population, and a standardized Likert scale was administered to measure the five dimensions of the proposed model. Finally, it is worth noting that the obtained results indicate that all direct and indirect effects considered in the model were statistically significant, except for the indirect effect, where the four predictor variables were arranged in series to verify their influence on the criterion variable: perceived learning.

Keywords: virtual teaching–learning environment, extended technology acceptance model, higher education, information and communications technology

Perceived Utility and Learning by Dominican University Students in Virtual Teaching–Learning Environments: An Analysis of Multiple Serial Mediation Based on the Extended Technology Acceptance Model

Virtual teaching–learning environments (VTLEs) have become an established reality that has been further reinforced by the COVID-19 pandemic and new educational needs (Adov & Mäeots, 2021; Herrador-Alcaide et al., 2019; Kortemeyer et al., 2023; Williamson et al., 2020) that have emerged in this new context. This is the starting point of our research, which aims to complement the existing scientific literature on VTLEs, but within the context prompted by the COVID-19 crisis among students enrolled in higher education in the Dominican Republic. Formally, these teaching–learning environments can be classified within a broader context known as *blended learning* (Hrastinski, 2019)—a broad term that refers to a continuum ranging from traditional face-to-face teaching–learning processes to innovative online teaching–learning processes (Garrison & Kanuka, 2004). In the context of VTLEs, learning management systems (LMSs) are valuable for supporting students' teaching–learning process (Araka et al., 2021; Bansah & Agyei, 2022).

However, at this point, it is worth asking to what extent the teaching–learning process based on these virtual environments can influence perceived learning outcomes among students. With this aim in mind, this research proposal emerged, grounded in a set of hypotheses related to specific variables (perceived usefulness, subjective norm, ease of use, and intention to use) and their influence on perceived learning within VTLE contexts. Thus, conducting a study of this nature and with these characteristics would seek to generate an explanatory theoretical model based on the technology acceptance model (TAM) and subsequent variations as a cornerstone for new pedagogical models and methodologies within VTLEs. Some current references on the practical utility of these models include Martín-García et al. (2019), Schimidthuber et al. (2020), and Ranellucci et al. (2020); the levels of satisfaction of students immersed in these VTLEs are also emphasized (Hamutoglu et al., 2020).

Theoretical Support

The field of educational practice and research is not immune to the new demands and innovations being developed to provide a rapid and accurate response to each situation that arises. All these changes share a common denominator: the exponential increase in new technologies and digital devices. As a result, a new way of understanding teaching–learning processes is emerging, where students are assuming an increasingly active role as they progress through educational levels, eventually reaching higher education (Gallego-Gómez et al., 2021; Quevedo-Arnaiz et al., 2021).

There are studies that demonstrate this paradigm shift, where new methodologies and active learning are gaining prominence—notably, Mohamed (2021), Rodríguez-Sabiote et al. (2020) Roitsch et al. (2021), and Tan et al. (2021). However, due to the COVID-19 pandemic, the global population was forced to endure periods of confinement. Specifically in the field of education, face-to-face classroom instruction in elementary schools, high schools, universities, and other educational centers had to be replaced with virtual classrooms and environments. Undoubtedly, education has undergone rapid changes in a very short period, and it is not surprising that various difficulties have arisen, such as dealing with misinformation in the media, maintaining the level of engagement in the teaching–

learning process, and managing anxiety toward these accelerated changes (Martin et al., 2022; Unger & Meiran, 2020). Thus, processes that were already underway were accelerated, and many changes and innovations that were introduced due to the new reality have ultimately become permanent. In this new context, students and teachers have been compelled to adapt to online learning and distance education in a short time, giving rise to a new model in education in the so-called post-COVID era (Lockee, 2021).

In this context, VTLEs gain significant strength and presence. VTLEs are understood as virtual environments that facilitate pedagogical communication among participants in an educational process, whether fully online, face to face, or in a blended nature that combines both modalities in varying proportions (Weller, 2007). Therefore, VTLEs can be considered as highly potential and functional alternatives that effectively combine technology and pedagogy, enabling the execution of learning activities and tasks across different subjects in virtual environments or classrooms, where both students and teachers can visualize and access various educational resources (Baez-Estrada & Ossandón Núñez, 2015). Furthermore, VTLEs promote collaborative learning, where the teacher acts as a mediator in the learning construction process and students are the protagonists of their own development (Huang et al., 2010). They foster social interaction in the teaching–learning process (Hernández-Sellés, 2021; Limniou & Smith, 2010; Uzunboylu et al., 2011), which is considered one of the main pillars of these platforms and tools.

All of this originates from the TAM proposed by Davis (1989) and from subsequent extended and adapted models (Abdullah & Ward, 2016). The purpose of this model is to explain the factors that determine the use of information and communications technology (ICT) by a significant number of users, suggesting that perceived usefulness and perceived ease of use are determinants of a user's intention to use a system. This predictive model of ICT use is based on two main variables:

1. perceived usefulness (PU): the user's perception of how adopting the technology would enhance their performance or productivity.

2. perceived ease of use (PEoU): the user's perception of how effortless it is to use the technology.

Following the TAM, there are external variables that can directly influence PU and PEoU (Yong-Varela et al., 2010). These external variables indirectly influence attitude toward use, behavioral intention to use, and actual behavior. PEoU has a causal effect on PU, and PU significantly affects an individual's attitude toward using a particular system, which can be either favorable or unfavorable. Among the external variables that have been studied with great interest in the scientific literature over the years (Bueno & Salmerón, 2008; Huffman & Huffman, 2012; Ngai et al., 2007; Venkatesh, 2000), five can be highlighted: social influence, technological support, cooperation among organization members, academic success, and knowledge need.

Objectives and Hypotheses

The first objective was to define an explanatory theoretical model (extended technology acceptance model) as tested by Urquidi Martín et al. (2019) and to confirm it through a multiple serial mediation model with three mediating variables to relate perceived usefulness (PU) derived from the use of VTLE and perceived learning (PL) in these contexts, taking into account the mediation of subjective norm (SN), perceived ease of use (PEoU), and behavioral intention to use (BIU). The second objective was to

analyze the relationships and the given direct, indirect, and total effects among the variables comprising this model. Based on these research objectives, a series of hypotheses were derived. These hypotheses are based on model 6 proposed by Hayes (2022) within the mediation models, which will be discussed in detail in the methodology section. The following hypotheses are enumerated accordingly.

Hypotheses With a Single Mediator

The following hypotheses were derived from the indirect effects of the predictor (x = PU) on the criterion (y = PL) modulated by a single mediator (indirect effect of x on y through only $m_i = a_i b_i$):

hypothesis 1: greater PU derived from the use of a VTLE, along with a stronger SN imposed within this environment, enhance PL: Ind_1 = PU→SN→PL or, alternatively, *m1* SN ~ PU.

hypothesis 2: greater PU derived from the use of a VTLE, combined with a higher PEoU, increase PL: Ind_2 = PU→PEoU→ PL or, alternatively, *m2* PEoU ~ PU.

hypothesis 3: greater PU derived from the use of a VTLE, coupled with a higher BIU, enhance PL: Ind_3 = PU→BIU→PL or, alternatively, *m3* BIU ~ PU.

Hypotheses With Two and Three Mediators

The following hypotheses were derived from the indirect effects of the predictor (x = PU) on the criterion (y = PL) modulated by two or three mediators (indirect effect of x on y through *m1*, *m2*, *m3* in serial):

hypothesis 4: greater PU derived from the use of a VTLE, along with a stronger SN imposed within this environment, as well as a higher PEoU within the same environment, enhance PL: Ind_1 = PU→SN→PEoU→PL.

hypothesis 5: greater PU derived from the use of a VTLE, coupled with a stronger SN imposed within this environment, as well as a higher BIU within the same environment, enhance PL: Ind_2 = PU→SN→BIU→ PL.

hypothesis 6: greater PU derived from the use of a VTLE, along with a higher PEoU and a higher BIU within the same environment, enhance PL: Ind_3 = PU→PEoU→BIU→PL.

hypothesis 7: greater PU derived from the use of a VTLE, combined with a stronger SN imposed within this environment, associated with a higher PEoU within the same environment, as well as a higher BIU, enhance PL: Ind_4 = PU→SN→PEoU→BIU→PL.

Methodology

Study Variables

The study considers five distinct variables, which are actually latent dimensions formed by grouping observable variables (scale items) of the proposed model: PU, SN, PEoU, BIU, and PL. The role and definition of each variable in the proposed model are as follows (Urquidi Martín et al., 2019, p. 6):

- PU: the perception held by students receiving their classes in a VTLE regarding the usefulness of an innovation in improving their learning competence. ROLE→ (*x*: independent).

- SN: the set of social pressures exerted by relevant individuals on students receiving their classes in a VTLE, with the aim of influencing these users to perform a specific action or behavior. ROLE→ (*m1*: mediator 1).

- PEoU: the degree to which a student considers the use of a particular innovation to be free of additional effort. ROLE→ (*m2*: mediator 2).

- BIU: the perception held by students receiving their classes in a VTLE regarding their future employment of an innovation. ROLE→ (*m3*: mediator 3).

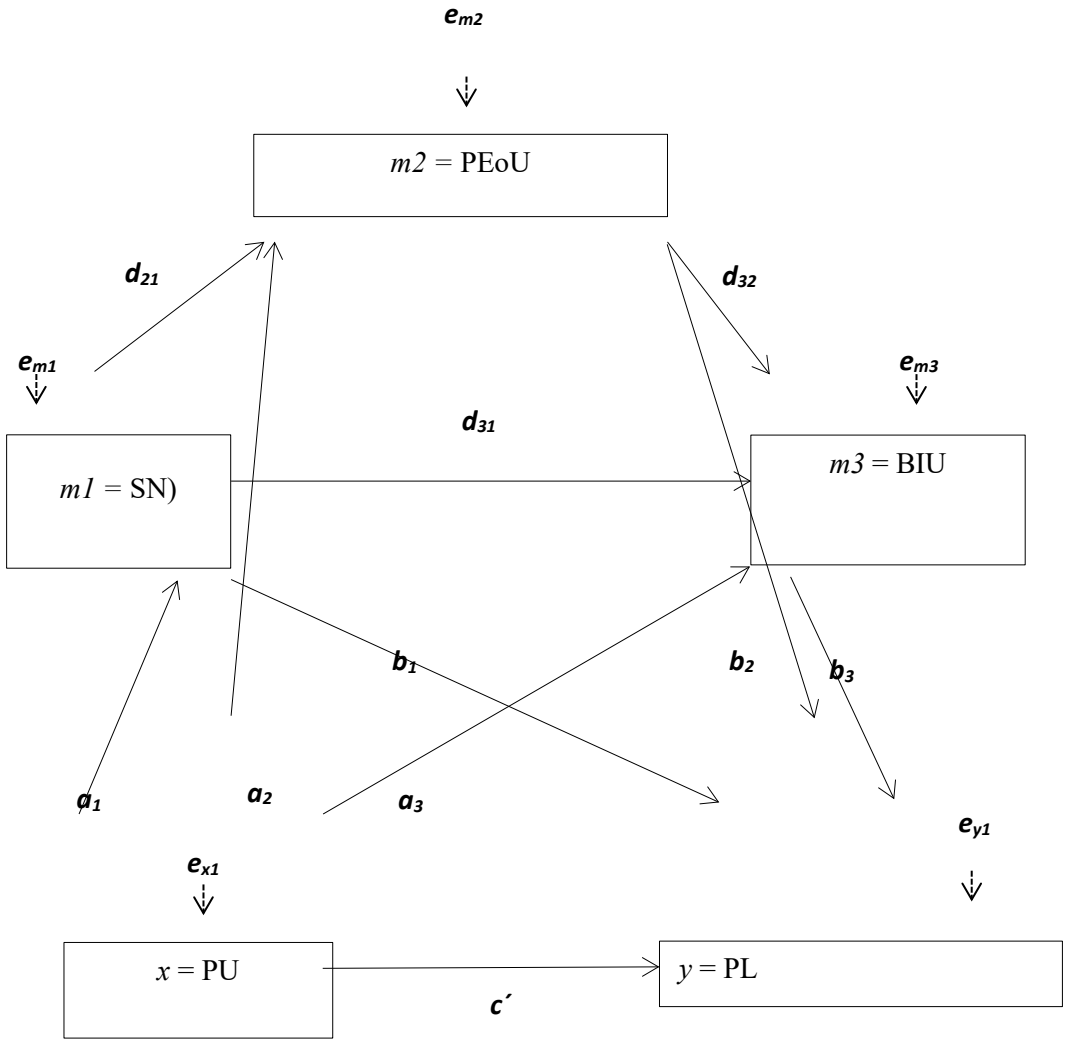
- PL: the relationship between the use of an innovation by students receiving their classes in a VTLE and the improvement they could achieve in their learning. ROLE→ (*y*: dependent).

Methodological Design

The methodology used in the research follows an ex post facto correlational-predictive design of a cross-sectional nature, characterized by establishing relationships of covariation and regression among variables of different nature—namely, independent, dependent, and mediator variables—aiming to confirm a specific mediation model. The model being tested is model 6 proposed by Hayes (2022). This model is a mediation model that involves a criterion or dependent variable *y* = PL, an independent variable *x*= PU, and three sequential or serial mediator variables, namely, *m1* = SN, *m2* = PEoU, and *m3* = BIU. Conceptually, it can be referred to as a multiple mediation model with three variables in a series. The model can be represented schematically using a statistical diagram, where, in addition to the five variables, each of the regression coefficients (β) or standardized/unstandardized slopes corresponding to the regression equations that make up the model are represented by letters (Figure 1). In our case, we would have the following regression coefficients: *a1, a2, b1, b2, b3, d21, d31,* and *c´*, along with an overall coefficient *c* (total effect not shown in the diagram), as well as different errors (e_n) associated with the different regression coefficients.

Figure 1

Statistical Diagram (Model 6 With Three Mediators)



Note. PEoU = perceived ease of use; SN = subjective norm; BIU = behavioral intention to use; PU = perceived usefulness; PL = perceived learning; indirect effect of x on y through m_i only = a_ib_i (a_1b_1, a_2b_2, and a_3b_3); indirect effect of x on y through $m1$ and $m2$ in serial = $a_1d_{21}b_2$; indirect effect of x on y through m_1 and m_3 in serial = $a_1d_{31}b_3$; indirect effect of x on y through $m2$ and $m3$ in serial = $a_2d_{32}b_3$; indirect effect of x on y through $m1$, $m2$, and $m3$ in serial = $a_1d_{21}d_{32}b_3$; direct effect of x on y = $c´$.

Data Collection

Instrument

For data collection, a single instrument was used: the measurement scale of the extended technology acceptance model (MSETAM) by Urquidi Martín et al. (2019). There are three reasons for using a single instrument. The first is that it is properly standardized in terms of reliability, internal consistency, and concurrent and construct criterion validity (Urquidi Martín et al., 2019). It also has content validity, as

it was developed by adapting several previously standardized instruments. The sources of the dimensions and items that constitute the instrument are presented in Table 1.

Table 1

Sources of the Dimensions of the Instrument

Scale dimension	Sources
PU	Arteaga Sánchez & Duarte Hueros (2010); Davis (1989); Islam (2013); Premkumar & Bhattacherjee (2008)
SN	Sánchez-Prieto et al. (2017)
PEoU	Arteaga Sánchez & Duarte Hueros (2010); Davis (1989); Islam (2013); Premkumar & Bhattacherjee (2008)
BIU	Arteaga Sánchez & Duarte Hueros (2010); Davis (1989); Islam (2013); Premkumar & Bhattacherjee (2008)
PL	Islam (2013)

Note: PU = perceived usefulness; SN = subjective norm; PEoU = perceived ease of use; BIU = behavioral intention to use; PL = perceived learning. Adapted from "Entornos virtuales de aprendizaje: modelo ampliado de aceptación de la tecnología [Virtual Learning Environments: Extending the Technology Acceptance Model]," by A. C. Urquidi Martín, M. S.Calabor-Prieto, & C. Tamarit-Aznar, 2019, *Revista Electrónica de Investigación Educativa*, *21*, p. 6 (https://doi.org/10.24320/redie.2019.21.e22.1866). Copyright 2019 by the Revista Electrónica de Investigación Educativa.

The second reason for using a single instrument is that the scale consists of 20 items (5 items for each included dimension), making it a short and easy-to-complete scale. The third reason is that the instrument is structured around the dimensions that will constitute the mediation model being tested. The MSETAM used in this study is composed of five dimensions, PU, SN, PEoU, BIU, and PL, each consisting of four items. The response format is a Likert-type scale ranging from 1 to 5 (1 = strongly disagree; 5 = strongly agree). The scale was administered online.

Sample

The sample size of this research was 407 students from 15 public and private universities or higher education institutions in the Dominican Republic. Of these, 108 were male and 299 were female, with ages ranging from 17 to 54 years (M = 25.86, SD = 7.35). No specific sampling technique was used, as the instrument was made available to the target population in an online format. The population from which the sample was drawn was approximately 580,000 individuals (i.e., students enrolled in higher education in the Dominican Republic during the 2020–2021 academic year, the latest year for which data were available). For this particular study, the sample size was determined based on the following parameters: significance level (1-α) = 0.95, sampling error = ±4.8%, and unknown proportions (p = q = 0.5). Once the sample size was calculated to be approximately n = 471, the instrument was administered online. Sample attrition amounted to 64 participants (13.58%), which was not a cause for concern, as the focus was on the proportion of participants per variable (subject to variables [STV]). The resulting STV ratio was 20.35 (407/20). While the minimum value for STV is relative and varies depending on the consulted author, a minimum value of 10 is recommended (Garson, 2008). Our value

was comfortably above this threshold (20.35 > 10). The data collection process is described in more detail in the procedure section.

Reliability and Validity of the Data Collection Instrument

The scale used in our study has been properly standardized and demonstrates the necessary psychometric properties, including content and construct validity. We will now present the results obtained for the complete scale and the various subscales in terms of reliability (internal consistency) and concurrent criterion validity in the context of our particular study.

For internal consistency reliability, we calculated Cronbach's alpha (α) coefficient and McDonald's omega (ω) coefficient after a single administration of the instrument. For concurrent criterion validity, we calculated the corrected item-total correlation. The results for both aspects are presented in Table 2 and discussed below.

Table 2

Scale and Subscales Reliability Statistics

Scale/subscale	Cronbach's α	McDonald's ω
Subscale PU (4 items)	0.838	0.844
Subscale SN (4 items)	0.877	0.878
Subscale PEoU (4 items)	0.705	0.725
Subscale BIU (4 items)	0.891	0.894
Subscale PL (4 items)	0.849	0.853
Full scale (20 items)	0.950	0.954

Note. PU = perceived usefulness; SN = subjective norm; PEoU = perceived ease of use; BIU = behavioral intention to use; PL = perceived learning.

The results for the reliability coefficients, Cronbach's α and McDonald's ω, indicate high internal consistency for the evaluated subscales, except for the isolated case of the PEoU subscale, which shows slightly lower internal consistency. Notably, the overall scale demonstrated high internal consistency with α = 0.950 and ω = 0.954. In conclusion, moderately high α and ω values were obtained, indicating good internal consistency of the scale as a whole (Zumbo et al., 2007), with slightly lower consistency for the PEoU subscale.

Regarding criterion validity, we calculated the corrected item-total correlation or item-rest correlation, which represents the correlation between each item and the total score of the scale after removing that particular item. In most cases, the reported correlations were $r > 0.65$, suggesting that most items in the scale accurately measured the same construct as the total scale (internal consistency criterion).

Data Analysis

To test the proposed mediation hypotheses, we employed the PROCESS macro for SPSS v4.0 (Hayes, 2022) using the bootstrapping method. This strategy is advantageous for addressing violations of parametric assumptions such as normality and small sample sizes (although this is not the case in our

study). It is considered a more robust approach Hayes & Rockwood, 2020) than, for example, jackknifing method or permutation tests. The bootstrapping method is based on repeated random sampling with replacement from the data set to calculate the desired statistic for each resample, in our case with 10,000 bootstrap samples. Its major advantage over the initial methods used in sequential mediation models (e.g., Baron & Kenny, 1986) and the Sobel test (Preacher & Hayes, 2004) is its ability to provide point estimates and confidence intervals. With the help of these confidence intervals, we can assess whether the mediation effect is statistically significant (Igartura & Hayes, 2021).

Table 3

Regression Analysis and Total, Direct, and Indirect Effects of x on y

Outcome variable: Subjetive Norm (SN)

Model summary

R	R-sq	MSE	F	df1	df2	P
.73	.53	6.75	456.29	1	405	.000***
Model	**Coeff.**	**Se**	**T**	**p**	**LLCI**	**ULCI**
constant	3.34	.55	6.04	.000***	2.25	4.42
PU	.76	.04	21.36	.000***	.69	.83

Standardized coefficient PU= .73 (a_1)

Outcome variable: Perceived Easy Use (PEOU)

Model summary

R	R-sq	MSE	F	df1	df2	p
.67	.45	5.50	162.70	2	404	.000***
Model	**Coeff**	**Se**	**T**	**p**	**LLCI**	**ULCI**
constant	5.12	.52	9.83	.000***	4.10	6.14
PU	.47	.05	9.96	.000***	.37	.56
SN	.14	.04	3.07	.000***	.05	.23

Standardized coefficients PU= .54 (d_{21}); SN =.14(a_2)

Outcome variable: Behavioural Intention Use(BIU)

Model summary

R	R-sq	MSE	F	df1	df2	p
.86	.74	3.83	391.86	3	403	.000***
Model	**Coeff**	**Se**	**T**	**p**	**LLCI**	**ULCI**
constant	.99	.48	2.05	.04*	.04	1.94

PU	.32	.04	7.38	.000***	.24	.41
SN	.55	.04	14.64	.000***	.48	.63
PEoU	.13	.04	3.17	.000***	.05	.21

Standardized coefficients PU= .30 (a_3); SN =.54(d_{31}); PEOU=.11(d_{32})

Outcome variable: Perceived Learning(PL)

Model summary

R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**p**
.86	.69	3.99	224.98	4	402	.000***
Model	**Coeff**	**Se**	**T**	**p**	**LLCI**	**ULCI**
constant	1.74	.50	3.51	.000***	.76	2.71
PU	.18	.04	7.38	.000***	.09	.27
SN	.30	.04	14.64	.000***	.21	.39
PEoU	.26	.04	3.17	.000***	.18	.34
BIU	.20	.05	4.01	.000***	.10	.30

Standardized coefficients PU= .18 (c´); SN =.32 (b_1); PEOU=.23 (b_2); BIU=.22 (b_3)

TOTAL EFECT MODEL

Outcome variable: Perceived Learning (PL)

Model summary

R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**p**
.73	.54	5.94	486.93	405	1151	.000***
Model	**Coeff.**	**Se**	**T**	**p**	**LLCI**	**ULCI**
constant	4.91	.52	9.48	.000***	3.89	5.93
PU	.72	.03	21.65	.000***	.66	.79

Standardized coefficient PU= .73 (a_1)

TOTAL AND DIRECT EFECT OF *X* ON *Y*

Total effect of X on Y

Effect	**Se**	**t**	**P**	**LLCI**	**ULCI**	**c_ps**	**c_cs**
.72	.03	21.65	.000***	.66	.79	.20	.73

Standardized coefficient PU= .73 (a_1)

Direct effect of X on Y

Effect	Se	t	P	LLCI	ULCI	c_ps	c_cs
.18	.05	3.81	.000***	.09	.27	.05	.18
Standardized coefficient PU= .18 (total)							

*Note. *p<.05, **p<.01, ***p<.001.*

Level of confidence for all confidence intervals in output: 95%

Number of bootstrap samples for percentile bootstrap confidence intervals: 10000.

After applying the PROCESS program, the results regarding the various regression equations that statistically support model 6 are presented. In this regard, we can observe the different regression analyses developed as follows:

1. $x \rightarrow m1$ (coeff. a1) $y = \alpha + \beta 1\ (a_1)$, where the variable x (PU) acts as the sole predictor of mediator 1 (SN). All parameters were statistically significant ($p < 0.001$).

2. $m1, x \rightarrow m2$ (coeff. d21, a2) $y = \alpha + \beta 1\ (d_{12}) + \beta 2\ (a_2)$, where both mediator 1 (SN) and the main predictor (PU) act as predictors of moderator 2 (PEoU). All parameters were statistically significant ($p < 0.001$).

3. $m1, m2, x \rightarrow y$ (coeff. $b_1, b_2, c´$) $y = \alpha + \beta 1\ (b_1) + \beta 2\ (b_2) + \beta 3\ (c´)$, where the two mediators, 1 and 2 (SN and PEoU), along with the main predictor (PU), act as predictors of the criterion or dependent variable (PL). All parameters were statistically significant ($p < 0.001$).

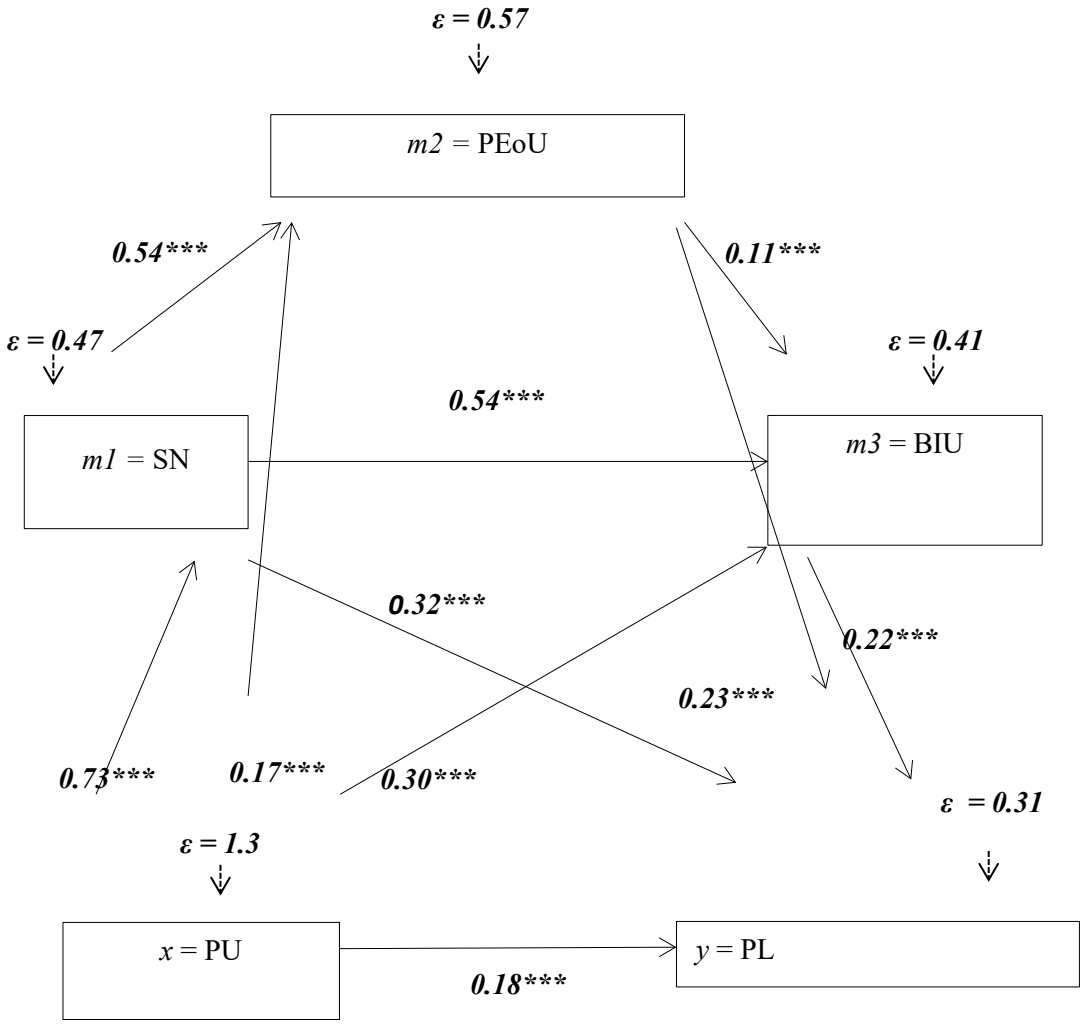
4. $m1, m2, m3, x \rightarrow y$ (coeff. $b_1, b_2, b_3, c´$) $y = \alpha + \beta 1\ (b_1) + \beta 2\ (b_2) + \beta 3\ (b_3) + \beta 4\ (c´)$, where the three mediators (SN, PEoU, and BIU), along with the main predictor (PU), act as predictors of the criterion or dependent variable (PL). All parameters were statistically significant ($p < 0.001$).

5. Finally, both the total effect $\beta\ (c) = 0.72$ ($p < 0.001$) and the direct effect $\beta\ (c´) = 0.18$ ($p < 0.001$) were statistically significant.

Empirical confirmation seems to support the relevance and possibility of including the main predictor (PU) and its mediators (SN, PEoU, and BIU) as variables that can help predict PL. Figure 2 presents a diagram of the inferred model with the calculated parameters.

Figure 2

Statistical Diagram With Coefficients (Model 6 With Three Mediators)



Note. PEoU = perceived ease of use; SN = subjective norm; BIU = behavioral intention to use; PU = perceived usefulness; PL = perceived learning. Indirect effect of x on y through m_i only = $a_i b_i$ ($a_1 b_1$, $a_2 b_2$, and $a_3 b_3$). Indirect effect of x on y through $m1$ and $m2$ in serial = $a_1 d_{21} b_2$. Indirect effect of x on y through m_1 and m_3 in serial = $a_1 d_{31} b_3$. Indirect effect of x on y through $m2$ and $m3$ in serial = $a_2 d_{32} b_3$. Indirect effect of x on y through $m1$, $m2$, and $m3$ in serial = $a_1 d_{21} d_{32} b_3$. Direct effect of x on y = $c´$. Betas are completely standardized.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Second, we present the results concerning the mediating indirect effects, as well as the comparison between them using binomial tests to either accept or reject each of the seven hypotheses proposed (Table 4).

Table 4

Completely Standardized Indirect Effect(s) of x on y

Types of effects	Effect	Boot_SE	Boot_LLCI	Boot_ULCI
Total	0.55	0.04	0.47	0.63
Ind_1^	0.23	0.04	0.15	0.32
Ind_2^	0.12	0.03	0.07	0.18
Ind_3^	0.07	0.02	0.03	0.11
Ind_4^	0.03	0.01	0.01	0.05
Ind_5^	0.09	0.03	0.04	0.14
Ind_6^	0.01	0.01	0.01	0.03
Ind_7	0.00	0.00	0.00	0.01
Specific indirect effect contrast definition(s)				
C_1 (Ind_1 vs. Ind_2)	0.11	0.06	0.00	0.23
C_2 (Ind_1 vs. Ind_3)^	0.16	0.06	0.06	0.27
C_3 (Ind_1 vs. Ind_4)^	0.20	0.05	0.11	0.29
C_4 (Ind_1 vs. Ind_5) ^	0.14	0.06	0.02	0.26
C_5 (Ind_1 vs. Ind_6) ^	0.22	0.05	0.13	0.31
C_6 (Ind_1 vs. Ind_7) ^	0.23	0.04	0.14	0.31
C_7 (Ind_2 vs. Ind_3)	0.06	0.04	−0.02	0.13
C_8 (Ind_2 vs. Ind_4) ^	0.10	0.04	0.04	0.16
C_9 (Ind_2 vs. Ind_5)	0.04	0.04	−0.05	0.12
C_{10} (Ind_2 vs. Ind_6) ^	0.11	0.03	0.05	0.17
C_{11} (Ind_2 vs. Ind_7) ^	0.12	0.03	0.06	0.18
C_{12} (Ind_3 vs. Ind_4)	0.04	0.02	−0.01	0.09
C_{13} (Ind_3 vs. Ind_5)	−0.02	0.02	−0.06	0.01
C_{14} (Ind_3 vs. Ind_6) ^	0.05	0.02	0.02	0.10
C_{15} (Ind_3 vs. Ind_7) ^	0.06	0.02	0.03	0.11
C_{16} (Ind_4 vs. Ind_5)	−0.06	−0.03	−0.12	0.00
C_{17} (Ind_4 vs. Ind_6)	0.01	0.01	−0.01	0.04
C_{18} (Ind_4 vs. Ind_7) ^	0.02	0.01	0.01	0.04
C_{19} (Ind_5 vs. Ind_6)	0.07	0.02	0.03	0.12
C_{20} (Ind_5 vs. Ind_7) ^	0.08	0.03	0.04	0.14
C_{21} (Ind_6 vs. Ind_7)	0.01	0.00	0.00	0.02

Note. LLCI = lower limit confidence interval; ULCI = upper limit confidence interval; PU = perceived usefulness; SN = subjective norm; PL = perceived learning; PEoU = perceived ease of use; BIU = behavioral intention to use. ^confidence interval (boot LLCI–boot ULCI) does not cover the value 0 → statistically significant. Indirect effect key: Ind_1 PU → SN →PL; Ind_2 PU → PEoU → PL; Ind_3 PU → BIU → PL; Ind_4 PU → SN → PEoU → PL; Ind_5 PU → SN → BIU → PL; Ind_6 PU → PEoU → BIU → PL; Ind_7 PU → SN → PEoU → BIU → PL.

As can be seen from the seven direct effects, six were statistically significant, considering that at a 95% confidence level, confidence intervals (boot LLCI–boot ULCI) have been estimated that do not include the value 0 (Hayes, 2022). Specifically, the statistically significant indirect effects include all but one, which is the indirect effect 7 (Ind_7). In this effect, we obtained a standardized coefficient $\beta = 0$, associated with a standard error boot = 0, which, considering a 95% confidence level, yields a confidence interval of 0.00–0.01, where the value 0 is indeed included, indicating the non significance of the contemplated effect (Hayes, 2022).

Another relevant aspect, once the indirect effects have been examined, is to determine which are more significant and whether there are statistically significant differences among them (post hoc contrasts). For this procedure, the seven indirect effects were compared using binomial tests. In this way, a total of 21 comparisons were conducted, corresponding to the combinations of seven elements taken two at a time ($C_2^7 = 7! / 2! \times [7 - 2]!$). Out of these 21 comparisons, 12 were statistically significant, meaning that their confidence intervals (boot LLCI–boot ULCI) did not include the value 0. In more detail, the indirect effects with statistically significant differences when compared to each other are comparisons 2, 3, 4, 5, 6, 8, 10, 11, 14, 15, 18, and 20. On the other hand, the remaining comparisons—1, 7, 9, 12, 13, 16, 17, 19, and 21—were not statistically significant, as they included the value 0 in the confidence intervals (boot LLCI–boot ULCI).

Furthermore, the comparisons that showed the greatest differences among the indirect effects were those with higher standardized effects β, which corresponded to the comparisons involving the indirect effect 1 (Ind_1 = PU → SN → PL) with the other indirect effects.

Discussion and Conclusions

The results obtained regarding the three initial hypotheses (hypotheses 1, 2, and 3) indicate that PU is a good predictor of PL when mediated by each mediator individually, namely SN, PEoU, and BIU.

As a result, we can conclude that higher PU derived from the use of a VTLE in the teaching and learning process, along with a stronger subjective norm imposed within this environment, increases PL. Additionally, higher PU derived from the use of a VTLE, coupled with a greater PEoU, enhances PL. Finally, higher PU resulting from the use of a VTLE, combined with a greater BIU, increases PL.

Furthermore, regarding hypotheses with two mediators (hypotheses 4, 5, and 6) and three mediators (hypothesis 7) in series, we also observed that PU is an excellent predictor of PL when mediated by SN and PEoU in series, when mediated by SN and BIU in series, and when mediated by PEoU and BIU in series. However, no empirical evidence was found to conclude that PU is a good predictor of PL when mediated by SN, PEoU, and BIU, all in series.

Based on these findings, we can conclude that higher PU derived from the use of a VTLE, along with a stronger SN imposed within this environment, as well as a greater PEoU within the same environment, increases PL. Similarly, higher PL derived from the use of a VTLE, coupled with a stronger SN imposed within this environment, and a greater BIU, also enhance PL. Finally, we can also conclude that higher PU derived from the use of a VTLE, along with a greater PEoU and a higher BIU, increases PL. However, we cannot conclude that higher PU when using a VTLE, combined with a stronger SN imposed within this environment, a greater PEoU within the same framework, and a higher BIU, increases PL.

Furthermore, the total and direct effects of the model were also found to be statistically significant. Therefore, it can be concluded that PU is a good predictor of PL in VTLE, both when it directly influences learning and when it does so through the mediation of subjective norm, ease of use, and intention to use.

When comparing our conclusions with those of other studies, we found a solid agreement with the findings obtained from other research. Considering the specific characteristics and specific approaches of the different studies selected for this comparative purpose, we observe that they indeed bear a considerable resemblance to our conclusions. However, we do note a difference with some of these studies. For example, in the work of Urquidi Martín et al. (2019), PEoU did not prove to be an influential variable in PL. On the other hand, we highlight the works of Baez-Estradas and Ossandón Núñez (2015), Calderón et al. (2020), Islam (2013), Montagud Mascarell and Gandía Cabedo (2014), Hernández-Sellés (2021), Ranellucci et al. (2020), Talantis et al. (2020), Severt et al. (2020), Schepers and Wetzels (2007), Şimşek and Ateş (2022), Tırpan and Bakirtas (2020), and Wismantoro et al. (2020), whose findings are more in line with those obtained in the present research. All these findings propose the TAM model and its different variants as a robust reference model for determining the effectiveness of VTLE and LMS as environments where certain mediating variables can determine PL (Murillo et al., 2021).

Limitations

This study has several limitations, primarily related to methodological aspects. For instance, the sample size, although adequate, could be larger in future explorations to ensure greater representativeness by including more private and public institutions in the Dominican Republic. Another concern is the imbalance of gender representation among study participants. In this case, female participants accounted for nearly 75% of the total sample, which led the researchers in a previous study (Rodríguez-Sabiote et al., 2023) to conduct a confirmatory factor analysis on the administered scale, examining gender invariance. The results indicated that the factorial structure is similar for men and women. Therefore, it can be concluded that the scale is consistent, valid, and invariant in determining PL in VTLEs within the extended TAM in the Dominican context. Another limitation encountered in this study was the difficulty comparing the conclusions with previously published research in the scientific literature, as very few studies consider PL as a criterion variable within the extended acceptance model of learning.

Implications

The use of VTLEs in distance education, research, and practice has a number of implications. Some of the most relevant ones are as follows. Regarding education, we highlight global access, time flexibility, interactivity, and multimedia. For research, we highlight access to global resources, remote data collection, and international collaboration. Finally, for practice, distance education can be useful for teleworking, lifelong learning, cost reduction, and improved work–life balance.

Data Availability Statement

The authors will provide the raw data on which the conclusions of this article are based without any reservations.

Ethics Statement

The study conducted adhered to all necessary ethical aspects. In this regard, the Ethics Committee of the "Higher Institute of Teacher Training Salomé Ureña (ISFODOSU)" ensured the anonymity of the participants, and it was ensured that none of the items on the administered scale posed a threat to the physical, psychological, and/or social profiles of the participants.

Author Contributions

Clemente Rodríguez-Sabiote analyzed and interpreted the data. Álvaro Úbeda-Sánchez, Roberto Batista-Almonte and Ana Teresa Valerio-Peña contributed to the development of the theoretical framework and data collection. All authors made significant contributions to the development and writing of this article and have conceived and designed the work.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Exploring Teachers' Digital Literacy Experiences

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Abstract

The present study analysed digital literacy issues encountered by elementary school teachers in remote classrooms due to COVID-19. The study sought to derive a plan for cultivating teachers' digital literacy to support students' distance education. To this end, focus group interviews were conducted with five elementary school teachers in charge of upper grades, the results were analysed, and strategies to improve teacher digital literacy were derived. Specifically, three main areas of teacher digital literacy were identified for improvement. The first was providing training to use digital devices and online platforms, develop online content, and strengthen copyright understanding. The second was providing professional development programs to train digital teaching methods or pedagogies by level and by subject characteristics. The third was activating online and offline platforms for information sharing among teachers and establish a digital teaching support system. This study will be of value to teachers and school administrations in preparing for distance education in the era of digital transformation because it presents measures to foster teachers' digital literacy required by future society.

Keywords: teachers' digital literacy, digital competency, elementary school, distance learning

Exploring Teachers' Digital Literacy Experiences

The digital transformation brought about by the COVID-19 pandemic has also profoundly affected the education sector, creating demand for various educational innovations to adapt to the new educational landscape. The field of education has been changed by untact digital trends, and interest in various forms of educational technology has increased, such as artificial intelligence, augmented reality, and virtual reality. There is new demand for educational innovation to nurture learners in the era of digital transformation. In future societies where digital technology will continue to develop, learners who are able to integrate creativity, personality, and emotion will thrive in comparison to learners who merely possess various knowledge (Trilling & Fadel, 2009). Therefore, for successful distance learning, it is necessary to provided learner-centred collaborative learning opportunities to support the development of creativity, interaction, and coordination competency (Pearcy, 2014).

Despite the demand for various educational innovations within the field of education based on remote and digital paradigms, prompted by the changes induced by the COVID-19 pandemic, it has not been easy for educators to keep up with the rapidly changing trends in the field of education. The expansion of distance learning due to COVID-19 has brought about many changes to the educational field, but distance learning that was conducted in response to the emergency conditions of the pandemic brought numerous problems to light, such as lack of infrastructure (Kruszewska et al., 2022), difficulty in using digital devices (Jung et al., 2020; Shagiakhmetova et al., 2022), limitations in using teaching methods (Shagiakhmetova et al., 2022), and challenges in equitable evaluation (Jung et al., 2020). In particular, elementary school students experienced more challenges in adapting to distance learning compared to middle or high school students, so elementary school educators were required to demonstrate greater capacities in designing, implementing, and assessing distance learning (Ben-Amram & Davidovitch, 2021; Taimur et al., 2021; van Wyk, 2021; Wang et al., 2021).

The direction of education has also been changing to support learner-centred, individualized, and customized education based on digital technology. Against this backdrop, changes were also required in teacher professionalism in order to meet the demands of future education. In particular, teachers' digital literacy has been critical to preparing distance instruction (Prior et al., 2016). In this context, exploring challenges encountered by educators in terms of digital literacy during distance learning, and deriving insights for cultivating teacher digital literacy, can contribute to enhancing distance learning quality.

Therefore, the present study aimed to analyse the status of teachers' digital literacy as a prerequisite for the effective implementation of distance teaching, which has become an essential modality in the realm of school education, particularly in the context of the second year of the COVID-19 pandemic. In particular, this study focused on exploring the difficulties of elementary school teachers in providing distance learning to elementary school students due to COVID-19 in connection with teacher digital literacy. Through a review of the literature and semi-structured interviews with elementary school teachers, the present study sought to identify the components of teacher digital literacy that required support and suggest implications for teacher digital literacy cultivation. In other words, the research concentrated on the use of teachers' digital literacy for the purpose of supporting students within distance instructional contexts. To achieve this, the study was guided by two research questions. What digital literacy challenges did elementary school teachers face? How can schools foster digital literacy among elementary school teachers?

Literature Review

Components of Teacher Digital Literacy

Digital literacy refers to "the overall capacity of an individual to use digital media, information processing and retrieval, participate in social networks for the purpose of creating and sharing knowledge, and employ a wide range of computing skills" (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2011, p. 1). With the advent of the digital transformation era, there has been a growing interest in digital literacy. Digital literacy, encompassing the ability to explore and use information using digital technologies, has also been referred to as digital competence (Jung & Shin, 2022). In this study, the concept of digital literacy is approached comprehensively to encompass digital competence, information and communication technology (ICT) skills, and related aspects.

Recently, within the educational domain, there has been a growing emphasis on digital literacy as a critical competency for teachers, given the advancement of Internet technologies and the expansion of distance education (From, 2017). With the full-scale implementation of distance education during the first half of 2020 due to the COVID-19 pandemic, the importance of teachers' digital literacy has escalated in formulating effective teaching and learning strategies within the distance education environment. According to prior research, teachers' digital literacy encompassed understanding and use of technology, information and data exploration and management, digital ethics and safety, active engagement, digital problem-solving, and digital teaching and learning strategies (Jung & Shin, 2022). Additionally, other essential components of teachers' digital literacy, as identified by prominent global institutions, encompassed digital content creation and problem solving (El Instituto Nacional de Tecnologías Educativas y Formación del Profesorado [INTEF], 2020), educational sciences and ICT (UNESCO, 2011), and activity and learning environment design (International Society for Technology in Education [ISTE], 2017). ISTE, INTEF, and UNESCO have all conducted extensive research on digital competence over the years, providing valuable resources referenced by many scholars.

Table 1

Digital Competence Elements Identified by Major Institutions

Organization and citation	Elements of digital competence
INTEF (2020)	Information literacy, problem solving, safety, digital content creation, communication and collaboration
UNESCO (2011)	Understanding ICT in education, curriculum and assessment, pedagogy, ICT, organization and administration
ISTE (2017)	Collaborators: Collaboration with both colleagues and students to improve practice, learner-driven activities and environments Facilitators: Facilitating learning with technology to support student achievement

From "Teacher training strategies for improvement technological pedagogy knowledge (TPK) connected with problem solving" by S. Shin, C. Kim, & Y. Jeong, 2018, *Journal of the Korean Association of Information Education, 22*(1), p. 25. Copyright 2018 by Korean Association of Information Education.

As observed thus far, the digital literacy that teachers need to prepare and deliver digital instruction has been composed of skills involving the use of digital devices and technology, information collection and analysis, the creation of video content, and the application of teaching and learning methods for distance instruction (Redecker & Punie, 2017). Moreover, teachers' digital literacy encompassed problem solving, communication and collaboration, as well as organizational and managerial skills (Redecker & Punie, 2017; UNESCO, 2018). Therefore, teacher digital literacy has been defined as the ability not only to effectively use digital devices and online platforms, but also the capability to implement a variety of teaching and learning strategies effectively in actual lessons, leading to successful distance learning.

Thus, cultivating post-pandemic teacher digital literacy has entailed providing opportunities to enhance not only the digital device-related competencies outlined earlier but also skills in teaching and learning strategies, communication, operation, and management that are crucial for effectively guiding distance instruction. In this regard, the present study divided teachers' digital literacy into the following six areas and conducted research based on them: (a) understanding and use of technology, (b) search for and administration of information and data, (c) digital ethics and safety, (d) proactive participation, (e) digital problem-solving, and f) digital learning and teaching strategies.

Challenges in Distance Education and Teacher Digital Literacy

In attempting to cultivate post-pandemic digital literacy among elementary school teachers, it is useful to examine the challenges they faced when preparing their courses for online instruction during the pandemic. A review of the literature on this topic has suggested that teachers had difficulties with using digital technologies, with information retrieval when creating or adapting course materials, and with communicating with students.

Pandemic-induced school closures in early 2020 necessitated the use of a variety of technological devices for effective remote teaching, and research has suggested that elementary teachers who possessed prior knowledge and experience with information and communication technologies fared better in adapting their courses to online instruction (Bozkurt et al., 2020; Woltran et al., 2021). However, even younger teachers who were considered digital natives (Prensky, 2001) often did not possess extensive knowledge of digital technologies (König et al., 2020; Kundu & Bej, 2021). This is in line with a body of research showing that very few teachers were knowledgeable about digital education prior to the pandemic (Wu, 2021). This lack of knowledge and experience with regard to digital technologies caused disruptions to the effective delivery of online instruction for a number of elementary educators (Klapproth et al., 2020). Consequently, elementary teachers required training in the use of digital technologies and related teaching methods to ensure the smooth delivery of online instruction (Kundu & Bej, 2021).

The shift to online modes of instruction have often necessitated the creation of new learning materials that students could access online. While the Internet offered an abundance of educational resources for young learners (Hew & Cheung, 2020), elementary instructors often struggled with information retrieval in their

quest to identify pertinent, accurate, and age-appropriate resources. This was because discerning the credibility and authenticity of online sources required high levels of digital and media literacy, and many elementary teachers lack training in these skills (Scull & Kupersmidt, 2011). To address this, Wen and Shih (2008) recommended the incorporation of information literacy training in teacher education programs.

Effective communication is crucial in any educational setting, but particularly so with distance education for elementary students. Elementary school teachers encountered a number of challenges in maintaining clear and engaging communication with their young students through digital platforms. This lack of communication between teachers and students seemed to have negatively impacted students' emotional well-being, as research has shown that elementary students were more likely to report missing their teachers during distance learning as compared to middle and high school students (Holtgrewe et al., 2020). The feeling was mutual, as many teachers reported feelings of missing their students due to the lack of in-person contact during the pandemic (Letzel et al., 2020). Such disruptions to the communications and relationships between teachers and students were cited as a major source of stress for elementary teachers during the pandemic (Anderson et al., 2021). Due to school closures, elementary school teachers often relied on parents for communication with students, which resulted in significant challenges (Ferguson et al., 2021; Kundu & Bej, 2021). This indirect communication method exacerbated teachers' difficulties in trying to maintain open communication and good relationships with large numbers of students (Kim & Asbury, 2020). Therefore, it is fair to say that the closure of schools disrupted or at least weakened the communicative bonds between students and teachers, which were typically a significant source of satisfaction for educators (Colao et al., 2020) and students.

Summary

Extant research has suggested that teachers realize the need to be able to use digital devices, retrieve information, and communicate with students in order to smoothly deliver distance education. For this reason, cultivating teacher digital literacy is important. In order to resolve the difficulties teachers have experienced, technology-related support for the development of digital literacy is needed. Moreover, there has been a need to provide support for teaching and learning method development (UNESCO, 2011) and problem-solving capabilities using digital devices (INTEF, 2020) in order to foster learners' problem-solving skills required in future societies.

Method

Research Procedure

This study consisted of a literature review and a focus group interview to identify the challenges and digital literacy status of teachers in distance learning situations, and to assess and analyse the digital literacy of elementary school teachers in the era of digital transformation. Table 2 outlines the specific research procedure for this study.

Table 2

Research Procedure

Step	Description	Method
1. Review literature and prepare research	Set the research topic and establish the research plan Analyse the digital literacy literature	Literature review
2. Develop interview questionnaire	Develop a semi-structured interview questionnaire	Expert review
3. conduct focus group interviews	Conduct interviews with teachers	In-depth interviews
4. Analyse status and issues	Analyse digital literacy status and issues	Analysis of interviews
5. Deduce implications	Draw implications for improving teacher digital literacy through expert review	Cross-analysis by researchers

In the preliminary phase of the study, the characteristics of teacher digital literacy were explored through analyses of the literature related to distance learning and digital literacy. Second, an interview questionnaire was developed based on the implications of literature reviews. The questionnaire was revised and refined for validity after three rounds of review by five PhD-holders in education, each of whom had more than 10 years of teaching or research experience. Third, focus group interviews were conducted using the developed interview questionnaire. Fourth, the current status and issues related to the digital literacy of elementary school teachers were analysed. Fifth, based on the findings of the literature reviews and the focus group interviews, implications for promoting teacher digital literacy were deduced.

Focus Group Interviews and Analysis

The focus group interviews, which were the core research method of this study, were conducted with five teachers in charge of upper grades in elementary schools. The interviewees were selected by the recommendation of the city and provincial education department officials in charge of distance learning and related tasks. Information on the participants' teaching experience is shown in Table 3.

Table 3

Participants' Teaching Experience

Participant identifier	Teaching experience	Grade taught
A	10 years	4th grade
B	10 years	5th grade
C	11 years	6th grade
D	12 years	6th grade
E	13 years	6th grade

Each interview was conducted via video teleconferencing and took between 60 and 90 minutes. Participant responses were recorded and transcribed with the consent of all participants prior to the interview. The content of the interviews consisted of experiences and challenges related to distance learning, and the status

and issues of teacher digital literacy based on the literature review (see Table 4). The interviews were conducted based on a semi-structured questionnaire, and additional questions were asked, if necessary, without deviating significantly from the research purpose. After transcribing the recordings, each researcher read all the transcripts to identify key concepts and designate themes for each category. Then, the content that fit into the themes of each category were classified, and where disagreements occurred, a consensus was reached among the researchers through cross-analysis.

Table 4

Key Interview Questions

Area	Key question
Understanding and use of technology	What challenges have you experienced with using digital devices and online platforms, and creating digital content?
Search for and administration of information and data	What challenges have you experienced with searching for, understanding, and reconstructing information and data?
Digital ethics and safety	What challenges have you experienced with digital manners, protection of private information, and protection of copyright?
Proactive participation	What challenges have you experienced with communication and collaboration via digital devices?
Digital problem-solving	What challenges have you experienced while helping students solve digital problem using critical thinking?
Digital learning and teaching strategies	What challenges have you experienced with designing and developing distance learning?

Analysis Results of Elementary School Teacher Interview

Understanding and Using Technology

According to the interviewees, students acquired the necessary skills to use digital technology relatively quickly. However, in the lower grades (i.e., grades 1 to 3), students struggled to use various functions and settings of digital technology and teachers afforded substantial support related to these. Prior to COVID-19, teachers used digital devices in their classes based on their own interests, and there was some variation in the use of technology among teachers. Particularly during the pandemic, more experienced teachers (with at least 11 years of experience) had greater difficulty using digital devices and perceived the need for training in the use of various educational applications and programs. In particular, they felt the need for technical skills related to creating learning content and requested more systematic training to promote their content-authoring competency. Some of the interviewees benefited from training on online platforms.

Accordingly, the present analysis revealed that training regarding technology needed to particularly consider more experienced teachers who may have difficulty using digital devices.

> If I don't have an interest in digital devices, I'm not good at using them either. So I'd like to have more chances to strengthen my skills. Especially among more experienced colleagues, there are many teachers who are struggling, so I thought there should be some help. (Teacher C)

> It was not easy to produce learning content or use online platforms. I am learning through online lectures, but I think I need to increase my learning through various trainings because there many things that I haven't done before. (Teacher E)

Search for and Administration of Information and Data

Experienced teachers were found to have difficulties in exploring and managing information and data. In particular, they were found to be unfamiliar with gathering the necessary information and integrating it to make suitable learning materials, and the help of colleagues was found to have a significant impact in overcoming these difficulties. On the other hand, it was identified that teachers experienced difficulties in ensuring that the information they found on their own was, in fact, a useful resource. In other words, teachers needed to improve their media literacy in order to find appropriate information and modify them for educational purposes. One example of fostering teachers' media literacy was to activate teacher communities, thereby promoting voluntary collaboration among fellow colleagues. Furthermore, it was possible to offer teachers opportunities to enhance media literacy by implementing a media literacy course in teacher professional development programs.

> I am not used to creating and managing learning materials using digital devices. So it took so much time, and there were numerous errors. Fortunately, I was able to overcome these difficulties because my capable colleague helped me. (Teacher C)

> I experienced difficulties in making sure that the materials I found were appropriate. Recently, there has been a lot of fake news and inaccurate information, so it was difficult to find the exact materials I needed to make learning materials. I refined and elaborated the information through feedback from my colleagues. (Teacher E)

Digital Ethics and Safety

Regarding digital ethics and safety, teachers reported having the most difficulty with copyright protection when creating content rather than the difficulties related to personal information protection. Although there were guidelines and instructions on copyright, it was difficult for teachers to understand them all, which created difficulties for teachers in creating learning content. In addition, most of the copyright guidelines provided to teachers were not very helpful in creating learning materials in practice. Interviewees recognized the need to provide more specific guidelines.

> I really struggled with copyright when I was creating content, and even though there was a guideline, it wasn't really made up in a way that would help me produce content. (Teacher B)

> I mean, there are always guidelines and instructions about copyright, but I don't think it makes sense for a teacher to teach a class with all those guidelines. (Teacher C)

Proactive Participation

Teachers found it difficult to communicate with students while teaching remotely and constantly checking in with students to see if they were learning, which affected their relationships with students. Impeded communication was identified as a challenge for teachers in managing students' learning, as students found it difficult to focus on the lesson and lost interest due to the lack of physical presence in the virtual classroom. This suggested that it was necessary to apply various tools or interactive teaching strategies to facilitate interaction with learners. Specifically, the teachers reported that they experienced communication difficulties with their students in discussion activities in the Zoom chat box, and they tried to compensate for these by changing the communication style such as using a Google Classroom online discussion forum to create anchored comments.

> Some students in the course participate, but there are some aspects where students don't communicate as efficiently as they did when they were when they were talking in a face-to-face class. . . . I think it was an opportunity for both the teacher and learners to learn a little bit about communication modalities because some of the students said that it would be much better to have a discussion using anchored comments via online discussion forum rather than chatting. (Teacher C)

On the other hand, some teachers had difficulties communicating with parents through online means and other digital devices. These difficulties were mainly due to the problem of parents themselves having difficulty communicating with others through digital technologies, as well as the fact that parents were not enthusiastic about communicating with teachers due to their own work. Moreover, the teachers also felt difficulties communicating with students in distance classes compared to face-to-face classes. Teachers experienced difficulties in delivering their messages clearly to the students and as a result, teachers used multiple channels such as text messages, e-mail, and chat apps to facilitate communication with students.

> In the end, multiple communication channels should be open so that students and parents can choose the ones that they feel comfortable communicating through, particularly with regard to the parents. (Teacher A)

On the other hand, it was found that teachers benefited from collaboration among their colleagues in distance learning situations. In particular, they obtained necessary learning materials through collaboration with teachers in charge of the same grade while producing learning content. Substantial collaborative efforts were made by teachers through active participation within the teaching and learning community, such as coaching activities on class content led by teachers with high digital literacy.

> I was very lucky that the collaboration among the teachers in the same grade was quite good. We didn't use external content, but the teachers in charge of the subject made it themselves. So, we shared it with each other. (Teacher C)

> I was a teacher with above-average digital literacy in my grade. So all of the classes joined with me remotely, and I taught them. Then, I also coached the other teachers. (Teacher D)

Digital Problem-Solving

Despite the fact that teachers perceived that digital literacy helped students solve problems, there were limitations in developing students' digital problem-solving skills in online learning contexts. In the present study, digital problem-solving encompassed the concepts of critical thinking, creative thinking, logical thinking, and computational thinking. The teachers recognized that in order to support students' development of digital problem-solving skills in the era of digital transformation, where the use of digital devices is becoming more common in daily life, teachers should be provided with opportunities to develop digital problem-solving skills of their own.

> Digital literacy is very relevant to developing problem solving and critical thinking skills in students, and as a competency itself, it really helps students develop higher-level skills. (Teacher D)

> In terms of whether or not students are developing digital literacy or problem-solving skills, I don't think so. I think that in order for students to develop digital problem-solving, teachers' digital problem-solving plays an important role, and I don't think there are many opportunities for teachers to develop digital problem-solving. So I think there needs to be more opportunities for that. (Teacher E)

Digital Learning and Teaching Strategies

Teachers attempted to effectively design, develop, and implement their distance learning classes, but they experienced difficulties in enhancing students' sense of learning presence and in promoting learning motivation. Teachers promoted learners' participation by asking questions and applying peer assessment in group activities.

> I think that's where we have to get some feedback from the students in the form of questions and answers. . . . We have to make them aware that there's a group, even in a distance learning situation. . . . I think they're more engaged when they feel like they're being evaluated by their peers. (Teacher B)

On the other hand, when designing distance learning, teachers recognized that it was necessary to use more teaching strategies that promote interaction, such as exchanging opinions and discussion activities. In addition, they acknowledged that the quality of distance learning depended largely on the competence of individual teachers, and they made great efforts to participate in relevant education programs or to learn various teaching strategies related to distance learning.

> I think that teaching students how to express themselves through chat and social media is quite meaningful in terms of learning how to communicate in this era. (Teacher E)

> Of course, there are some things that I just found by myself, but . . . I think I was able to learn a great deal through education programs, information, and materials that other teachers provided. (Teacher E)

Teachers recognized the need to apply the most appropriate instructional methods based on the characteristics of each grade level. For example, they said that the effectiveness of content-oriented classes and synchronous classes may vary depending on the grade, and they recognized that the most effective teaching method should be determined by considering the developmental process of each grade. In particular, it was difficult to conduct synchronous classes for lower grades because their concentration and cognitive skills were lower than those of upper grades. Teachers responded that effective teaching methods may vary not only by grade level but also by subject matter. In other words, they recognized that some domains are better taught through real-time interactivity while others are better taught through content-oriented instruction, and they used the most appropriate method for the subject matter. This result suggested that it was necessary to vary teaching methods that considered not only learner characteristics but also domain characteristics.

> I think the teaching method should be differentiated according to the grade level. For example, first and third graders have very different developmental levels, so the teaching method should be designated considering the grade level. (Teacher A)

> Depending on the subject and the content characteristics, some classes are more efficient with real-time delivery, and other classes are better with asynchronous delivery. (Teacher D)

Discussion

Digital Literacy Challenges Faced by Elementary School Teachers

The purpose of this study was to analyse the experiences of elementary school teachers regarding digital literacy in the context of distance learning, and to derive insights for fostering teacher digital literacy to support students' digital literacy. The implications derived from the research results were as follows.

First, the concepts of understanding and using technology, the basis of digital literacy, have been emphasized in in the literature even before the COVID-19 pandemic. However, elementary school teachers still experienced difficulties in their understanding and use of technology. Specifically, elementary school teachers faced minimal challenges in basic digital device use but had more serious difficulties in using online learning platforms and creating learning content. This implied that elementary school teachers had the basic skills to use technology but did not have sufficient capacity to apply technology to enhance distance learning. Meanwhile, elementary school teachers also experienced difficulties in the search for and administration of information and data. This proficiency, essential for developing learning content, has been considered a foundational skill required for preparing remote classes, alongside competence in using technology. Therefore, to facilitate teachers' digital literacy, it is essential to establish a systematic competency education framework that emphasizes the fundamental aspects of digital literacy, including

understanding and using technology (Kundu & Bej, 2021), as well as exploring and managing information and data (Wen & Shih, 2008).

Second, digital ethics and safety encompassed digital etiquette, personal information protection, copyright preservation, and digital identity. However, elementary school teachers primarily encountered the most significant challenges in comprehending and abiding by copyrights laws. Copyright laws are an essential element that must be adhered to when creating digital content (Campidoglio et al., 2009). The government required copyright adherence when procuring, creating, and adapting educational materials, and they provided teachers with guidelines. Without clear guidelines on copyrights, producing high-quality learning materials becomes challenging; learning content that does not abide by copyright laws has restrictions on its use. For example, to produce video learning content containing human faces for learning purposes, prior consent to use copyrighted human images is required. This means that not only technological proficiency but also comprehension and use of copyrights influence the creation of learning content.

Third, the difficulty of interaction, reported as a disadvantage of distance learning, was also experienced by the teachers who participated in this study. In particular, as suggested in previous research (Kruszewska et al., 2022), there were communication difficulties due to the lack of smooth interaction between students and teachers. This issue was also connected to digital learning and teaching strategies. Specifically, it was necessary to apply teaching strategies that promoted active interactions with students (Tsai & Machado, 2002). Given that elementary school teachers experienced difficulties in employing various digital teaching and learning methods, teachers must develop the ability to use teaching activities and methods that can be effectively used in distance learning in order to strengthen communication between students and themselves. Examples included the use of online discussion boards (Hsieh, 2017; Fanguy et al., 2023) and the Zoom chat box (Nash et al., 2023) to facilitate discussion of course content, as well as pop quizzes (Salas-Morera et al., 2012) to measure students' comprehension of course contents.

Fourth, digital problem-solving has emerged as a component of digital literacy that has attracted recent attention (UNESCO, 2018). Teachers often experienced challenges in solving problems using digital devices based on critical thinking, creative thinking, logical thinking, and computational thinking. Despite recognizing that digital literacy aids students in digital problem-solving, teachers have encountered challenges in guiding the cultivation of students' digital problem-solving abilities. It can be assumed that this has been due to the lack of sufficient teacher competence in digital problem-solving. Therefore, there is a need not only to enhance teachers' digital problem-solving skills but also to support the development of students' digital problem-solving abilities through various instructional methods.

Implications for Fostering Digital Literacy Among Elementary School Teachers

The findings from this study suggested several implications with regard to enhancing teacher digital literacy in order to support students' digital literacy. First, to enhance their own digital literacy in the context of distance learning, teachers require strengthening in their use of a range of digital devices. The ability to use digital devices is one of the most basic components of digital literacy. As students engage in distance learning using various digital devices, teachers need advanced skills that go beyond simply handling and using computers such as such as the ability to log in to Web pages, upload data, and navigate Websites. This proficiency level needs to include the use of various online platforms and content creation using digital

devices. In addition, teachers must be able to assist students who encounter difficulties with digital devices. The results suggested that teachers must strive to deepen their understanding and use of digital devices.

Second, it was evident that strengthening both online and offline networks among teachers for sharing information, resources, and instructional strategies is essential. In the context of COVID-19 remote teaching, teachers collaborated to share diverse materials and instructional approaches for distance learning, thereby providing mutual support. While teacher collaborative communities took various forms during the pandemic, there is a need to systematically organize and operate these networks to enhance their effectiveness. Notably, the interview findings of experienced teachers underscored the substantial assistance gained through teacher collaboration, particularly in content creation and use of online platforms. This highlighted the need to establish a systematic network framework to foster a self-sustaining ecosystem for distance education through teacher collaboration.

Third, regarding digital ethics, the results suggested that the provision of accurate guidelines related to digital copyright protection and related training are necessary. Elementary school teachers indicated that they experienced many difficulties in creating digital learning content. One of the reasons for this is that elementary school teachers were not technologically proficient, but another was their lack of knowledge regarding copyright laws. Therefore, it is necessary to create more sophisticated copyright guidelines in order to train teachers to use copyrighted material in an ethical manner.

Fourth, there is a need to expand professional development opportunities in digital pedagogy to enable teachers to select and apply suitable digital teaching methodologies for the educational context. Teachers perceived that effective instructional strategies varied, based on the nature of the curriculum, and accordingly, they chose content-centred instruction or real-time interactive sessions tailored to their educational circumstances. Considering that the required teaching and learning strategies differed according to the types of lessons, such as theoretical, discussion-based, or experimental lessons, it is necessary to consider ways to expand opportunities for digital pedagogy training to teachers so they can apply effective instructional strategies suitable for educational settings (Doucet et al., 2020). It was also evident that customized digital pedagogy training, considering students' characteristics, is crucial to support individualized education.

Fifth, there is a need to enhance teachers' digital problem-solving competencies to support students in cultivating the essential skill of digital problem-solving demanded by future societies. Despite recognizing the significance of improving students' critical thinking, creativity, logical reasoning, and computational thinking abilities, teachers faced challenges in effectively fostering students' digital problem-solving skills. Given the recent expansion of coding education and the emphasis on learner-centred instruction, providing opportunities for educators to enhance their own digital problem-solving competencies is crucial to effectively nurture students' digital problem-solving abilities.

Conclusions

The purpose of this study was to analyse the experiences related to digital literacy among elementary school teachers in the context of remote teaching, and to derive insights for enhancing teachers' digital literacy to support students' digital literacy. The research findings revealed that elementary school teachers encountered difficulties in students' digital device-related problem-solving, designing digital problem-solving lessons, and facilitating communication between students and teachers within the remote teaching scenario. Additionally, teachers recognized the need to overcome these challenges through enhancing teachers' technological competencies, strengthening digital pedagogical approaches, and establishing and activating networks among teachers. The significance of this study was that it explored the digital literacy difficulties of elementary school teachers who experienced online education during the pandemic and revealed what support was needed to cultivate teacher digital literacy. Furthermore, given that elementary school students experienced many difficulties during pandemic-induced distance education, this study extracted insights for improving elementary school teachers' digital literacy to teach elementary school students. However, it is important to note that the interview sample was limited to five participants in charge of upper grades. Although this study included a small number of subjects, this sample size is common for this type of research (e.g., Hara, 2000; Lee, 2018; Pathak et al., 2011). Future research should include teachers in charge of lower grades in order to provide more comprehensive and in-depth research results.

Despite these limitations, this study will be of value to practitioners, as well as the administrators, because it brings to light the difficulties experienced by elementary school teachers providing distance education during the COVID-19 pandemic: (a) understanding digital copyright, (b) guidance with digital problem-solving, and (c) using various digital teaching methods. Given that various forms of blended learning have become more common since the pandemic, the results of this study are expected to help improve teacher professionalism for blended learning, specifically with regard to the online instructional components. This research not only reinforced the findings of previous studies by delving into the difficulties and obstacles of remote teaching but also provided practical insights into enhancing digital literacy, a topic that has garnered recent attention.

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Exploring the Feasibility of Deploying Technology Enhanced School-Based Teacher Continuous Professional Development in Internet-Limited Environments in Tanzania

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Abstract

In low-income countries, the use of technology to enhance teacher continuous professional development (TCPD) activities has been increasing significantly. However, most technology initiatives related to TCPD require the installation of complex information and communications technology (ICT) infrastructure in schools or availability of reliable Internet connectivity. While installation of ICT infrastructure is costly, the cost of the Internet is unaffordable to most teachers in low-income countries. This study explored the feasibility of deploying Raspberry Pi computers and tablets as micro-servers to facilitate school-based TCPD activities via a learning management system (LMS) without Internet connectivity. Teachers in eight schools in Dar es Salaam and Lindi accessed a TCPD sample module with Raspberry Pi and tablets providing hotspotting and treated as offline local servers hosting a LMS. After the trial, data was collected through focus group discussion, observation, and LMS logs involving 69 teachers. The findings showed that both Raspberry Pi and tablets could be used as micro-servers to provide access to learning resources in offline environments, but Raspberry Pi fared more favorably. Raspberry Pi was easy to set up and connected more devices than did the tablet. However, Raspberry Pi required careful handling as it is a delicate device. Interestingly, there was no significant difference in terms of the performance and cost of the two micro-servers. This study provided further evidence that both Raspberry Pi and tablets could be cost-effective approaches to deliver TCPD activities without installing complex ICT infrastructure or in areas with limited Internet connectivity.

Keywords: teacher continuous professional development, TCPD, Raspberry Pi, Internet-limited environment, learning management system

Exploring the Feasibility of Deploying Technology Enhanced School-Based Teacher Continuous Professional Development in Internet-Limited Environments in Tanzania

Effective teacher continuous professional development (TCPD) has been a driving force for improving teaching quality and, therefore, learning outcomes for children in low-income countries (Hennessy et al., 2022). This has been reflected in many countries' education sector development plans. In Tanzania, several TCPD reforms, models, transformations, and innovations have been implemented in the last five decades. These reforms can be traced back to macro-policies and education transformations such as the Arusha Declaration on socialism and self-reliance, Education for Self-Reliance (ESR), the Musoma Resolutions, the resolution on Universal Primary Education (UPE), and the Big Results Now Development Programme (Dachi, 2018)

The majority of these TCPD reforms have relied on traditional approaches such as the use of workshops, seminars, and conferences taking place in various places in the country (Komba & Mwakabenga, 2019). These approaches had significant drawbacks. For instance, they required that teachers travel and physically attend these activities (Komba & Mwakabenga, 2019). As many teachers' days were already filled with teaching and administrative responsibilities, squeezing time out of their busy schedule to attend TCPD activities has been a challenge (Kim et al., 2014). In addition, traditional TCPD approaches tended to occur separate from the realities of school or classroom challenges and therefore rarely focused on teachers' specific needs (Komba & Mwakabenga, 2019). These drawbacks and many others have led to the poor outcomes from TCPD programs in many low-income countries (Popova et al., 2022).

Recently, the Government of Tanzania, in collaboration with various partners, especially the Education Program for Results and the World Bank's BOOST component, has been implementing a school-based TCPD model for Tanzania's basic education sector. The primary delivery mode was school-based communities of learning supplemented with workshops, coaching and mentoring, and self-learning modules. This enabled teachers to come together in groups, each with a facilitator, to undertake semi-structured discussion and activities aimed at improving teaching and learning activities. This approach included activities such as reflecting on teaching and learning, sharing best practices, and creating new knowledge to advance the domain of professional practice.

While recognizing the improvement of information and communication technology (ICT) infrastructure and penetration of mobile technologies, the government complemented the school-based TCPD with various technologies including a learning management system (LMS) and e-library. The LMS facilitated teachers' self-learning and provided content and support for peer facilitators to facilitate TCPD sessions. It also acted as a content repository; teachers downloaded the TCPD materials to access them offline or for printing. Separately, the e-library also acted as a content repository, where all current relevant resources were uploaded and accessed by teachers as part of TCPD activities.

It should be noted that the LMS and e-library required digital devices, Internet access, and a power source. These infrastructural needs were not evenly distributed across the country; some regions had low or intermittent Internet access and electrical power. Although the TCPD resources were available via the LMS,

many teachers may not have been able to access them due to the cost of Ihe internet or lack of Internet connectivity.

It was important to explore the feasibility of teachers accessing TCPD resources without incurring Internet cost or relying on availability of Internet connectivity. LMS have been implemented in offline environments such as Moodle Mobile, and MoodleBox (Ncube et al., 2020; Ngom et al., 2012) and the use of Raspberry Pi (Dhuny et al., 2022; Ibarra et al., 2017). Nonetheless, Moodle Mobile required users to connect to the Internet first, before accessing the downloaded learning resources offline. This made it unsuitable in areas with no Internet connectivity.

The use of Raspberry Pi as a micro-server to provide offline LMS access has shown great potential in several contexts (Dhuny et al., 2022; Ibarra et al., 2017). These studies and others have compared the performance of LMS in various Raspberry Pi models. However, a comparison of performance in implementing LMS in an offline environment with other types of devices, such as tablets which have more storage and power capacity, has yet to be done.

This study explored the feasibility of deploying Raspberry Pi computers and tablets as micro-servers to facilitate school based TCPD activities; the activities used a LMS hosted on a local area network (i.e., without Internet connectivity). The main questions that were addressed included:

- How does the performance and effectiveness of Raspberry Pi and tablets as servers compare when running LMS?
- What is the feasibility of using LMS deployed on a tablet or Raspberry Pi for TCPD activities in a school environment?

The micro-servers were deployed for LMS access in eight schools in Dar es Salaam and Lindi for a duration of two days. After the trial, data was collected through focus group discussion, observation, and LMS logs involving 69 teachers. This study provided further evidence that Raspberry Pi and tablets could be a cost-effective approach to deliver TCPD activities without installing complex ICT infrastructure or computer labs in schools. We expected the findings from this work to inform the future provision of the most cost-effective and efficient technology options for implementing TCPD in Tanzania and beyond.

Literature Review

Using Technology for Teacher Professional Development

The last two decades have seen a growing adoption and use of various technologies to enhance the quality of TCPD activities in low-income countries (Hennessy et al., 2022). Whereas traditional professional development programs in the form of face-to-face training sessions proved to be expensive, due to the costs of the resource-intensive training and the time and travel needed for teachers, technology supported TCPD has been far more cost-effective (Dhuny et al., 2022). The use of technologies such as audiovisual media, mobile devices, and LMS have been used to offer virtual coaching and messaging for teachers, especially in

remote areas, thus reducing the cost of TCPD activities (Hennessy et al., 2022). For instance, in South Africa, a virtual coaching model proved to be inexpensive and effective in improving teachers' instructional practices and learners' proficiency in English as an Additional Language. Lesson plans and other resources were shared with teachers on tablets across 180 schools in low-income communities (Kotze et al., 2018).

The use of technology-supported TCPD can also reach teachers who are located in remote areas. With mobile network coverage rapidly expanding in most low-income countries, extending TCPD activities into communities that are difficult to reach via traditional face-to-face TCPD has become possible (Hennessy et al., 2022). In Nigeria, for instance, UNESCO implemented a project to develop the pedagogical practices of teachers to improve student outcomes in English language and literacy (McAleavy et al., 2018). Nearly 50 teachers received training with Nokia handsets to provide access to learning resources. McAleavy et al. (2018) concluded that it was possible to help hard-to-reach teachers access materials that engendered positive pedagogical changes and improved learner outcomes.

TCPD supported by technology has potential to improve teaching quality and student learning outcomes (Hennessy et al., 2022). It has proven effective in improving the skills of both established and newly trained teachers in places where both the quality and quantity of teachers are insufficient (McAleavy et al., 2018).

Despite the benefits of technology in supporting TCPD activities, some technology requires ICT infrastructure in schools, Internet access, and electrical power. Like many countries in the developing world, ICT infrastructure in primary schools in Tanzania is underdeveloped, with some schools having low or intermittent access to Internet connectivity and power. Therefore, investigating the use of technology in accessing technology enhanced TCPD activities in an offline environment is important. Next, literature related to the LMS customized for TCPD activities in Tanzania is explained in detail.

Learning Management System in Offline Environment

One of the biggest challenges of deploying LMS to support TCPD activities in school-based environments in low-income countries has been low or intermittent access to Internet connectivity and power. Several attempts have been made to ensure that users access the system without having to be connected to the Internet. Mobile Moodle enabled users to access learning resources offline. However, users had to first connect to the Internet to download learning resources before accessing them offline. In this case, using the mobile Moodle still required Internet access.

Ngom et al. (2012) configured an offline Moodle system based on three client-side modules: Java, Iperf, and Moodle. The Java client module was the client-side main process unit that managed installations, updates, and uploads to the server. The Iperf client module gave information about the connectivity state between client and server. In addition, four server-side modules: Java, Iperf, SMS, and Moodle were implemented. The Java server module acted as the server-side main process unit preparing updates for clients and end-user SMS notifications. The Iperf server communicated with the Iperf client about the connectivity state. The SMS module sent information about resources and activities updates to end users who were not connected full time. The Moodle Server module stored the resources and course activities. Nonetheless, like mobile Moodle, this solution required Internet connectivity to synchronize data to the

central server for updating the learning activities and resources, which made it unsuitable in areas where there was no Internet connectivity.

Raspberry Pi has been adopted to provide learners access to learning resources in offline environments. Ginting et al. (2020) implemented Raspberry Pi as a portable Moodle class application to provide access to lectures in an offline environment. Similarly, Patel et al. (2018) configured Raspberry Pi with a Wi-Fi router to deliver free educational content to school children in rural areas. Nonetheless, in both studies, the proposed solutions were not tested with actual users and courses.

Recently, Moodlebox has been popularly used as a stand-alone mobile device to implement Moodle LMS without the Internet, combining a wireless access point with a fully featured Moodle server. Specifically, MoodleBox has been built around a mini-computer (Raspberry Pi Zero W, Zero 2 W, 3A+, 3B, 3B+ or 4B) and the Moodle learning environment. It supported about 20 to 30 users in a learning environment without the need for heavy setup (Ncube et al., 2020). MoodleBox has been adopted and used in various contexts to provide access to the Moodle LMS in an offline environment.

For instance, Ndassimba et al. (2021) deployed MoodleBox in elementary school classes in conflict zones in Central Africa where students were assisted by teacher-parents who accessed the platform through tablets. Each student was equipped with a tablet that allowed them to connect to the digital elementary school platform via Wi-Fi. Similarly, Ncube et al. (2020) adapted MoodleBox in virtual learning environments integrated with adaptive testing functionalities for grade 12 learners. The aim of the project was to increase learning effectiveness for learners in remote villages by allowing them to browse learning content and do assessments offline. It was found that personalized learning enhanced learning effectiveness in terms of self-efficacy.

However, we noted that initiatives such as MoodleBox have mainly focused on provision of software, albeit for specific devices. While the deployment of the devices was for offline use, the setup and maintenance of the devices assumed a nearby-Internet scenario. In other words, the device was prepared with full access to the Internet, and then deployed in a nearby location offline, typically with reliable electrical power. If the device acquired a software fault (e.g., due to power failure) it was easily put back online and recovered. African schools are typically not nearby-Internet. Therefore, the choice of device is not just a software/hardware combination; factors such as durability, power management, and fault tolerance need to be considered. Moreover, operation and maintenance need to be as simple as possible.

Methodology

Testing Scenarios

Low-spec tablets and Raspberry Pis were used as offline micro-servers hosting the Moodle LMS. To ensure these servers were on and active during the testing period, the servers were connected to solar power banks instead of directly to electricity. The set of devices used, and their software stack, are shown in Table 1.

Table 1

The Set of Devices Used and Their Software Stack

Type	Model	Operating system	Software stack
Single-board computer	Raspberry Pi 4 B (Broadcom BCM2711, Quad core Cortex-A72, ARM v8, 64-bit SoC @ 1.5GHz; 4GB)	Raspbian Debian version: 10	Apache2 PHP 7.4 MariaDB Moodle 3.11
Tablet	Galaxy Tab A8 (Octa-core 2x2.0 GHz Cortex-A75 & 6x2.0 GHz Cortex-A55, 3GB, Hard drive: 32GB)	Android 11 + Termux	Apache2 PHP 7.4 MariaDB Moodle 3.11

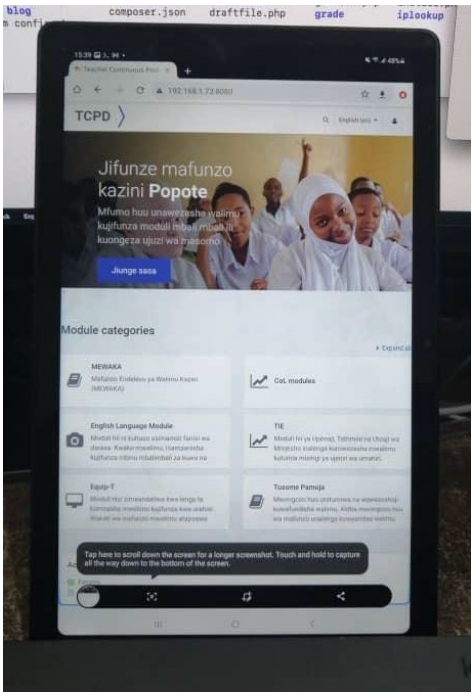
The team tested two scenarios, one where the micro-server was a Raspberry Pi and another where it was a tablet. In each scenario, teachers were asked to log in into the LMS and access a sample module (Upimaji na Mrejesho, Assessment and Feedback) using their smartphones. As part of testing multimedia content, each module had an introduction video, and units with at least three images each. Teachers accessed the LMS using hotspots that were provided by the micro-servers. A detailed description of each scenario is provided next.

Scenario 1: Using a Tablet as a Server

In this scenario, the low spec tablets were treated as the servers. These low spec tablets ran the Android operating system, a heavily modified version of Linux. The LMS could not be installed directly on the device. To allow the installation of the LAMP stack and Moodle LMS, each tablet was configured with a specialized software, Termux. This terminal emulation software allowed the installation of Linux on an Android device. In this scenario, it provided a full-fledged console window and file system that supported the installation of all the components and packages needed by the Moodle LMS. Through the console, LAMP packages including Apache, PHP, and MariaDB were installed on the tablet. Apache and PHP were then configured to allow the tablet to run as a local web server. Moodle files backed up from the online server were imported to ensure the same functionality was provided by the local server. Similarly, MariaDB was also configured and data from the live server was imported to restore the state of the online LMS. Figure 1 shows the Moodle LMS running on the tablet as a server.

Figure 1

A Low Spec Android Tablet Running Moodle Locally



After installing the LMS, the next step was to ensure the local LMS was accessible over a local Wi-Fi network. The tablets had hotspot functionality to act as access points for a local network. The Wi-Fi name and password for the local hotspot was configured on the devices. The tablets were also configured with static IP addresses to prevent address changes during the testing period. After configuration, the hotspot was activated so other devices could access the LMS by searching for the Wi-Fi name, entering the password, and connecting via the browser using the tablet's IP address.

Scenario 2: Using Raspberry Pi as a Server

The Apache2 Web server, PHP, and MariaDB were installed on the Raspberry Pi. The existing LMS with a sample module was then deployed on this server environment. Host Access Point Daemon (Hostapd) and dynamic host configuration protocol (DHCP) were then installed, and a hotspot was configured to allow Raspberry Pi to create and share its own local network. As for the tablet, the Raspberry Pi was also connected to a power bank which enabled it to be moved around easily without losing power, as shown in Figure 2.

Figure 2

Raspberry Pi 400 Set up as a Server in a School

Study Design

The study was conducted for two days in each of the selected schools. On the first day, the servers (Raspberry Pi or tablet) were installed at a given school. At the same time, teachers were provided the link to access the LMS and they were shown how to log in and access the sample module. To enable teachers to use the system more intensively, the servers were left at the school all day. The second day was dedicated to collecting the data through focus group discussions, observation, and data logs. Each server (Raspberry Pi or tablet) was tested in two schools per region, a total of eight schools for the whole study.

Sample Module

The Upimaji na Mrejesho module was used to test the LMS. The module consisted of 12 units, and each unit contained a quiz with five questions. The module also had a survey, a video in the introduction unit, and images in various units. Figure 3 shows the screenshot of how the Upimaji na Mrejesho module appeared in the LMS. The top menu contained links to the 12 units, and the last link went to a survey.

Figure 3

Screenshot of Upimaji Na Mrejesho Module in the LMS

Data Collection Instruments

The study used observation and data logging to collect data. The combination of observation and logs from the LMS enabled the team to observe areas where teachers struggled with specific system design and areas where the system worked well. In areas where the aspects of the design were problematic, follow-ups were conducted to get insights into the specific issues that teachers experienced.

The performance of the Raspberry Pi and tablet servers were investigated through analyzing the usage data from the LMS log file. The description of each data collection instrument follows next.

Observation

The effectiveness of the tablet and Raspberry Pi servers in providing hotspotting for other devices was investigated through observation. In general, we observed how many devices connected to the hotspot successfully, and how many devices experienced problems when connecting to the hotspot.

Log Data

As teachers accessed the system and navigated through the sample module, the LMS kept records of all users activities in the form of a log. The LMS logs were extracted and used to compare the effectiveness of the three server configurations. More specifically, the log data was used to determine the number of teachers who (a) completed the quizzes, (b) completed the survey, and (c) viewed the videos.

Participants

A total of 69 teachers from 8 schools (40 from 4 schools in Dar es Salaam and 29 from 4 schools in Lindi) participated in the study. The schools were purposely selected, considering both urban and rural areas with different socio-economic contexts. The distribution of respondents per each region is shown in Table 2.

Table 2

Distribution of Respondents

Region	School	Number of teachers
Lindi	Chiuta	6
	Nyangao	9
	Namangale	8
	Likolombe	6
Dar es Salaam	Toangoma	8
	Mbande	10
	Nzasa	12
	Majimatitu	10

Findings

Comparing Raspberry Pi and Tablet Servers

The effectiveness of the two micro-servers (Raspberry Pi and tablets) were compared in terms of number of devices connected to the hotspot successfully, and maximum distance/range that the hotspots covered. The findings of each parameter are explained next.

Maximum Number of Devices Connected

No formal studies have reported the maximum number of devices that can practically be supported by Raspberry Pi as a hotspot. However, various reports from the Internet indicate a maximum of 32 devices for both the Raspberry Pi 3 and Raspberry Pi 4 (Cloutier et al., 2014). . In this study, it was possible to simultaneously connect 16 devices in one school (simultaneously in Nzasa primary school) using Raspberry Pi. In the other schools, especially in Lindi, the number of teachers was quite low (ranging from six to nine)

so all teachers were able to connect successfully, and the number of connections supported was not an issue. Although it was possible to connect up to 16 devices, the number depended on the IP range set when configuring the hotspot.

According to Google's documentation, by design, an Android device that acts as a Wi-Fi hotspot can support a maximum of 10 devices only (El Alami et al., 2017) . Our testing confirmed that this was correct—for the devices and Android version tested, the hotspot declined additional connections once 10 devices were connected.

Despite these findings, two devices connecting to Raspberry Pi experienced problems as the system loaded too slowly. This happened in two schools—Nzasa primary school and Chiuta primary school. Upon troubleshooting, it was found out that whenever the mobile data of the phone was turned on, the LMS loaded very slowly as it tried to fetch some plugins and information online before resorting to those available offline. This problem was solved by disabling mobile data when using the offline version of LMS.

Management/Handling of the Micro-Servers

While the Raspberry Pi was usable in all the four schools, there were some challenges related to its handling. These need to be addressed if Raspberry Pi is to be used in a real environment. In one of the schools, when the Raspberry Pi was left for one day, it did not work the next day. After troubleshooting, it was discovered that the secure digital (SD) card that hosted the operating system was corrupted and this made it boot in a read-only mode; as a result, the DHCP server and other applications could not be fully started. To fix this problem, the SD card was mounted in read/write mode and the issue was fixed. The fault was attributed to abrupt power on and off or shifting the Raspberry Pi since it was moved from the teachers' staff office to the headmaster's office, and to another hall the second day.

The comparison of tablet and Raspberry Pi as servers in various observed parameters is summarized in Table 3.

Table 3

Comparing the Effectiveness of Two Servers in Providing Hotspotting

Parameter	Tablet	Raspberry Pi
Maximum number of devices that connected successfully	10	16
Number of devices that presented problems	–	2

Feasibility of Deploying a Moodle Server on a Tablet and Raspberry Pi

The feasibility of deploying TCPD activities in an offline environment on a tablet and Raspberry Pi as Moodle servers were compared in terms of ease of setup, reliability, performance, scalability, and cost. The comparison of each metric follows next.

Ease of Setup

While it was possible to deploy the TCPD LMS on both Raspberry Pi and the tablets, in terms of ease of setup, Raspberry Pi was the easiest since it used standard Linux packages with little to no tweaking required. However, for the tablets, it was necessary to add several applications and configurations before the tablet was operable as an Apache server.

Reliability

In terms of reliability, both Raspberry Pi and the tablets had weaknesses. For Raspberry Pi, in one school, the SD card became easily corrupted making the LMS inaccessible until it was fixed. This was an alarming problem since in the ideal situation, the Raspberry Pi would be left at the schools for teachers to use. Teachers did not have the technical knowledge to address or fix such difficulties; it was necessary for an IT person to go to the school. Another reliability challenge was observed during the installation phase where the Raspberry Pi was accidentally dropped and the card reader was broken. Clearly, Raspberry Pi was quite delicate and when used in a school environment, care was needed with how it is switched on and off, and how it is transferred from one location to another.

A minor reliability issue was experienced when the tablet went into sleep mode causing the Apache server to stop. This was fixed by waking the tablet and restarting the Apache server. Restarting the Apache server required some technical knowledge since it was done via the command line and was difficult for the teachers to do. However, a solution to this problem was to disable the sleep mode. If the tablet ran out of charge and shut down, it needed to be recharged for some time and restarted. Once switched on, the same process of restarting the Apache server needed to be performed.

Performance

From a user's perspective, both the Android tablet and Raspberry Pi showed comparable performance results. Teachers who accessed both devices did not detect any noticeable delays in response time while opening different pages in the LMS. Since the system was being accessed locally, every page could be opened in a few seconds. During the test, no page exceeded the maximum acceptable delay for Web applications (i.e., 2000 ms). Similarly, throughput performance was also comparable. Both devices were able to support concurrent access from all teachers. No device showed any noticeable slowdown in performance as the number of connected users increased. Even at the maximum when all teachers were connected all pages were still responsive. This included pages with heavy content such as videos and many images. The only limitation was the number of users that could simultaneously connect to the wireless hotspot.

Cost

In terms of cost, Raspberry Pi was cheaper than the Android tablet. However, to successfully configure the micro-server setup, Raspberry Pi required additional devices such as a screen, mouse, and keyboard. Had these devices not been available, they would have entailed additional costs. Table 4 below compares the prices of the two devices.

Table 4

Cost Comparison: Tablet and Raspberry Pi

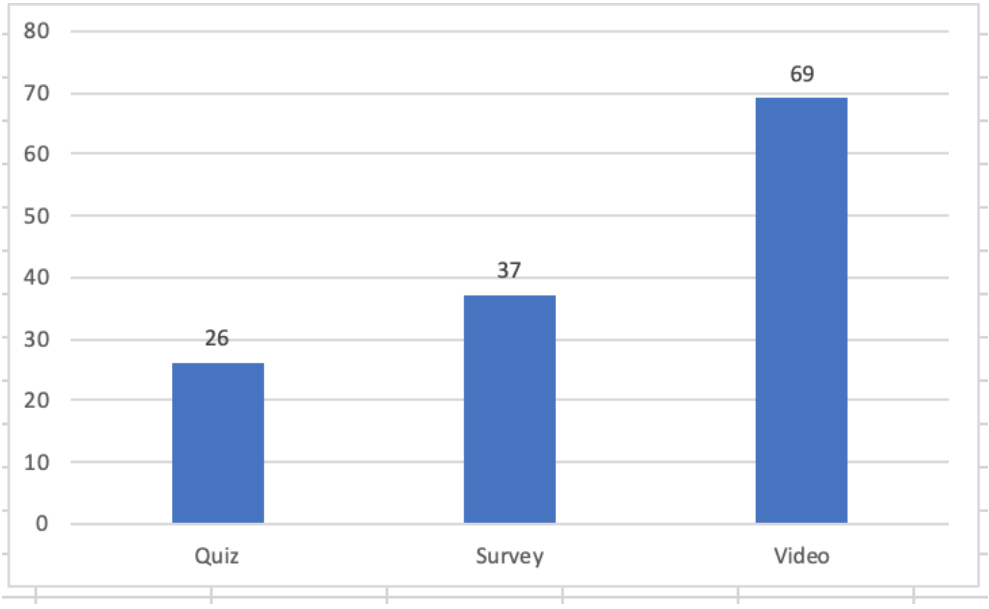
Category	Specifications	Price (Euros)
Android tablet	Samsung Tab A7, 10" (3GB/32GB)	297
Raspberry Pi	Raspberry Pi 4 B (4GB)	€175.23

Teachers Access to the LMS to Support TCPD Activities

Teachers' access to the LMS was investigated through assessing the number of teachers who completed the quizzes, survey, and the number of teachers who viewed videos. As pointed out earlier, the Upimaji na Mrejesho module was used as a sample. Teachers were asked to navigate from Unit 1 to Unit 12 (including playing the videos) and do a quiz at the end of the module. The data from the log file showed that nearly all teachers were able to view the introduction video while 26 out of 69 teachers completed all quizzes, accounting for 38% of the teachers. The findings also showed that 54% of teachers (37 out of 69) completed the survey, as shown in Figure 4. This indicated that even though the micro-servers were left in the schools for just one day, the teachers had time to interact with the sample module.

Figure 4

Distribution of Teachers per Completed Activity



Discussion

This study explored the feasibility of using offline LMS with Raspberry Pi and tablets as micro-servers to facilitate TCPD activities in schools. The low spec tablet and Raspberry Pi were treated as offline servers hosting the LMS and provided hotspotting in eight schools in Dar es Salaam and Lindi. The Upimaji na Mrejesho module was adopted as a sample for teachers to access learning resources via their smartphones.

This section provides a discussion of the results and answers the two research questions which are:

- How does the performance and effectiveness of the Raspberry Pi and tablet as servers compare when running LMS?

- What is the feasibility of using LMS deployed on a tablet or Raspberry Pi for TCPD activities in a school environment?

There was no significant difference in terms of the performance of the two micro-servers; teachers did not detect any noticeable delays in response time while opening different pages in the LMS. In fact, no page exceeded the maximum acceptable delay for Web applications (i.e., 2000 ms) and the throughput was comparable.

With respect to the feasibility of using micro-servers for offline deployment of learning management systems to facilitate TCPD activities in schools, our discussion is structured by two main themes, namely technical and logistic feasibility.

Technical Feasibility

Comparing Raspberry Pi and the tablets as servers showed that they both had weaknesses in providing hotspotting to support TCPD activities and therefore can be adopted and implemented conditionally. However, Raspberry Pi offered a better option in many regards. For instance, Raspberry Pi supported up to 32 devices compared to the tablet which was limited to 10 devices. Therefore, in schools with more than 10 teachers, Raspberry Pi would be a preferable option.

Setting up Raspberry Pi as a server was easier than setting up a tablet. Since many teachers were not prepared to deal with many IT solutions, having a device that they could easily set up without having technical skills was important. In this case, Raspberry Pi was preferred as a server compared to the tablet. However, the Raspberry Pi required careful handling as it was a delicate device compared to the tablet. In this study, in one school the SD card was corrupted while in another school, the Raspberry Pi was accidentally dropped resulting in damage to the card reader. In both cases, the LMS was unavailable until it was fixed. This finding showed that if Raspberry Pi is preferred as a server hosting the LMS for TCPD activities, care must be taken switching it on and off, and transporting from one location to another.

Logistics of Deploying LMS Via Offline Micro-Servers

From our results, two logistical aspects were important to make the deployment of offline servers successful. The first was where to locate the micro-server. As discussed earlier, Raspberry Pi, while able to support more users, proved to be more delicate especially when switched on and off randomly. We therefore suggest

that the micro-servers be located in a specific place. This could be a simple dedicated box with a power supply to ensure the device is well protected and not moved around randomly. The selection of where the micro-server should be placed also needs to ensure that the device is accessible by all teachers, as the hotspot coverage had a radius of about 100 meters. While we did not have any accidents leading to physical damage of the tablets, we foresee a similar situation if the tablets are not well handled. If tablets are used, we recommend that they should be protected with strong covers and placed in safe locations.

The second logistical aspect concerned the cost of the devices, with Raspberry Pi slightly cheaper than a tablet. However, the cost difference is reduced if you include devices to configure Raspberry Pi as a server (e.g., screen, mouse, keyboard). Therefore, the use of Raspberry Pi or tablets as micro-servers to facilitate TCPD activities should not be based on the cost. Other parameters need to be considered, such as the number of teachers present at the school and whether there is an ICT expert at the school.

Limitations of the Study

The study had two main limitations. The first was the amount of time the devices were used in the schools. Teachers had just two days to interact with the devices, so potential issues that could arise due to long-term use of the devices in schools were not captured by this study. Future research could therefore explore the long-term applicability of these micro-servers for supporting TCPD activities. The second limitation was that the study did not compare the devices from an end user's perspective. While the results of the devices' performance showed no significant differences, the study did not compare teachers' preferences, especially head teachers who were expected to maintain the devices in the long run.

Conclusion

Both the cost of the Internet and poor connectivity in lower- and middle-income countries hinder effective use of digital technologies in TCPD activities. This study explored the feasibility of deploying Raspberry Pi computers and tablets as micro-servers to facilitate school-based TCPD activities in an offline environment. It was found that technically, both Raspberry Pi and tablets can be used as micro-servers in delivering TCPD activities but need to be implemented conditionally, as both have strengths and weaknesses. It was found that there was no significant difference in terms of the performance and the cost of the two micro-servers. The Raspberry Pi had more merits technically since it used a standard operating system (Linux) and therefore was easy to set up and supported more users than did the tablet. The study therefore showed that in environments with poor or limited connectivity, learning management systems can be deployed locally using cheap devices and teachers can still access learning materials. For this method to work smoothly, a strategy to update the content on the offline devices needs to be set in place to ensure that teachers using the offline version can also get up-to-date learning materials.

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Centering Cultural Knowledge in TPACK— Evidence From a Collaborative Online International Learning Collaboration

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Abstract

In this qualitative study, we analyzed the processes of a collaborative online international learning (COIL) collaboration between two higher education institutions in Japan and the United States from the perspective of the technological, pedagogical, and content knowledge (TPACK) framework. The research question this study aimed to address was: What is the utility of the TPACK framework, as a lens of analysis, for this online cultural exchange? To address this question, we conducted semi-structured interviews with student participants and examined their written works. From the student participants' learning experiences, we identified evidence of cultural exchange as well as evidence of missed opportunities for cultural exchange arising from the limited knowledge of technology, pedagogy, content, and culture. COIL and TPACK both share a common goal of increasing students' access to multiple knowledge systems using educational technology. As a result, COIL conceptually aligns well with the TPACK framework. This collaboration showed an ongoing need for the centering of cultural knowledge and cultural exchange in both COIL and TPACK. We, accordingly, outline potential for a TPAC*C*K, a modified TPACK framework to center cultural knowledge in both with the hope of taking steps towards a more culturally sustaining framework of international collaboration.

Keywords: collaborative online international learning (COIL), technological pedagogical content knowledge (TPACK), culturally sustaining pedagogy, online education, college teaching

Introduction

In the past three decades, the number of tertiary students studying abroad increased dramatically until more than 5.6 million students chose to study abroad in 2018 (OECD, 2020). However, global instability and restrained mobility created by the COVID-19 pandemic reversed this growing trend. This changing global education environment demands more robust cultural exchange opportunities using online and virtual pedagogies and more advanced and tailored communications technology for use in education.

Collaborative online international learning (COIL) methodology is an applicable instructional choice that enables students to exchange cultural experiences through virtual collaboration (SUNY COIL Center, 2018). This virtual exchange has long been adopted in various postsecondary settings for its benefits in enhancing global perspectives and intercultural competence providing more equitable access to intercultural experiences than studying abroad. This methodology, amidst the pandemic, saw pedagogical value as one of the organized forms of virtual exchange in an online course at our large American Midwestern university. We collaborated with a Japanese liberal arts institution in a semester-long collaboration, using COIL, in which we had students from both contexts conduct a joint project throughout the semester. In this class, we saw both the potential and challenges at the crossroads of online learning, and international education in pursuit of cultural exchange.

As more educators shared their COIL practice in different educational settings, these academic conversations seemed to focus more on learning outcomes and students' satisfaction rather than the cultural learning process in online classes itself (Vahed & Rodriguez, 2021). Given the necessity of understanding this distinctive online, intercultural learning process at a deeper level, we revisited Koehler and Colleagues (2013) work on the necessity of technological, pedagogical, and content knowledge (TPACK). This model in online learning has become a powerful tool for educators throughout and since COVID-19 (Hodges et al., 2010). TPACK has been long used as a way of ensuring that learning with technology preserves similar outcomes and balances attention to how we teach with what is taught (Swallow & Olofson, 2017). By applying the revisited TPACK model to our COIL experience, we offer new insights into the COIL process toward a more culturally equitable COIL practice.

In this qualitative study, we answer the question: What is the utility of a TPACK framework suitable for online cultural exchange, given evidence from a multi-level (undergraduate, graduate) COIL collaboration? Students' experiences in a transnational COIL collaboration, which we examined in this study, invite further conversation in the fields of adult education and international education about how online international collaboration can better center cultural exchange in instructional design. Backed by evidence from this online collaboration, we argue that while COIL conceptually aligns with TPACK, there is an ongoing need to imagine both COIL and TPACK forward and modify both to center cultural knowledge and cultural exchange. We do so by first reviewing recent literature on COIL and TPACK, then demonstrating both evidence of, and further opportunities for, cultural exchange in the COIL collaboration. We conclude with a roadmap for COIL that centers on cultural knowledge and exchange to contemplate the potential for a TPACCK framework that adds a dimension of cultural knowledge with implications for international online education.

Literature Review

COIL is a pedagogy by which postsecondary students from different contexts can learn together virtually through a set of common learning outcomes and assignments (Appiah-Kubi & Annan, 2020; SUNY COIL Center, 2018). As many postsecondary educators have adopted this pedagogy, COIL has been emphasized as an effective learning method to enhance language skills, critical thinking, and intercultural competence (Hackett et al., 2023). COIL can be used in multiple ways, with instructional collaborations emphasizing technology adaptation and intercultural collaboration.

TPACK is a framework for teacher knowledge for integration of technology into pedagogical content knowledge (PCK; Keeler, 2008; Koehler & Mishra, 2009). This framework consists of three components of teachers' knowledge—content, pedagogy, and technology—and emphasizes the interactions among these components. Pedagogical knowledge is teachers' knowledge of how to teach and learn, while pedagogical content knowledge means the knowledge of pedagogy applicable to specific content. Technology knowledge is similar to fluency in technology: knowledge necessary to apply technology efficiently to classrooms and daily lives. Technological content knowledge is to understand how technology and content influence one another. Technological pedagogical knowledge is how teaching and learning change when specific technologies are adopted (Koehler & Mishra, 2009). Although this model explains knowledge of content and pedagogy when technology is integrated into the teaching and learning process, it shows a limited understanding of contextual knowledge influencing learners and their learning process greatly in various classroom settings.

COIL, we argue, presents a site of analysis to discern the potential limits of TPACK and focus on cultural exchange. Dalal and colleagues (2021), in their study of international teachers and a cultural exchange program, found that TPACK's limited attention to relationships and contextual concerns (cultural identity versus teacher self-knowledge) yielded demonstrable growth in teachers' confidence using educational technology integration. Similarly, MacKinnon (2017), aligned with other literature on cultural exchange and TPACK (Benton-Borghi, 2013, 2016; Porras-Hernández & Salinas-Amescua, 2013), argued that TPACK should continue to center contextual factors. COIL, in its explicitly international focus, helps to conceptually align with TPACK with its emphasis on technology to facilitate global learning and collaboration across contexts (Appiah-Kubi & Annan, 2020). COIL's epistemological groundings in transformative learning (Dirkx, 1998) foster outcomes for learners that demonstrate growth in their understandings of self and others. COIL, consequently, functions as a pedagogical and technological approach, from which the content and self-knowledge interplay within the learning experience by making the teachers' and students' self-knowledge central to facilitating a transformation from the collaboration (Tanhueco-Nepomuceno, 2019).

While COIL can be framed to be more student-facing, we align with Laal and Ghodsi's (2012) framing of collaborative learning as a joint effort with and by students and teachers. TPACK, similarly, can be seen to unite teachers and students in "how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology" (Koehler & Mishra, 2009, p. 66). COIL's explicit international focus is fundamentally grounded in how these differences and potential transformations in students' epistemologies are facilitated by technology (Appiah-Kubi & Annan, 2020). Instructors' pedagogical and content knowledge is therefore necessary for a successful COIL collaboration. While the technological media may differ, the need to facilitate movement between linguistic, cultural,

national, and educational contexts to align pedagogical parameters and learning outcomes is central to the student's learning within the collaboration as well.

Method

In our study, students in the joint COIL collaboration between an American Midwestern research university (MU) and a Japanese liberal arts college (LC) participated in the collaboration for 5 weeks. The COIL collaboration between MU and LC began with the meetings of instructors from both institutions, seven months before the start of the course. The courses COILed in this joint project were Teaching in Postsecondary Education, a remote master's level course at MU, and Innovation, Communication, and Change, a hybrid course at LC. When the COILed courses were designated, the instructors made small changes to their syllabi to include materials borrowed from the other courses.

After several scaffolds and initial measurements of students' senses of self and identities, the summative assessment of the COIL collaboration was a research paper assignment, which also served as a data source for this project. The assignment created was jointly crafted by instructors, asking students to conduct a pilot empirical study on a model of educational change in a postsecondary setting, or teaching approach. Students were assigned to five research teams and asked to create a brief "scholarly identity snapshot" by the end of week 3 of the 16-week course (MU) and by week 2 of the 10-week course (LC). They revised and expanded upon these narratives at the end of their respective courses which served as a further qualitative dataset for this collaboration. The intentionality behind this assignment was to gather qualitative data from students about their cultural and contextual situatedness as well as their self-knowledge of their socialization (Dirkx, 1998; Harro, 2000; Tatum, 2000).

Teams included at least one doctoral student to informally support the master's and undergraduate teammates with methodological work, and support students for whom this was their first time engaging in research. Teams communicated initially through a learning management software (LMS) and collaboration space designed for COIL collaborations and were asked to submit assignments and arrange meetings using this software. While some later communicated by other means, students were then assigned to create short asynchronous presentations to present their initial findings and generate feedback.

In this study, we collected and analyzed qualitative data collected in the form of semi-structured interviews with participants and their written works. We conducted semi-structured interviews in English with the participants after the 5-week COIL collaboration. Since the data collection needed to be completed by the end of the short program, we chose semi-structured interviews rather than in-depth forms. Four participants at MU (two master's and two doctoral students) and three participants at LC (one master's and two undergraduate students) shared their experiences. We recorded the virtual interviews and transcribed the recordings using pseudonyms for each participant (see Table 1 for more details). The first round of transcription was done algorithmically using Temi (https://www.temi.com/) and then checked by researchers for accuracy.

After completing the transcription, we engaged in exploratory open coding, which allowed us to approach the thematic fragments in the data systematically (Williams & Moser, 2019). With what we found from this initial exploration, we discussed the identified patterns in the data that may have been related to the conceptual framework we were developing (Suter, 2011). The analysis of the data was inductive in that we examined the data repetitively and applied the patterns identified to generate a new framework based on what we pre-developed. Through this iterative process of exploring the patterns and relationships among the constructs, we interpreted the meanings of participants' lived experiences of COIL from the perspective of the TPACK framework.

Table 1

Study Participants

Name (Interview #)	Institution	Program enrolled	Gender identity	Nationality
Elizabeth (#1)	MU	Master's	Woman	USA
Allie (#2)	MU	Master's	Woman	USA
Cassie (#3)	MU	Doctorate	Woman	USA
Jayson (#4)	MU	Doctorate	Man	China
Riku (#5)	LC	Undergraduate	Man	Japan
Minsu (#6)	LC	Master's	Man	S. Korea
Minato (#7)	LC	Undergraduate	Man	Japan

Note. All names are pseudonyms. MU = American Midwestern research university; LC = Japanese liberal arts college.

Findings

We discuss three strands of findings to explore the utility of the TPACK framework in this COIL collaboration: (a) students' perceptions of a lack of cultural exchange in the collaboration which suggests the *pedagogical* decentering of cultural exchange; (b) missed opportunities that participants identified which suggests the structural marginalization of cultural exchange; and (c) opportunities students did find for cultural exchange which indicates informal and unstructured opportunities for students to experience the sharing of cultural knowledge. These strands converge to show how informal opportunities for students to learn with and from each other happened in the cracks of the COIL collaboration design suggesting future pathways for COIL and TPACK. Each of our interviews will be referred to in this paper by the number assigned to them in Table 1 and appear in-text attributed by this number (e.g. #1).

Students' Perceptions of a Lack of Cultural Exchange

Students possess a variety of different goals and expectations when they decide to enroll in a specific course. Participants in the MU and LC COIL collaboration seemed to have certain levels of expectations for learning experiences enabling cultural exchange besides their course-oriented learning goals. COIL aims to encourage international and multicultural learning. From the interviews with participants, we realized that many students had prior knowledge of COIL and expected learning experiences to help them better understand different cultures. One participant, who was interested in experiencing COIL methods through this study, stated he expected "far more intercultural learning" from COIL including more cultural exchange and interactions among participants (#4).

As we noticed from what he and others said about his COIL experiences, COIL collaboration seemed to not fully meet students' expectations for cultural exchange. One participant from Japan expressed that he would have liked to have had more conversations on cultural and societal issues during his COIL collaboration with American students. He explained the gaps between what he expected and experienced in COIL by saying, "I expected some, something I speak to some about some, something about this current situation. Yeah. Emergency online, learning something like I suspected to know more about that" (#6). Another participant stated,

> I was expecting more stuff like a cultural study, like understanding the Japanese culture and . . . higher education broader than their higher education system, governing structure more. I was expecting to learn more about the cultural aspect of Japan in their higher education. (#4)

This shows the participants' expectations for COIL in broadening their cultural understanding and limitations in accomplishing their expected goals.

Students recognized the limitations of COIL in achieving their goals for cultural exchange compared to their study abroad experiences. One participant who used to participate in study abroad programs explained the difference by saying,

> …a study abroad is fully immersive, right? You get on a plane, and you go; and you're focused . . . Whereas COIL is not that immersive. I feel like at least this experience was a group project that almost just happened to have a person that is not from the US on it. (#1)

From her explanation of COIL, participants' experiences of cultural learning seemed more bounded than study abroad programs where they would encounter different cultures in an immersive environment. Participants thus perceived that COIL could not meet their expectations for cultural exchange. Most of these limitations in cultural exchange seemed to arise from the pedagogical design of the MU-LC COIL.

Missed Opportunities for Cultural Exchange

The COIL collaboration's foregrounding of transformative outcomes without centering cultural knowledge suggested we had to look elsewhere for evidence of structural, as opposed to perceptual, missed opportunities for cultural exchange. Participants reported that attention to the outcomes focus and a large-scale summative assessment rather than the pedagogical scaffolds suggest it was both students' perception and experiences with the pedagogical design that necessitated presenting both strands of findings. While

affective outcomes can be hard to measure qualitatively, we show in the section how participants were able to identify missed opportunities for cultural exchange because of the pedagogical design of the COIL collaboration which emphasized student technological and content knowledge as pedagogical knowledge to suggest the need to more explicitly center cultural knowledge in such international online collaborative experiences.

Five of the seven participants expressed some level of regret about their COIL experiences which is distinct from the disappointment we discussed above. Their specific critiques of the pedagogical and technological experiences help to locate the specific limitations of the collaboration. They show the outcome focus perhaps as a result of the confluence of the technological, pedagogical, and content knowledge, rather than the emphasis on the exchange. Several participants indicated how the COILed component of the courses felt "separate" (#1) and "task-oriented" (#3); both suggested how the structure of the collaboration and its integration into the courses was inimical to cultural exchange.

The participants' team-building interactions and platform onboarding showed this tension between the technological needs of COIL and its cultural exchange capacity demonstrating the need for instructors' pedagogical-cultural knowledge. Elizabeth, a social science doctoral student mentioned, for example, how "we were all super flexible with each other. I, we all were separated enough from the project that we didn't get emotionally attached" (#1). This report shows the distance between the project and the students because of a lack of cultural exchange opportunities. For another, Cassie mentioned that "I professionally do this work, but I would have built in time to intentionally do intercultural exchange" (#3) which explains this detachment to imply that, in addition to the assignment, there was an untapped desire to do an explicit cultural exchange. These two examples, taken together, suggest how the group dynamics were supportive and there was a desire for cultural exchange, but that the pedagogical knowledge of facilitating a technologically complex collaboration infrastructure with epistemologically distant courses could not be allayed by the instructors' pedagogical strengths.

Cassie, who works in student affairs, implies that the tasks intended in a COIL collaboration should protect time instead of creating constraints on the student groups' time. Elizabeth built upon this point by stating that "I was also coming from a non-research background, [and] I was very, 'if that sounds good to everyone else, then that sounds good to me too,' because I'm not really sure where to go" (#2). Allie, a master's student in student affairs, further exposes the technological knowledge heaviness of COIL that relied on simplified assumptions about the students participating in the collaboration. Doing so suggests a missed opportunity for cultural exchange insofar as the amount of labor needed to get to the high level of technological knowledge to engage in this collaboration synchronously across time zone contexts requires significant scaffolding by both sponsoring institutions. Further, as Elizabeth stated, "the COIL project more fit into a learning experience related to the research process, rather than the teaching" and, on top of her perception, that "this is a teaching class, but then there's a COIL thing on top" (#1).

This dichotomization perception suggests she perceived even less room than other participants for cultural exchange because of the compartmentalization necessary to manage the competing deadlines in the course which suggests cultural knowledge gaps in the COIL frameworks. Without an explicit curricular carve-out for cultural exchange, participants' perceptions of the course and the curricular space for cultural exchange opportunities, or lack thereof, could perhaps be explained structurally. Alternatively, this could also reflect

the operation of dominant identity markers, such as being associated with an American institutional context, that could revert to mistaking such dominant identity markers as "normal" and therefore less of a perceptible difference from normal coursework (Tatum, 2000). This matters because students in the Japanese context shared little that expressed missed opportunities for cultural exchange. While not all the participants from the Japanese institution were Japanese, the primary assumption as seen in the American institution's syllabus was to give the students an overview of Japanese educational practices. The assumption of a simple bilateral American-Japanese collaboration implies that there was little expected attention to the potential for a multidimensional cultural exchange between students from non-American contexts who were in the U.S., or students from non-Japanese contexts in Japan.

For example, one student, Jayson, a doctoral student of education at MU, identifies as Chinese and has been educated in mainland China, Canada, and the US. He stated that, about his group mates, who included a Korean student who had studied in the US and an American studying at the Japanese institution,

> In terms of intercultural learning, our group … wrote something about ourselves, and a group member called to read and discuss. But other than self-reflection, we didn't do any intercultural learning from each other. … [One student is] South Korean studying in Japan and he studied in the US before anyway, was the most quiet one. And I see that for two reasons. First, English is still quite challenging for him. And I'm an English second language learner. So I've been there, done that. And I really feel the institutional hierarchy from Japan because our Japanese colleague is a master's student. And I feel, I'm guessing that he felt, he's less knowledgeable in terms of offering ideas. (#4)

Jayson suggests, first, the institutional potential power dynamic that the COIL collaboration created between the American and Japanese institutions based on national context. Second, a power dynamic was at play between students in terms of academic rank, with the undergraduates and master's students being perceived as less knowledgeable than the doctoral students. As well, with the normalization of English-medium communication, the collaboration structurally privileged those from non-US and Japanese contexts who had more exposure or experience in English-medium settings. However, Jayson's comment reflects the tenuousness of a simple bilateral assumption in the COIL collaboration suggesting a structural missed opportunity within the COIL collaboration for cultural exchange. This also suggests the need for more nuanced cultural knowledge to feature more prominently in the design of the collaboration which theoretically aligns with the TPACK framework, as we discussed above. The simplicity of the assumed relationship between the two institutional contexts, in addition to the tacit assumptions that the student observed above, foregrounds the development of joint research skills. This was an example of how our pedagogical knowledge of our students was incomprehensive in course development.

Evidence of Cultural Exchange

Although students in this program explained their limited opportunities for intercultural learning coming from the research-oriented COIL project, intercultural communication among participants happened marginally during the COIL experiences. We noticed evidence of cultural exchange in experiences of those students who had a certain level of knowledge on intercultural learning from previous lived experiences. Among the interview participants, two students, one from MU and the other from LC, articulated their intercultural exchange during their COIL experiences.

Jayson, whom we quoted previously in this paper, seemed to arrive at a profound understanding of cultural differences from the interactions among students from MU and LC based on his prior experiences of various cultures. He explained the somewhat limited engagement of the LC participants in the group conversations, reflecting the different learning styles he observed from his global educational experiences.

> I've been studying in North America for almost eight years. So, I feel more comfortable doing that, but our American colleagues [are] very vocal, not necessarily more eloquent than, you know, the Japanese colleagues because English is their first language. (#4)

He also shared a story of how he gained intercultural insights from his interactions with a Korean colleague. He stated the distinctive concern of this colleague.

> Being South Korean, living in Japan is not an easy decision because of the historical conflict between South Korea and Japan, I heard about it. I'd heard about the, you know, some Japanese and Koreans don't get along. He said it's not an easy decision. (#4)

He paid attention to his Korean teammate's cultural concern about studying in a country conflicting with his home country for he already had knowledge of the historical conflicts.

The evidence of cultural exchange was most salient in the interview with one participant, named Riku, from LC. This Japanese student, who used to live and spent a year as a high school exchange student in the US, seemed to have more extensive intercultural experiences during the COIL project than other participants. Riku's intercultural exchange largely started from communicating his prior experiences in the US with MU participants who shared similar lived experiences. He explained his successful interactions with American students through these shared experiences.

> I didn't know that I had, [but] I lived really near to X [Student Name]. Ah, right. He lived in Madison. I was in Heartland, which is really close, like an hour's drive in Wisconsin. So those small discoveries were a positive point. (#5)

He shared his experience talking about the Japanese prime minister with the same colleague in the group. He seemed to enjoy this type of small talk with American participants and gain more expanded intercultural perspectives from these experiences.

Riku's intercultural experience in the COIL was more extensive compared to other participants. We noticed that not many students in the interviews, either American students at MU or Japanese/Korean students at LC, discussed their intercultural exchange experience to this extent. From what he said about his goals for this course, we thought that his cultural experience was possible because his COIL activities aligned well with what he wanted to accomplish, enhanced by his prior knowledge of different cultures. He explained the reason he took the course.

> The course. Like I said, because I wanted to kind of apply for the exchange program. I want it to have English or at least some kind of multicultural communication in my classes. So the COIL project really helped on that one. (#5)

The COIL project allowed him to have opportunities to communicate in English in classes to prepare for his participation in study abroad programs in the coming semesters. For English learners who are in non-English speaking countries, important learning goals might include learning and practicing English with foreign colleagues and having a meaningful intercultural experience. When his goal to practice English was combined with his prior intercultural knowledge and English language proficiency, the levels of intercultural exchange seemed to be more elevated through this short five-week collaboration.

These two participants exemplify how students' intercultural experiences would differ based on their cultural knowledge and learning goals. Compared to other colleagues in the COIL project, these two students reported gaining a more extensive intercultural experience. This highlights the importance of understanding learners' cultural aspects in designing and implementing COIL. Considering the intercultural learning goal of COIL, this cultural knowledge seemed to be as important as other pedagogical, content, and technological knowledge teachers should have addressed in the TPACK framework. Rather, other aspects of higher education suggest several ways in which cultural knowledge within the TPACK framework can fortify the COIL approach to international online collaboration that can mitigate the high technological and content knowledge barriers to entry for a pedagogical-methodological approach that intends to be an alternate to study abroad. In this section, we have shown that there was space within the COIL collaboration for cultural exchange, but not necessarily space structurally created in the instructional design. Furthermore, findings suggest that students perceived our design to be disappointing for its lack of structured opportunities for cultural exchange, despite instructors' attempts to center pedagogical, content, and technological knowledge in the collaboration. Next, we argue for the utility of a TPACCK (TPACK that adds a dimension of cultural knowledge) framework and how COIL can be more culturally sustaining if aligned thereto.

Discussion

Thus far, we have shown evidence of students' cultural exchange despite the structural and curricular limitations of the COIL collaboration and the missed opportunities associated with their perceptions of a lack of cultural exchange in the COIL collaboration as a result of both pedagogical and technological limitations described in the interviews. While the interviews exposed the definitional limits of what students understand cultural exchange to be, we also found that this shows the conceptual limits of TPACK as a guiding but also an analytical framework for assessing COIL. Next, we discuss the implications of these findings and argue that they present an opportunity to showcase how COIL aligns with the TPACK framework of online teaching and learning. However, there remain opportunities for a more culturally sustaining TPACK, which we argue can be achieved by centering cultural (exchange) knowledge in TPACK, which we are calling TPACCK. While COIL does not purport to extend or even apply TPACK as a framework (Appiah-Kubi & Annan, 2020; SUNY COIL Center, 2018), we have shown its theoretical alignment, as well as the students' perception that this was a cultural exchange opportunity. We nuance and clarify how COIL purports to be a global learning experience. By doing so, we make a twofold argument: (a) for a TPACK framework that also centers cultural knowledge, which we call TPACCK, and (b) the potential for a more cultural knowledge and exchange centering COIL.

Towards a TPACCK Framework

In the COIL experience, students showed a hesitancy to equate their experience to cultural exchange or study abroad, evident in how they exposed a narrow concept of what cultural exchange is (as opposed to learning about another [educational] context). While we do not argue in this paper that COIL is a methodological panacea for students to gain universal access to cultural exchange opportunities, participants did show the limits we, as instructor-researchers, exhibited as we tried to disrupt in our framing of cultural exchange, informed by TPACK. In the case of the Japanese institution, students were more often themselves amidst a global learning experience or were undergraduates. While they reported that the COIL experience was an opportunity for international cultural exchange, there was some hesitancy due to how the pedagogical and technical knowledge were foregrounded in the collaboration, rather than the cultural or content knowledge (Koehler et al., 2013). The students' disappointments or identified missed opportunities for cultural exchange suggested that deliberate attention needs to be paid to both instructors' and students' cultural knowledge. Paris and Alim (2014) and Carter Andrews (2021), in teacher education, argue for cultural knowledge to be more multidimensional and not merely reliant upon food and festivals. Based on our findings, centering cultural knowledge also suggests a need to center cultural knowledge in the pedagogical design.

Specifically, the difference we see in the data between the COIL collaboration being simply bad pedagogical design and evidence of a need for a more comprehensive TPACCK framework is in students' reflections about the aims of the course content. For example, we showed above how Elizabeth (#1) perceived the relationship between the COIL component of the course and the existing course content as being laid on top of one another. The SUNY COIL Center (2018) instructs COIL collaborators not to closely integrate course content materials into the COIL collaboration component. However, students' experiences of seeing the COIL component as separate from the course content, which Cassie (#2) noted had a significant technological learning curve, leaves the cultural exchange scaffolds to the discretion of the instructors, and developers' assumptions. For example, the LMS platform used in the COIL collaboration was English medium, and there were other popular apps such as LINE in non-US contexts. However, requiring students to use the COIL-affiliated LMS suggests the US-centric assumptions of the collaboration that prioritized a "neutral" LMS and thus shows how COIL can attend to the technological, content, and pedagogical knowledge without centering the cultural aspects in a COIL collaboration. Alternatively, given that neither institution has universally Japanese or American students, participants' identified concerns about their COIL experience suggest that this is less a fault of the instructional design but an opportunity to make visible how attending to pedagogical, content, and technological aspects alone can be limiting, especially on the assumption that content is cultural. As a result, our findings suggest that imagining a more culture-centered COIL is a framing issue and that pedagogical scaffolds could offer students space to deliberate about how and to what extent cultural knowledge is embedded within our technological-pedagogical teaching as much as the content that instructors cover.

As a result, nuancing TPACK further to include the extra "C" can instead create intentional space in instructional design to lessen the burden on the pedagogical and content knowledge domains to account for cultural learning. As well, doing so would have prevented students from having to learn another LMS as part of the instructional design. While explicit space for cultural knowledge and exchange in the instructional design would not have necessarily prevented some of the instructors' assumptions about the

need to learn about the Japanese educational system, the pedagogical design would not have fully accounted for the largeness of the COILed assignment that did account for all aspects of the TPACK framework.

A TPACCK framework, while providing a potentially useful framework through which to assess cultural knowledge relative to technological and pedagogical content knowledge, offers possibilities for further study of COIL, and improving future collaborations. This COIL collaboration studied in this paper would have benefited significantly, as participants indicated, from a more nuanced cultural exposition less reliant upon a binary and nation-state-centric construction of the collaborating institution. This framework, beyond the scope of this single collaboration, also has implications for other forms of online learning, and other COIL collaborations, in which even more social context is lost between collaborating partners (such as the absence of required synchronous work). As well, in addressing these gaps, despite COIL's clear alignment with the TPACK framework, instructors with limited curricular space or narrow expertise can also struggle, without explicit cultural knowledge preparation, to avoid making assumptions about the collaboration partner institution's national or sociocultural context. Next, we offer a discussion on how the data in this study can be used to create a more culturally centering COIL.

The Potential for a More Culturally-Centering COIL

Our central contentions in this study are twofold: (a) to show COIL's connections to TPACK with the hope of showing how TPACK can better center cultural knowledge and exchange, and (b) to analyze COIL to propose a more culturally centered COIL. In this section, we discuss how the TPACCK framework and the findings we outlined above can suggest potential futures for a more culturally-centering COIL. While COIL, we have shown, is both theoretically and empirically aligned with TPACK, we suggest potential areas of growth for both models.

While COIL's inherent structure necessarily brings together pedagogical, content, and technological knowledge, we also understand how transnational collaboration can be necessarily predicated upon assumptions about the other institution. However, that relationship building is often left to instructors who have to negotiate those relationships based on partial or nascent cultural knowledge. While both of us as authors have ample experience in East Asian higher education contexts, it is by no means a guarantee that instructors will be sufficiently open to learning from and with the partner institution.

Creating a more cultural-knowledge-centering COIL using the TPACCK framework facilitates collaboration that departs from essentialized cultural knowledge. Instead, co-creating knowledge with the partner institutions as a scaffold of the collaboration can benefit and offset opportunities for essentialism in the cultural exchange components of COIL. For example, participants in this study identified wanting more opportunities to get to know one another rather than on the assignment and structured opportunities for both instructors and students to engage with each other in more culturally sustaining technological environments (such as the LMS). It is important to be student-centered and pair with their consciously noticed, self-assessed shifts in their cultural knowledge rather than having that "told to" by a "neutral" instrument.

Centering cultural knowledge can also lead to more nuanced content-knowledge alignment between the two courses in the COIL collaboration. For example, in this collaboration, the Japanese institution borrowed readings from the American course's syllabus, but the American course added readings about Japanese higher education. While COIL's guidance to instructors is not to create joint courses, the multiple entry points embodied in both content and cultural knowledge should be centered. Interviews show that these distinct entry points manifested in both content and the amount of work students had to do to get to a common understanding within the collaboration components.

Instead, centering cultural knowledge as interconnected to content, pedagogy, and technology can yield different outcomes. Centering cultural knowledge in content suggests the curricular conversation described above, while cultural knowledge centered in technology identified in the findings above can bring the LMS into closer alignment with user needs and lower linguistic barriers implied in the COIL design. Also, the joint teaching component can more closely center a variety of intervention strategies that are more efficacious in contexts presumed to be non-homogenous (Shahjahan & Kezar, 2013). This will ultimately coalesce around a COIL framework that centers collaboration grounded in mutual understanding, rather than the supposedly neutral principle of collaboration. While many COIL studies are neither inherently nor intended to be cultural exchange opportunities, facilitating intellectual dialogue across contexts can also disrupt the presumed monopoly of intellectual legitimacy and privilege that Western contexts have. Critically interrogating the structural reinforcements for this implicit ideology allays some of COIL's potentially problematic pedagogical implications, which still conceptually align with the TPACK framework. Additionally, a TPACCK framework can serve to model for instructors how to create these high-impact moments of collaboration that draw more on precedent in established literature on project-based learning, rather than virtual exchange. Seeing all four knowledges (technological, pedagogical, content, and cultural) as equal in supporting student learning, therefore, can support a more centering cultural exchange in COIL that integrates the expertise that instructors bring to their courses.

Conclusion

In this paper, we have shown the perceived and structural missed opportunities in an American-Japanese COIL collaboration. We have shown how the collaboration between our two institutions exemplified the TPACK framework in that COIL's commitments largely align with the need to interconnect technological, pedagogical, and content knowledge in an online learning space. However, despite this alignment, there was ample (structured and unstructured) space needed for further and deeper cultural exchange between students in each class, and a need to recognize the assumed national homogeneity of both contexts, which was not the case. As a result, we have used these findings to argue for a more culturally-centering form of COIL, and an expansion of the TPACK framework to create conceptual space for cultural exchange, especially if COIL is positioned to be an alternative to study abroad.

Reflecting on this experience, we see how many considerations there are to create sustainable relationships and substantive opportunities for students to learn with others in different contexts. Despite the additional complications of online learning across time zones, languages, institutional contexts, and courses, this study affirms the need to center the sharing of cultural knowledge in postsecondary international online learning,

even when courses do not explicitly call for it. In many ways, we were lucky to have students who represented a multiplicity of national, racial, and cultural experiences and who, in their research areas, centered cultural knowledge, but to create a more generalizable set of outcomes, further study is needed to support educators who are well-intended in their desire to promote greater international learning. That said, as we have shown in this paper, there remains ample potential for COIL to be a culturally sustaining and cultural knowledge-advancing pedagogical intervention in a postsecondary educational environment equipped with seeing the long-term benefits of online collaborative learning.

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Decoding Video Logs: Unveiling Student Engagement Patterns in Lecture Capture Videos

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Abstract

Lecture capture videos, a popular type of instructional content used by instructors to share course recordings online, play a significant role in educational settings. Compared to other educational videos, these recordings require minimal time and effort to produce, making them a preferred choice for disseminating course materials. Despite their numerous benefits, there exists a scarcity of data-driven evidence regarding students' use of and engagement with lecture capture videos. Most existing studies rely on self-reported data, lacking comprehensive insights into students' actual video engagement. This research endeavor sought to bridge this gap by investigating university students' engagement patterns while watching lecture capture videos. To achieve this objective, we conducted an analysis of a large-scale dataset comprising over one million rows of video interaction logs. Leveraging clustering and process mining methodologies, we explored the data to reveal valuable insights into students' video engagement behaviors. Our findings indicate that in approximately 60% of students' video-watching sessions, only a small portion of the videos (an average of 7%) is watched. Our results also show that visiting the video page does not necessarily mean that the student watched it. This study may contribute to the existing literature by providing robust data-driven evidence on university students' lecture capture video engagement patterns. It is also expected to contribute methodologically to capturing, preprocessing, and analyzing students' video interactions in different contexts.

Keywords: lecture capture video, video analytics, engagement pattern, data-driven evidence, video interaction log

Introduction

The incorporation of videos in education has its roots in distance learning, where television-recorded videos were used for their unique delivery, presentation, and control features (Bates, 1988). In the last decades, in higher education, digital videos have been increasingly used in online or blended courses. If integrated properly, videos can enhance teaching and result in higher learning gains (Ahmet et al., 2018). Videos can provide a dynamic and engaging way for students to access and retain information, as they can pause and rewind videos to better understand difficult concepts. The literature provides sufficient evidence regarding the benefits of video use in higher education. For example, Carmichael et al. (2018) showed that videos can promote flexibility and independence of students as learning agents, which may increase their motivation to study and learn. Moreover, videos can increase students' satisfaction with learning environments (Choe et al., 2019; Nagy, 2018) and positively affect students' achievement (Eidenberger & Nowotny, 2022). With the global growth of online learning, videos have become even more essential in higher education to create flexible and effective learning experiences for students.

The types of educational videos may range from lecture captures to demonstrations, from animated explanations to interactive tutorials (Winslett, 2014). Although most video types require a tedious time-consuming production process, lecture videos that are unedited recordings of an instructor delivering an online or in-person lecture are exceptional. These videos are commonly called lecture captures (Owston et al., 2011), and they can be readily available to students soon after the lectures. Lecture captures can play quite an important role in reinforcing student learning after class (Giannakos et al., 2013). The prominence of lecture captures has increased significantly during the COVID-19 pandemic due to the abrupt shift to online lecturing all around the world (Pal & Patra, 2021; Tabakin et al., 2021; Wang et al., 2022). A recent study by Fina et al. (2023) also highlighted that videos in the lecture capture format are becoming a new standard in pharmacy education since the pandemic.

Although video lecture materials hold a significant place in online learning environments, the primary data source in learning analytics studies has been the log records of learning management systems. The main reason for this is that learning management systems automatically record the interaction data used in learning analytics research. However, many learning management systems only store superficial information such as whether the webpage containing the video was visited with regard to students' video interactions. In other words, they do not record data on students' interactions with the video. Meanwhile, a considerable portion of the studies examining students' video interactions are carried out within the context of massive open online courses (MOOCs; Yürüm et al., 2023). The main reason for this is that the open-source platforms used to create MOOCs (e.g., edX) automatically record video interactions. Research conducted within the MOOC context has significantly contributed to our understanding of how MOOC learners interact with videos (Kim et al., 2014) and helped identify distinct student profiles based on their video-engagement behaviors (Belarbi et al., 2019). The insights gained from previous studies have offered important implications for the design of instructional videos and the implementation of video-based learning (Guo et al., 2014).

However, findings from MOOC contexts may not apply well to the case of lecture captures especially in blended learning contexts. In MOOCs, the primary mode of instruction is through a series of short, segmented video modules (Diver & Martinez, 2015); on the other hand, lecture captures are lengthy video

recordings of entire lectures and serve as a supplementary learning resource to complement the main lecturing. Therefore, the way university students interact with lecture captures is likely to differ significantly from how diverse MOOC learners interact with brief, divided videos. Nonetheless, there is scarce data-driven research on the identification of engagement with lecture captures, and still little is known about how university students benefit from them to improve their learning.

This study aimed to address the aforementioned gap through an examination of the video-watching behaviors of university students when engaging with lecture capture videos. Using techniques from cluster analysis and process mining, we examined the large dataset, containing more than one million video interactions (e.g., play, pause, seek, etc.), to uncover significant patterns in students' video engagement. This investigation enriches the current literature by providing a comprehensive, data-driven understanding of university students' engagement with lecture capture videos. Specifically, the following research questions were addressed.

1. What patterns of video engagement do students commonly exhibit while watching lecture captures?

2. What are the process models that characterize the prominent video engagement patterns exhibited by students?

The remainder of the study is structured as follows: in the second section, related literature is presented; in the third section, the method of the study is explained, followed by the results and a discussion of the main findings; and in the last section, concludes the study and provides suggestions for future research and practice.

Literature Review

Learning Strategies

Students usually demonstrate strategic behaviors while engaging with learning materials (Gasevic et al., 2017). For example, while some students might allocate more time to study in advance, others may tend to spend their time catching up (Nguyen et al., 2018). Such strategic learning behaviors are typically framed under the theories of self-regulated learning (SRL; Roll & Winne, 2015). According to SRL theories, students are active participants in their own learning process, where metacognitive strategies, such as planning, monitoring, and evaluating, play an important role (Pintrich, 2000; Zimmerman, 2000).

While previous SRL research primarily used self-report data to measure SRL behavior (Rovers et al., 2019), the emergence of the learning analytics field has popularized the use of interaction logs in identifying students' SRL-related behaviors (Wilson et al., 2021). Among others, unsupervised machine learning methods such as clustering and sequence mining have been the most widely used learning analytics approaches to detect students' engagement behaviors (Mirriahi et al., 2016; Walsh & Rísquez, 2020). While these behaviors are typically known as learning behavior or behavioral patterns (Cicchinelli et al., 2018; Kokoç et al., 2021), other researchers interpreted student behavior as a sequence of student actions forming

"learning tactics" and suggested that the combination of these tactics shapes students' learning strategies (Fan et al., 2021).

Students demonstrate similar strategic behaviors to regulate their engagement with educational videos. The term *video analytics* serves as an umbrella to encompass the research studies that employ video interaction logs to identify and interpret student behavior. Video analytics aims to help educators, researchers, and instructional designers better understand and improve video-based learning and teaching (Mirriahi & Vigentini, 2017). The following section presents a synthesis of video analytics studies.

Video Analytics

Researchers have used students' video interaction logs to explore answers to different research questions. For example, Merkt et al. (2022) analyzed students' pausing behavior in educational videos. They observed instances where students faced difficulties or identified meaningful structural breakpoints in the video content. The findings revealed that students' pausing behavior was significantly influenced by their perception of difficulty and meaningful breakpoints in the video. In another study, Zhang et al. (2022) analyzed video lecture engagement patterns for evidence that learners exhibit a selective and purpose-driven approach. Indeed, the learners preferred content aligned closely with their learning objectives, often skipping introductory or less relevant material. This trend was particularly noticeable in videos covering advanced concepts, which captured significant attention and engagement. Conversely, introductory videos, typically covering course overviews and methodologies, were less frequently watched, suggesting that learners either had pre-existing familiarity with the course structure or preferred to engage directly with more substantive content. Re-watching behavior indicated that learners revisited specific sections or concepts instead of re-engaging with entire videos. Videos that were re-watched more frequently tended to have higher technical content or unique instructional methods, suggesting that content complexity and engaging delivery styles were factors prompting repeat viewings.

Guo et al. (2014) showed that while learners watch lecture videos more linearly, they demonstrate seeking or searching behavior more frequently in tutorial videos. They also found that students show a high number of re-watch behaviors in non-visual explanations or in sections where an important theory or topic is explained. It means that the parts of the video that are hard to understand or that are perceived to be important are often watched. While some students skip the initial parts of the video material, others visit the missed content. Akçapınar and Bayazıt (2018) compared deep and surface learners' video-watching behaviors in terms of interactions such as play, pause, seek forward, and seek backward. They found that surface learners made more seeks forward than deep learners who watched videos with more seeks backward.

Methodology

Research Context

The context of this study was five courses conducted remotely by the same instructor using the Moodle learning management system (LMS) during the COVID-19 pandemic. These courses consisted of

compulsory and elective courses for undergraduate students of the Educational Technology Department at Hacettepe University, Türkiye. While the total number of students enrolled in the courses was 451, the number of students who had at least one video-watching session was 381. Excluding students enrolled in more than one course, the total number of unique students was 181. The video type used in all courses was the same, and they were lecture captures. These videos were Zoom recordings of live lecture sessions with students present. Video lengths ranged from 13 minutes to 100 minutes, with an average video length of 64 minutes. Video contents were in the form of presentation and screen sharing. A similar learning design was used in all courses. Course activities such as assignments, quizzes, discussion forums, Sharable Content Objects (SCOs), and live lecture video recordings (lecture captures) were used in the lessons.

Data Collection Tool

The data were collected with a video player developed by the authors, which is integrated into the Moodle LMS. Through this JavaScript-based video player, students' video interactions (play, pause, seek, etc.) were recorded in the database as time-stamped events. The events recorded by the video player and their descriptions are presented in Table 1. Using this video player, more than one million rows of click-stream data were obtained from 4,402 unique video-watching sessions pertaining to 74 videos.

Table 1

Types of Events Logged by the Video Player

Event	Description
Load	Video loaded
Play	Play button pressed
Pause	Video paused
Seek	Jumped forward or backward in the video
Time Update	Video playing (automatically generated every 5 seconds)
End	Video finished

Data Analysis Techniques

Cluster and process mining analysis were used to understand students' video engagements. Cluster analysis is a technique for grouping entities based on their common characteristics (Ungar & Foster, 1998). Based on the attributes of the entities, the algorithm divides the similarities among the individuals in the data set into a small number of sub-groups. In most cases, after the application of clustering analysis, the characteristics of the groups formed are discovered, similarities of the individuals or objects in the groups are revealed, and these groups are named with cluster labels (Yoon et al., 2021). On the other hand, process mining focuses on extracting process-related knowledge from event logs and other data sources. Process

mining uses information systems' event logs to uncover, monitor, and enhance processes in different areas (Cairns et al., 2015). An event log may be thought of as a collection of traces. In terms of the actions performed, each trace reflects the life cycle of a process instance. Additional information about events, the resource executing or starting the action, the timing of the event, and data items associated with the event are frequently stored in event logs (van der Aalst, 2019).

Data Analysis

Before the analysis, the raw interaction data were preprocessed which first involved extracting the video-watching sessions. In this paper, a session is considered a time frame of interactions with a specific video after the video is loaded. A video-watching session starts with the Load event, which indicates that the page with video content is loaded in the Moodle environment. In other words, each Load event is considered the start of a new video-watching session. All video interaction events until the same or a different video is loaded (e.g., until a new Load event comes) are considered to be within the same session.

Since the number of activities that students perform in each video-watching session is variable, clustering them as they are will not fully answer our research questions. Therefore, in this study, we followed a novel approach in which students' interactions were transformed into standard sequences over the video timeline. In this way, it was also possible to align the sessions. The steps for this transformation process were as follows: First, video lengths were standardized between 0 and 100, as the videos were of varying lengths. In other words, the videos were analyzed by dividing them into 100 equal units. The student's engagement in each unit was labeled as unseen, active, or passive. Unseen indicated no interaction at a specific unit, suggesting that the student did not watch that part of the video (skipped it or never saw it). If the student had an interaction log on that unit, such as pausing, playing, or seeking, this situation was labeled as active (i.e., active engagement). This label indicated that the student was actively engaged with the video at that specific unit. Finally, if student interaction at a specific unit was in the form of a Time Update (automatic progress event—see Table 1), then the passive label was used (i.e., passive engagement). This label represented the situations where students watched the relevant section without any interaction. Thanks to this labeling, it was possible to identify the moments of videos that students watched or not as well as their engagement (i.e., active or passive) regardless of video length.

In order to extract different video-watching patterns, the video-watching sessions of the students were grouped using sequence clustering analysis. The preprocessing steps carried out resulted in the representation of video sessions as sequences of video interaction events in a timeline divided by 1% segments in each lecture capture video. This representation was used to perform a clustering analysis based on the sequences of interaction events and identify distinct video-watching behaviors where the interactions unfold in varying orders and times. Data preprocessing was done automatically with the help of a tool developed by the authors. Clustering analysis was performed with the TraMineR (Gabadinho et al., 2011) package in the R software (Version 4.3.1). In order to describe the characteristics of the sessions in the clusters, descriptive statistics (e.g., mean, standard deviation, percentiles) were used. The metrics used to characterize sessions in each cluster and their descriptions are presented in Table 2.

Table 2

Description of Video Interaction Metrics

Metric	Description
session_duration	Duration of a session in terms of minutes
total_action	Total number of actions in a session
play	Number of times a play button was pressed in a session
pause	Number of times a pause button was pressed in a session
backward	Number of times a video was backwarded in a session
forward	Number of times a video was forwarded in a session
time_update	Number of times time update event was recorded while watching a video
max_percent	The maximum point reached in the timeline of the video in terms of percentage
total_percent	Total percentage of video portion watched

Finally, the process mining analysis was performed using the Disco process mining software (Version 3.6.7) to reveal the interaction patterns of students in the video-watching sessions in different clusters. In this way, we aimed to reveal the interaction sequences of students in the video-watching sessions. For process mining analysis, the video-watching sessions in each cluster were organized as timed event logs.

Results

We present our results under two subheadings that refer to our research questions; the first concerns engagement patterns, while the second deals with process models that characterize these engagement patterns.

Research Question 1: What patterns of video engagement do students commonly exhibit while watching lecture captures?

The cluster analysis yielded four groups of sessions with distinct video engagement behavior, as shown in Figure 1. For each subplot in this figure, the x-axis represents the video timeline divided into 1% segments, while the y-axis represents individual video-watching sessions. Within the subplots, video segments

skipped are indicated in white, segments passively watched are blue, and segments where students interacted with the video (e.g., pausing or skipping) are red.

In the first group, shown in Figure 1A (n = 2,565, 58% of all sessions), students barely watched the videos. This is represented by the large white area. In 50% of these sessions, students spent less than 1.8 minutes and watched only 6% (or less) of the videos.

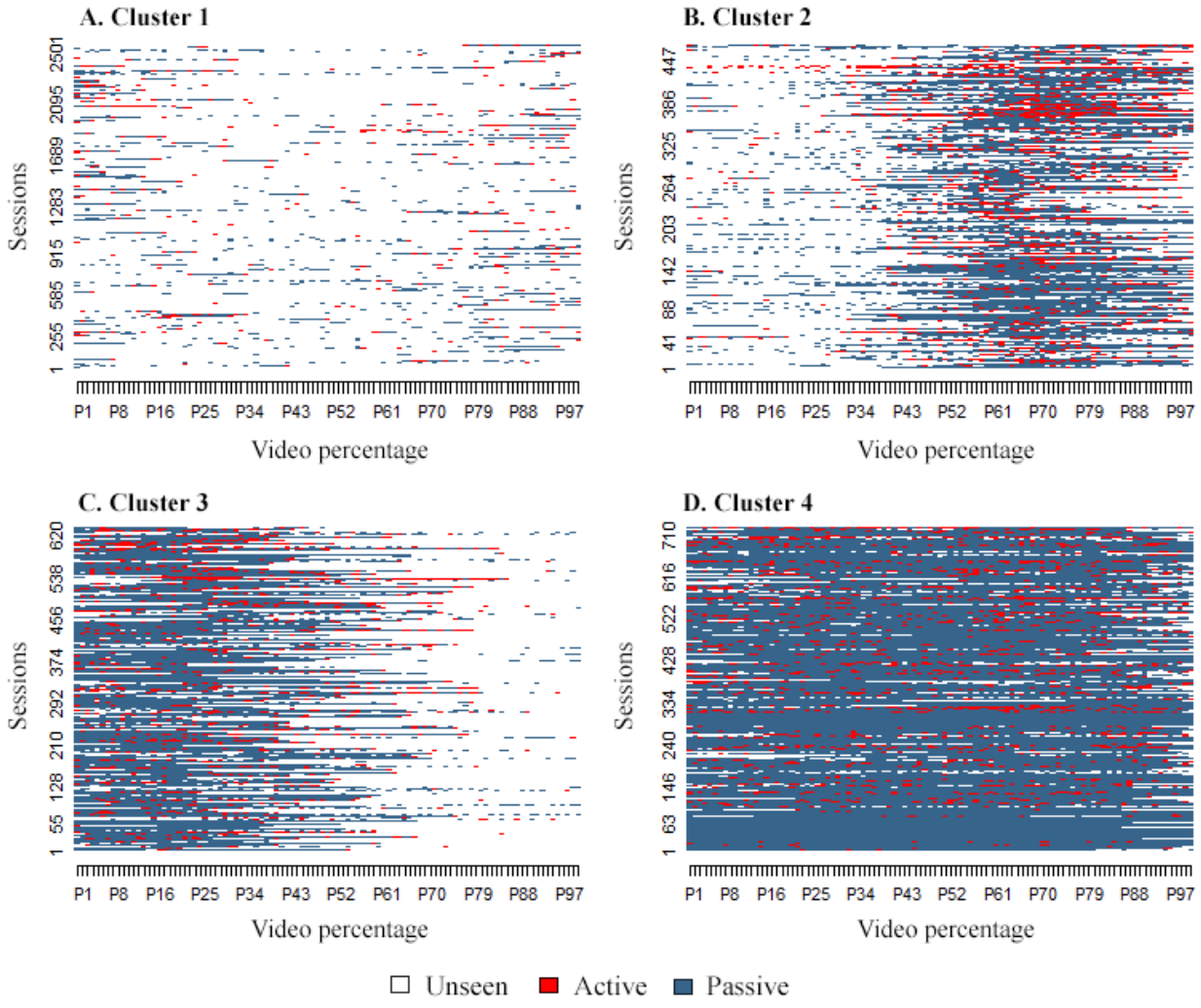
In the second group, shown in Figure 1B (n = 472, 38% of all sessions), students engaged mostly with the second half of the videos and discarded the first half. This is represented by extensive white on the left side of the panel, whereas on the right, blue and red are the dominant colors. In 50% of the sessions in this group, students stayed on the videos 29.45 minutes at maximum, and they watched 38% (or less) of the videos.

Moreover, Figure 1C, which represents 17% of the sessions (n = 637), demonstrates a different student behavior that involves engagement with the first part of the videos, opposite to what is seen in Figure 1B. In these sessions, students watched and/or interacted with videos mostly until around the midpoint of the timeline, but they began to disengage thereafter. In 50% of the sessions represented in this cluster, students stayed with the video for 32.5 minutes at maximum, while they watched 39% (or less) of the total videos.

Last, Figure 1D represents 14% of the sessions (n = 728). These sessions differed from the others in terms of the strength and consistency of the engagement. In 50%, students spent up to 62.8 minutes and watched 96% or less of the videos.

Figure 1

Distinct Groups of Engagement Behavior Produced in the Cluster Analysis



Note. n Cluster 1 sessions = 2,565; n Cluster 2 sessions = 472; n Cluster 3 sessions = 637; n Cluster 4 sessions = 728

Research Question 2: What are the process models that characterize the prominent video engagement patterns exhibited by students?

Process mining analysis was used to mine the video interaction patterns in each cluster. The most prevalent behaviors found in these patterns, along with their descriptions, are presented in Table 3. These sequences reflect a significant part of the behaviors exhibited by students during the video-watching sessions.

Table 3

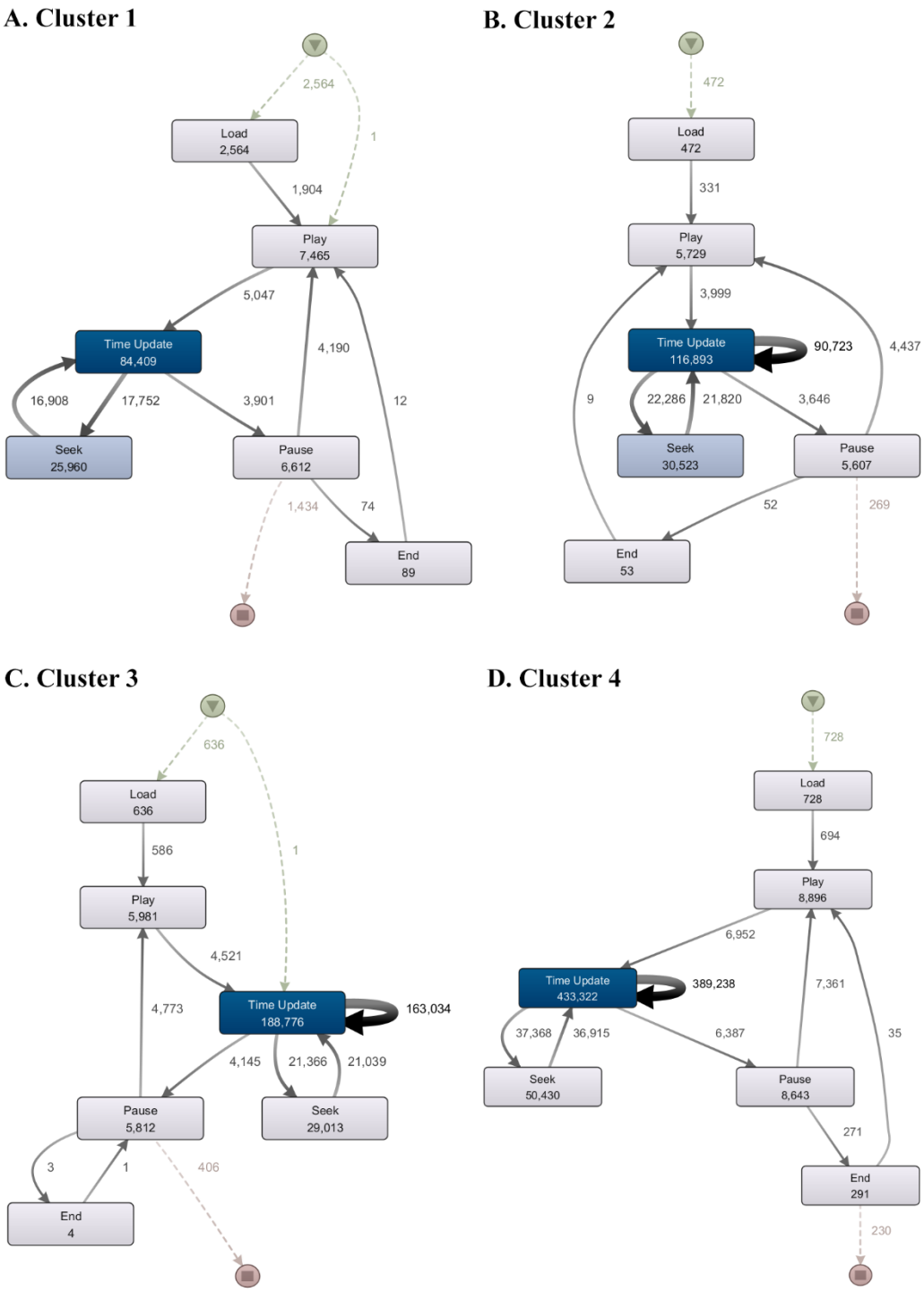
Students' Video Interaction Sequences and Descriptions

Sequence	Description
Load → Play	After the video is loaded, the student plays it from the beginning.
Load → Seek	As soon as the video is loaded, the student moves to a later section.
Time Update → Time Update	The student continues to watch the video without any interaction.
Time Update → Pause	The student pauses the video.
Pause → Play	The student plays the paused video.
Play → Time Update	The student plays the video and continues to watch it.
Time Update → Seek	While watching it, the student jumps forward or backward in the video.
Seek → Time Update	After jumping forward or backward, the student continues to watch the video.
Seek → Seek	The student continuously jumps forward or backward in the video.
Seek → Pause	After jumping forward or backward, the student pauses the video.
Seek → Play	After jumping forward or backward, the student plays the video.

The most frequently encountered patterns in the sessions in each cluster are visually presented as process maps in Figure 2. In the process models, only the prominent paths are included to make the graphics look plain, but all paths were considered when explaining the process models.

Figure 2

Process Models of Student Interactions in Each Cluster



Note. In the process model, the triangle symbol represents the start of the process, while the endpoint is indicated by the stop symbol. Activities are depicted as boxes and the process flow between activities is illustrated by an arrow.

Dashed arrows indicate activities at the beginning and end of the process. The numbers inside the boxes and next to the arrows signify the absolute frequencies. The thickness of the arrows and the coloring of the boxes reflects these numerical values (Fluxicon, 2024).

Figure 2A shows that the videos were loaded 2,564 times in total during the sessions in Cluster 1. The Load event is followed by the Play event by 74% (Load → Play) and by the Seek event by 25% (Load → Seek). The Play event is followed by the Time Update event at a rate of 68% (Play → Time Update) and a Pause event by 20% (Play → Pause). In 10%, the Seek event follows (Play → Seek). The Time Update event, which indicates that the video was being viewed, is followed by the Time Update event at 74%, while the Seek event is followed by 21%. The Seek event is followed by the Time Update event in 68%, while the Seek event is followed by another Seek event in 24%.

Figure 2B shows that the videos were loaded 472 times in the sessions in Cluster 2. The Load event is followed by the Play event at 70% (Load → Play) and the Seek event at 30% (Load → Seek). After the Play event, 70% were a Time Update event (Play → Time Update) and 20% a Pause event (Play → Pause). In 10%, the Seek event follows (Play → Seek). The Time Update event, which indicates that the video is being watched, is followed by the Time Update event at 78% and the Seek event at 19%. The Seek event is followed by Time Update at 71%, while the Seek event is followed by another Seek event at 23%.

Figure 2C shows that the videos were loaded 636 times in the sessions in Cluster 3. The Load event is followed by the Play event at 92% (Load → Play), while the Seek event represents only 0.04% (Load → Seek). After the Play event, the Time Update event comes at a rate of 75% (Play → Time Update) and the Pause event at a rate of 22% (Play → Pause). Only 1% follow the Seek event (Play → Seek). The Time Update event, which indicates that the video is being watched, is followed by another Time Update event at 86% and the Seek event at 11%. While the Seek event is followed by Time Update at 72%, it is followed by the Seek event again at 23%.

Finally, Figure 2D shows that the videos were loaded 728 times in the sessions in Cluster 4. The Load event is followed by the Play event at 95% (Load → Play) while the Seek event represents only 0.04% (Load → Seek). After the Play event, the Time Update event comes at a rate of 78% (Play → Time Update) and the Pause event at a rate of 16% (Play → Pause). Only 1% follow the Seek event (Play → Seek). The Time Update event, which indicates that the video is being watched, is followed by another Time Update event at 90% and the Seek event at 9%. The Seek event is followed by Time Update in 73%, while the Seek event is followed again in 24%.

When each cluster was evaluated in terms of prominent patterns, a few noteworthy points emerged. Although 58% of the analyzed video sessions are in Cluster 1, when the interactions in the sessions are examined, it is seen that the least number of interactions occurred here. On the other hand, it is seen that the sessions with the highest value in terms of interaction took place in Cluster 4, which includes just 14% of all sessions. Since the event named Time Update is created automatically at 5-second intervals, it is an expected result that there would be the largest number of such events in all models.

Discussion

In this study, the video-watching behaviors of university students were analyzed, focusing on their interaction with lecture capture videos. For this purpose, a total of 4,402 video-watching sessions were identified and processed to label video segments that students watched, actively or passively engaged with, or did not watch. Subsequently, the video-watching sessions were clustered to identify prominent viewing behaviors, and process models were examined for each cluster.

The cluster analysis yielded four groups of behavioral patterns. Although the sessions in Cluster 1 were abundant, students engaged in rather superficial activities during these sessions. The low duration of video viewing, low number of activities, predominance of unwatched sections in the video, and distribution of activities across different regions of the video timeline may indicate that students were browsing for information in these sessions. The process model associated with Cluster 1 also suggests a non-linear, skipping-based viewing pattern, implying that these sessions may be more related to skimming rather than learning. Alternatively, students may have exhibited this behavior to locate specific topics covered in videos. This behavior may also be related to students' approaches to learning. For instance, a study conducted by Akçapınar and Bayazıt (2018) revealed that students with a surface learning approach tended to skip forward more while watching videos. Yoon et al. (2021) referred to the behavioral pattern of superficial interaction with the video player as "browsing." They also found that students who exhibited only this behavior pattern had lower learning achievement. Considering that the content was derived from lecture captures, an alternative interpretation of these findings could be that students were promptly revisiting the videos to reinforce and deepen their conceptual understanding after participating in the live lecture sessions. This behavior may suggest a proactive approach to learning, using the recorded lectures as a tool for revision and comprehension enhancement.

In the video viewing sessions within Cluster 2, it is observed that students tended to skip the initial part of the videos but actively engaged with a specific section. This viewing behavior could be related to video design or course design. In the analyzed courses, students were given an assignment at the end of the lesson, and the details of this assignment were explained during the lesson. Therefore, some students might have re-watched the relevant section of the lesson while working on the assignment. Yoon et al. (2021) referred to similar behavior as "information seeking" which involves cognitive efforts to retrieve and organize information. Seo et al. (2021) considered these behaviors as "search," based on students' self-reported intentions.

In the video-watching sessions within Cluster 3, it is observed that students watched the initial part of the videos but ended the session without watching the final part. While some of these sessions may indicate passive engagement, in others, students actively engaged with the initial part of the video. This may be due to the longer duration of the videos, particularly in lecture captures that cover the entire lesson. These videos may contain irrelevant information, such as dialogues happening during the lecture, which can also affect the flow of the lesson. Consequently, the lesson may not go as planned, creating uncertainty for students and leading them to leave the video without watching it entirely. Students may get bored, disoriented, or feel lost due to the lack of guiding information within the videos. Kim et al. (2014) analyzed user interactions in 862 videos from four different MOOCs on the edX platform and found that video length and video type were significant variables in predicting students' video dropout. They also found that the

dropout rate increased with video length. Another study conducted by Guo et al. (2014) examined approximately seven million video sessions on the edX platform and investigated the relationship between video design and student engagement. The research findings indicated that shorter videos were more engaging, while pre-recorded classroom lectures, even when presented in smaller chunks, were less engaging compared to other video types.

In the video-watching sessions within Cluster 4, it is observed that students mostly watched the videos from start to finish. However, upon visual analysis, it is noticed that in some of these sessions, students passively watched the videos without engaging in any activity. Students may exhibit this behavior believing that their video-watching will impact their final scores. This behavior could be related to gaming (Baker et al., 2008) or off-task behavior. In the other part of these sessions, more active engagement is observed with activities such as pausing, playing, and skipping. Seo et al. (2021) explored how students' video-watching activities map to different engagement goals and intents. Some of the mappings found between active video engagement and video activities are as follows: Students reported that they often pause to summarize in their notebooks. They often rewound when they wanted to make sure they did not miss anything or when they did not get the explanation the first time.

Conclusion

Although lecture capture videos may not be considered best practice from the perspective of multimedia learning theory (Clark & Mayer, 2016), they are often preferred by teachers due to their ease of preparation. Studies based on self-report data also indicate that students have positive perceptions of lecture captures (Dommett et al., 2020). However, the widespread use of lecture capture or positive student perceptions does not provide evidence of their actual usage. Therefore, this study has focused on actual usage data to provide evidence-based insights into students' engagement with the lecture capture videos. Our results showed that most of the video-watching sessions examined (58%) consisted of superficial interactions. Moreover, in only a small number of sessions, students actively watched the video from start to finish. In other sessions, they actively watched only a part of the video.

Limitations

The scope of this research study is limited to the use of click-stream data to identify common behavioral patterns; however, it doesn't delve into the underlying motivations behind students' specific engagement with the videos. Aspects such as the level of attentiveness of students during video viewing and its correlation with the nature of the video content were not investigated in this study. This leaves room for further exploration.

Implications

The findings of this research offer important implications for designing more effective video-based learning environments. Within large lecture capture videos, instructors can mark the time points where specific topics are taught or discussed during the lectures to help students browse through videos more effectively. For example, the instructor can mark the moment when the assignment is discussed, which would allow students to easily refer back to the instructions when working on the assignment. Moreover, although

lecture captures have the advantage of being quickly available to students, their segmentation into smaller, manageable portions might be more desirable for several reasons. These segments can focus on specific topics, which may allow students to easily locate and revisit specific sections for reinforcement of concepts.

In the field of learning analytics, sequence analyses are applied to click-stream data to identify similar sequences of student or learning sessions. The commonly used approach for this purpose is clustering the clickstreams of students' learning sessions as they are. However, clustering similar sessions becomes challenging due to the varying number of interactions in these sessions. In this study, students' video-watching sessions were processed using a custom script developed by the researchers and transformed into standard sequences before applying the clustering process. This also allowed for the alignment of sessions in a similar manner, despite differences in video lengths and activity counts in the sessions.

Future Directions

This study presents a novel approach to the analysis of video-watching sessions. By using this approach, answers to different research questions can be sought in future studies. For instance, future research can analyze how students' video-watching behaviors vary over time and across tasks. Similarly, it can be determined whether these watching behaviors are individual characteristics of students or if they are employed as a temporal strategy. The process mining analysis used in this study has shown that three different watching behaviors are commonly used: linear, pausing and replaying, and skipping. It is important to analyze in future studies when students exhibit these behaviors and which watching behaviors are more related to learning outcomes. Moreover, employing a similar approach, the impact of modifications in video design (such as dividing videos into smaller segments based on topics or incorporating markers on the video timeline indicating different topics) on students' video-watching behaviors can be investigated. This would enable the acquisition of data-driven evidence to maximize the benefits derived from commonly used and highly preferred video materials in educational environments. Also, the frequency of students' video visits and the time delay between them could provide additional insights into students' video engagement. Future research can explore these aspects to identify other student behaviors, such as the tendency of specific student groups to rewatch videos, and the videos that were more frequently visited by students.

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Alone in the Academic Ultraperiphery: Online Doctoral Candidates' Quest to Belong, Thrive, and Succeed

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Abstract

Despite the increasing number of non-traditional doctoral researchers, this population's experiences remain largely understudied and their voices unheard. Through in-depth interviews with 24 part-time online doctoral candidates, we explored the perceived facilitators and barriers to academic integration and sense of belonging, as well as how online delivery influences the doctoral journey. Reflexive thematic analysis revealed a strong drive for participation, sometimes matched by the supervisor but rarely supported by the institution, which in the end does not sufficiently promote community building. Online delivery was viewed as both a blessing for the accessibility it enabled and a curse due to pervasive feelings of isolation and virtually non-existent peer networks. Online doctoral researchers coped by breaking free from the fully online model whenever possible to seek in-person and synchronous interactions and guidance. We conclude that online doctoral candidates constitute an ultraperipheral population in the academic landscape. Support provided by online PhD programmes should be modelled after the actual needs of their non-traditional students.

Keywords: online PhD studies, part-time online doctoral student, thematic analysis, lived experience, ultraperiphery

Alone in the Academic Ultraperiphery: Online Doctoral Candidates' Quest to Belong, Thrive, and Succeed

Doctoral education continues its global expansion trend of the last few decades (Organisation for Economic Co-operation and Development [OECD], 2022). Hybrid and fully online programmes are now commonplace (Lee, 2022), particularly in a post-pandemic world where online work and study have become increasingly entrenched. Concurrently, doctoral candidates are now much more diverse than in previous decades in terms of gender, age, socioeconomic background, and ethnicity (UK Council for Graduate Education, 2023). The non-traditional profile of doctoral candidate is rapidly challenging the traditional young, on-site, and full-time candidate as the norm in this educational stage (Palmer-Pratt, 2023). However, despite its growing dominance in numbers, individuals within this demographic remain underrepresented, with their voices underheard, and their experiences understudied. PhD programmes continue to be primarily tailored to the needs of traditional, full-time students (Fawns et al., 2021). Furthermore, institutional and governmental policies, as well as grant schemes, frequently overlook or outright exclude the non-traditional student body (Neumann & Rodwell, 2009).

Part-time online doctoral researchers share many challenges with the general doctoral population. Recent research has raised concern over the pervasive low well-being of the whole doctoral student body (Boone et al., 2022), and how early-career researchers are an at-risk group in academia plagued by feelings of isolation and mental health concerns (Naumann et al., 2022; Woolston, 2022). All these factors can compound in the case of mature doctoral researchers studying online and leading complex lives with multiple responsibilities. These candidates face additional challenges in building a community of peers or establishing fulfilling supervisory relationships (Melián et al., 2023), which in turn can affect their satisfaction and engagement (Byrnes et al., 2019), thus putting them at an increased risk of dropout (Studebaker & Curtis, 2021).

Profiles of Non-Traditional Doctoral Candidates

The use of the term non-traditional has grown in the literature, coinciding with the rising numbers of this student demographic. Offerman (2011) characterised these doctoral candidates as older than 30, with professional and family obligations, self-funded, increasingly female, and diverse. More recent definitions (Savva & Nygaard, 2021) described a "peripheral" doctoral candidate pointing at "the on-campus international student, the distance student, the more mature and returning student, the part-time student, and the student pursuing a professional doctorate" (p. 155). This geographical analogy of peripherality originated in Lave and Wenger's (1991) communities of practice and has been employed in doctoral literature to highlight the distinct challenges experienced by non-traditional students. These challenges include overcoming the absence of face-to-face interaction (Cronshaw et al., 2022), sustaining connection and well-being (Elliot et al., 2022), and fostering a sense of belonging to academia (Savva & Nygaard, 2021).

On the other hand, scholarship on part-time doctoral researchers has been particularly poignant in describing this group's predicament. Despite being a significant part of the doctoral population globally and the outright majority in the social sciences (Zahl, 2015), part-time candidates remain invisibilised, with neglectful institutions not supporting them in the same way as full-time candidates (Evans, 2002; Fawns et al., 2021). Likewise, little information about them is available in institutional or public policy reports,

where their needs are rarely discussed. Evans (2002) suggested that universities primarily view part-time doctoral researchers as a reserve army of cheap research labour, simultaneously providing substantial enrolment fees at a marginal maintenance cost. Notably, despite having slightly earlier completion rates and research output adjusted for dedication time (Neumann & Rodwell, 2009), part-time doctoral researchers exhibit lower satisfaction and higher dropout rates compared to their full-time counterparts (Zahl, 2015).

Belonging and Community in Online Doctoral Studies

The inherent flexibility of online studies is a crucial driver of their perceived value among prospective non-traditional doctoral researchers (Pollard & Kumar, 2021). Thus, the classical "anywhere, anytime" motto of online education remains alluring. However, coordinators of doctoral programmes must strike a delicate balance, since too much structural flexibility might end up widening the psychological gap typical of online doctoral candidates, leaving them feeling disconnected (Lee, 2022). This bears significance because disengagement, dissatisfaction, or demotivation in doctoral studies have all been linked to poor academic progress and higher dropout risk (Studebaker & Curtis, 2021). Therefore, "it is critical to ensure that distance students feel that there is a strong academic community in their programme and that they also belong to the community" (Lee, 2022, p. 12).

Doctoral candidates express overwhelmingly positive opinions about their peer community (Pollard & Kumar, 2021). Peer networks provide learners with emotional support and validation, benchmarking of academic progress, and the informal exchange of crucial information (Wang et al., 2023). When crises hit, having a supportive community of peers can compensate for the effects of inadequate supervision and even tilt the balance towards persisting in the PhD when faced with thoughts of discontinuing (Zahl, 2015). Although building such communities is more challenging in the absence of physical interaction, institutions fostering cohort-based structures and facilitating synchronous interactions can successfully contribute to community building among their online learners (Lee, 2022; Savva & Nygaard, 2021).

Although research into online doctoral candidates is growing, it remains relatively scarce, with most studies still focused on young, face-to-face, and full-time doctoral candidates. Considering this gap and willing to contribute to the understanding of online doctoral researchers' experiences, this study posed the following questions:

- What factors support or hinder online candidates' participation in the academic community?
- How does the online environment impact the experiences of doctoral researchers?
- What coping strategies do online doctoral researchers employ when facing challenges?

Methodology

Context of the Study

This research was conducted at a Spanish open online university. The doctoral school coordinates and organises nine PhD programmes in both the social sciences and technical domains. The doctorates are taught in English and generally consist of an initial stage (2 or 3 semesters) with a few compulsory courses, followed by an unstructured stage of supervised research and autonomous work towards the writing of journal articles and/or a dissertation. There are no compulsory residential or other in-person activities, but some seminars throughout the PhD are held online and synchronously. A minority of the enrolled PhD candidates in these studies (21%) complete their PhDs full-time in a hybrid format and receive a grant/salary as regular university staff. In contrast, the vast majority (79%) pursue their degrees on a part-time basis, fully online, and without funding (Universitat Oberta de Catalunya, 2023).

Design and Participants

This research was a qualitative, interview-based, single-case study. We employed a maximum variation sampling approach (Merriam & Tisdell, 2009) to ensure we captured the widest range of experiences from online doctoral researchers across various programmes, stages, and backgrounds.

The sample consisted of 24 part-time online doctoral candidates. Table 1 provides demographic information about each participant. They came from six different programmes, with most participants enrolled in education and information and communication technology (ICT; n = 10), and information and knowledge society (n = 8). There were also participants from the fields of psychology (n = 3), business (n = 1), tourism (n = 1), and information technology (IT; n = 1). Participants were at different stages of their studies: from the first year (n = 7), to mid-phase (n = 9), to the final stage or graduated in the last five years (n = 8). Their average age was 43 years, ranging from 27 to 63. Half of the participants were female. Of the 24 participants, 15 originated from Spain, with representation from other countries in Europe (n = 4), Latin America (n = 2), North America (n = 2), and Africa (n = 1). All participants balanced paid work alongside their doctoral studies, with eight holding positions at various universities.

Table 1

Participant Demographics (n = 24)

Pseudonym	Country	Gender	Age	PhD programme
Josep	Spain	M	63	Information and Knowledge Society
Anya	Russia	F	50	Business Management
Obi	Nigeria	M	40	Society, Technology, and Culture
Andreu	Spain	M	57	Education and ICT
Maria	Spain	F	55	Information and Knowledge Society

Pedro	Spain	M	41	Network and Information Technologies
Marta	Spain	F	48	Education and ICT
Ana	Spain	F	32	Education and ICT
Sarah	Canada	F	43	Education and ICT
Oriol	Spain	M	53	Society, Technology, and Culture
Manel	Spain	M	40	Information and Knowledge Society
Pau	Spain	M	59	Education and ICT
Federica	Italy	F	31	Health and Psychology
Juan	Spain	M	33	Information and Knowledge Society
Sandra	Spain	F	28	Education and ICT
Carles	Spain	M	27	Education and ICT
Emma	UK	F	55	Education and ICT
Matteo	Italy	M	48	Education and ICT
Laura	US	F	48	Tourism
Aroa	Spain	F	27	Health and Psychology
Héctor	Spain	M	31	Health and Psychology
Paola	Colombia	F	36	Education and ICT
Vicent	Spain	M	37	Information and Knowledge Society
Sofía	Argentina	F	46	Information and Knowledge Society

Data Collection

After receiving approval from the university's ethics committee, and with the help of the doctoral school, we sent out invitations to participate in the study to all individuals currently enrolled part-time in a Universitat Oberta de Catalunya PhD programme, along with recent graduates. Initially, 32 candidates expressed interest, but eight, being unresponsive, did not proceed. Ultimately, 24 participants advanced to the interview stage. We provided them with information about the interview process, including its procedure, duration, and subject matter, as well as details about confidentiality and their rights. All participants signed an informed consent form. We piloted the interview to get feedback and make the necessary adjustments. The interview guide covered the following topics: (a) the candidate's background and context; (b) initial expectations regarding the PhD and future career prospects; (c) barriers and

facilitators to doctoral study; (d) crises and critical moments; (e) interactions between personal life, work, and study; and (f) identity and sense of competence.

We carried out the interviews from June to November 2022. Most of the interviews were held via videoconference, but two were conducted face-to-face at the request of the participants, who preferred to meet the researcher at the university premises. The interviews typically lasted around one hour, with some being as short as 50 minutes and others extending to 75 minutes. We recorded the conversations with the participants' consent. The interviews were semi-structured, prioritising building rapport with participants over strictly following a predetermined question order. As interviews progressed, we allowed for greater flexibility by excluding questions that didn't align with the participant's current narrative or introducing unscripted questions when necessary to gain deeper insights into their most salient experiences. In several cases, we sent follow-up questions via e-mail a few days after the live interview to clarify some key aspects that were discussed. In one case, a participant reached out to us to share relevant afterthoughts stemming from our previous conversation.

Data Analysis

After transcribing the interviews and reviewing them for accuracy against the recorded audio, we utilised Atlas.ti 23 software to assist us during the coding process. The analysis followed the six-phase approach to reflexive thematic analysis described in Braun and Clarke (2021). These phases comprised (a) familiarising oneself with the data, (b) generating codes, (c) developing themes, (d) reviewing themes, (e) defining and naming themes, and (f) producing the report. In practice, these stages were not linear and involved an iterative exercise of refining codes and themes. The first author took notes from the outset of the fieldwork and conducted an initial trial coding that was then discussed with the second author in successive meetings. These meetings served to build a shared understanding of the research focus, discard codes deemed irrelevant, and agree on the themes that would articulate the findings. Some of the topics discussed had been emphasising the impacts of the online modality, avoiding the psychologisation of students' struggles, or considering the close position of the first author and the participants. Our objective during the analysis was to capture participants' experiences as lived and described by them, in their own way. Therefore, we leaned towards a critical realist theoretical framework in which coding is primarily inductive, and theme development focuses on the semantic level of the participants' accounts (Braun & Clarke, 2021, p. 10).

Findings and Discussion

We will now present the study's results and analysis, organised into three themes. First, we cover general factors that affect the integration of online candidates. Next, we delve into the perceived influence of the online medium on participants' doctoral journeys. Finally, we explore the coping efforts that candidates deploy when facing challenges.

Ways of (Not) Belonging—Or the Search for Inclusion

One of the most prominent patterns crossing the dataset was the participants' strong desire for inclusion and participation within the academic community. They consistently emphasised the importance of not equating their part-time status as a PhD candidate with a somehow diminished or part-time commitment

to their doctoral journey. In the following excerpt, Manel exemplified the tensions of balancing a part-time status with a wholehearted dedication:

> I have always been clear that I would pursue a doctorate; it is a personal priority, though not a financial one. . . . It's always on my mind, like a worm crawling through my head, saying "I am here." It's a lifelong project that I love, but I cannot dedicate more hours, I simply can't.

This theme, therefore, encapsulates the participants' shared desire for inclusion and belonging within the academic community. It also highlights the factors that either facilitate or impede their sense of belonging.

Supervision has been identified in the general doctoral literature as the most crucial of the said factors, greatly affecting the overall doctoral researchers' journey (Palmer-Pratt, 2023) and, particularly, their assessment of whether the PhD was worth the time and effort invested (Rainford & Guccione, 2023). Accordingly, it was the most frequently discussed topic in our participants' accounts. Broadly, most candidates in our study expressed satisfaction with their supervisors, aligning with recent literature regarding both on-campus (Woolston, 2022) and online doctoral programmes (Jameson & Torres, 2019). However, some of these positive evaluations may have been influenced by the lack of references regarding what to expect from supervisors, as we will discuss in more detail later. Meanwhile, some participants had critical views of their supervision experience so far, and only in two cases were the assessments exceptionally positive or negative.

Supervision can "make or break a PhD student" (Lee, 2008, p. 267). Supervisors are key in keeping doctoral researchers engaged and motivated, while a perceived lack of support has been linked to increased cynicism and burnout (Boone et al., 2022). According to our participants, the supervisor was, at its best, a figure that was present, reachable, and supportive. Participants valued having regular meetings, particularly in the early stages of the online doctorate. This support was crucial to prevent a frequently reported problem for those unsatisfied with their supervisors: the loss of time, often weeks or even months, pursuing research paths that eventually led nowhere. Ana illustrated this point by noting, "I don't want to bother asking too much. So, I go ahead on my own and then we meet up and they tell me, 'Not this, not that.' I've stumbled a lot because of this." Indeed, supervisors who were available through various means (e.g., WhatsApp, e-mail, videoconferencing) and provided timely and specific feedback on the written work were highly appreciated. A proactive stance was generally preferred but accompanied by the supervisor's ability to adapt to the candidates' changing life conditions, leaving them more space when needed.

Accounts of satisfactory supervision always had an emotional side to them. Many participants considered emotional support just as important as academic support. Words of reassurance at the right moment had dramatic effects on the doctoral researcher, even tipping the balance towards continuing with the doctorate. This was the case with Sandra, who, after changing supervisors, recalled the impact of a conversation with her new supervisor that completely changed her mindset. From initially feeling inadequate and thinking she would be "one of those who quit in the first year," to eventually experiencing great encouragement and motivation, thinking "oh, well, this can actually work!" Indeed, the doctoral pursuit has been characterised as emotional labour in the literature; most doctoral researchers experience a roller coaster of emotions during their doctoral studies (Wang et al., 2023) and some even report existential crises at some point due to heavy pressure and competition (Skakni, 2018).

Our dissatisfied participants mostly shared experiences of a hands-off approach by their supervisors. General unavailability was compounded by the inherent power imbalance within the supervisory relationship and the doctoral researchers' hesitation to bother their allegedly extremely busy professors with what they considered petty doubts and concerns.

Among the dissatisfied participants, we encountered a case of toxic supervision. Sarah initially dealt with the typical hard-to-reach supervisor, who gradually escalated into an angry one when she grew tired of waiting for feedback that never seemed to arrive, and started fending for herself by looking for connections and help beyond her supervisor, in her home country. The fear of negative repercussions on her reputation stemming from an actively antagonising prestigious academic in the field, coupled with internalised guilt, was paralysing. Paradoxically, these challenges eventually led Sarah to find a new opportunity as a research assistant, where she received the guidance she lacked, allowing her to complete her doctorate and ultimately build a research career. It is important to note that this case was an exception, both in terms of the extreme negativity of the relationship and the ultimately positive outcome for the doctoral researcher career-wise. Typically, though, even the more common hands-off supervision is detrimental to candidates' mental health, networking opportunities, and degree completion (Wang et al., 2023; White et al., 2022).

Research analysing the roles of supervision and community has found that serving distinct functions, the latter complements rather than compensates for the former (Wang et al., 2023). Concurrently, other authors have emphasised the pivotal role of peers in providing support to online candidates when supervision falls short (Rainford & Guccione, 2023). Along these lines, Sarah exemplified how peers can act as a lever for change in times of crisis:

> I wouldn't say that communication [with the supervisor] improved, but I developed a strong friendship with my peers, I found more people whom I could connect with, who could answer my questions, and in the end, I just did my own work.

In this regard, our participants demonstrated resilience despite the widely held perception that the institution does little to actively promote community building among part-time online candidates. Josep observed that "there's a lack of an online doctoral student community that connects people. . . . In the end, I set up the WhatsApp group myself with people I've met." In the early stages of the programme, online doctoral researchers have some opportunities to meet and work with each other through mandatory courses. A few participants then established some friendships, but they generally proved transitory, fading gradually.

Indeed, referring to on-campus doctoral candidates, Pilbeam et al. (2013) remarked that it was common for peer networks formed in the initial stage of the doctorate to decline due to increased specialisation and different rates of progress among the candidates. Therefore, it is crucial to design a programme, especially within the constraints of online delivery, that promotes ongoing shared experiences and a common purpose, facilitating lasting peer connections.

Following the early stages, several training sessions or evaluation seminars were held synchronously throughout the online doctorate under study. These seminars proved valuable to many of our participants, helping them learn about their peers' work and discover strategies that could be useful to them. For

instance, Paola remembered how watching a presentation from a colleague who was further along in their research both overwhelmed and encouraged her to conduct her own systematic review. This case exemplified one of the primary benefits offered by a peer network, which is the ability to measure your progress and receive validation that you can achieve your objectives (Pilbeam et al., 2013). More rarely, online candidates had interactions with other learners under the same supervisor or within their supervisor's research group.

Despite these instances of connection, almost all our participants felt the acute effects of the lack of regular socialisation. This proved a major contributing factor to not feeling they belonged to the academic community and, for some, their main challenge in the doctorate. For Aroa, it was draining and demotivating not to have fellow researchers with whom she could share her frustrations and experiences. Other participants explicitly reported feeling "very lonely" (Héctor, Sofía, Anya, Josep, Obi, Marta, Ana), "immense loneliness" (Pau), "abandoned" (Paola), "disconnected" (Sarah), or "lost" (Carles, Oriol). These data aligned with research stressing how isolating PhD programmes are (Naumann et al., 2022), particularly in the distance mode (Melián et al., 2023). Crucially, a sense of belonging to the community is a protective factor against poor mental health and intentions to drop out (Boone et al., 2022).

Besides the mentioned factors typically emphasized in the literature, our participants highlighted additional barriers to inclusion and belongingness related to their socio-demographic backgrounds and life events. First, international students from the Global South disproportionately struggled with material issues, ranging from currency devaluations and social crises (Sofía) to unreliable electricity grids or Internet connections (Obi), that seriously hampered their progress. These stark differences in concerns compared to doctoral candidates from the North were already highlighted in Woolston's large PhD survey (2022). Gender also proved to be a significant factor. For several female participants, recent parenthood had seriously disruptive effects, whereas no such challenges were reported by any of our male participants. In this regard, emergent research has been exploring the inhospitable terrain doctoral degrees often present to mothers (Mason et al., 2023) and the ways they may alleviate isolation through fostering online communities (Cronshaw et al., 2022). Finally, the global pandemic further impacted the doctoral journeys of all participants. While some reported experiencing reduced income, job dismissals, and unforeseen family responsibilities, others found they unexpectedly had more time to dedicate to their thesis.

Online Delivery is a Double-Edged Sword

The participants' relationship with online delivery was characterised by ambivalence, which stemmed from the fact that choosing the online mode came with trade-offs. The same characteristics of the programme that allowed students to access a doctorate that would be impossible otherwise were to blame for some of its more relevant drawbacks. Andreu illustrated the tensions between convenience and isolation:

> The advantage of this university is the flexibility, otherwise, I would not have been able to pursue the doctorate. But, on the other hand, it implies that informal exchanges and creating a community of peers simply are not possible.

This ambivalence has been reported in Melián et al.'s review (2023), which highlighted an apparent paradox in which online PhD researchers were both grateful for the opportunity that the online modality allowed

and, simultaneously, yearned for physical presence and interaction. Relatedly, some participants pondered whether some of the challenges they were experiencing—such as inadequate supervision, limited institutional support, or a lack of socialisation—were attributable to the nature of online delivery or the particular features of either the overall doctoral educational stage or the specific doctoral programme they were enrolled in.

Our participants expressed two main perspectives on this issue. On the one hand, a more fatalistic stance assumed that "the institution can do little more [as this situation is] normal in all distance universities" (Pedro), and ultimately "the price you pay for accessibility" (Andreu).

Conversely, other participants adopted a more possibilist stance. They compared their current experience with other postgraduate online education they had received in the past and aimed to prove that online delivery did not inevitably imply high levels of disengagement. For example, Paola recalled building an "active community with continuous exchanges in an environment that cared" during her online master's degree, something she only glimpsed in the initial year of her current PhD. Other participants, in the same vein, pondered that their struggles in the doctorate were not necessarily determined by online delivery and that there was ample room for improvement in their PhD programme if there was a willingness on the part of the coordinators. In this regard, Vicent opined:

> This university might feel cold because it is an online university. But if, on top of that, no effort is made to humanise it a little—to make the professor, supervisor, and administration more approachable—then we are in trouble.

In alignment with Fawns et al. (2021), we argue that online learning is not inherently predisposed in any particular way; its nature is shaped by our actions. As the singer Björk has said, "if there is no soul in computer music, then it's because nobody put it there" (as cited in Fawns et al., 2021, p. xvi), and the same applies here. Therefore, the discourse should primarily focus on institutional and faculty commitment, along with the allocation of resources that cultivate online environments conducive to promoting socialisation and community building. This becomes even more crucial when we consider the transformative effects many candidates experience in their lives and personalities because of pursuing a doctorate online (Savva & Nygaard, 2021). Advocating for programme adaptation to the needs of non-traditional PhD researchers is therefore essential to avoid wasting this potential.

On a final note, our participants' narratives revealed that the division between online and face-to-face programmes does not operate categorically but rather exists along a spectrum. Even in an allegedly fully online programme such as theirs, many doctoral candidates actively sought face-to-face interactions to bypass the constrictions of the format and enhance their sense of belonging. They achieved this by seeking face-to-face contact with supervisors, attending conferences, doing short-term stays, or networking through social media. Andreu only felt that he somehow belonged to the academic community when he went to a conference, "not so much when presenting the paper, but afterwards at lunch, being surrounded by professors from the university." Even participating in this study was seen by several online candidates as a way to feel included, accessing the university premises for the first time. Oriol expressed this sentiment during the face-to-face interview, repeating, "in this doctorate, I'm missing out on making contact."

Our participants were, thus, particularly active in trying to move away from rigid categories such as fully online. When this approach to learning did not serve their purposes, usually because they felt they needed some face-to-face interaction to progress, they found ways to break free from it. Ultimately, online and face-to-face learning always exist on a continuum (Veletsianos, 2020), and if the programme structure fails to meet the needs of doctoral researchers, they find ways to adapt it themselves. In line with this perspective, Lee (2022) called for reflection on the designs of online PhD programmes, emphasising that sometimes sacrificing some flexibility and accessibility to provide opportunities for physical and synchronous interaction can be extremely beneficial. This is because these types of interactions, even in small doses, can alleviate isolation and boost the formation of peer networks (Conrad, 2005).

Nobody Knows What to Expect (But Candidates Cope)

Our participants began their PhD journeys with high hopes and excitement. However, many found themselves lacking direct knowledge of the broader doctoral stage, particularly when it came to pursuing a PhD online. Their prior educational experiences were often limited to on-campus education during their younger years. Consequently, online candidates frequently held unrealistic expectations, especially concerning aspects such as the feasibility of the program and the expected workload. For example, both Anya and Obi were told prior to beginning the programme that "the online PhD is easier than face-to-face and has a flexible schedule that you can adapt to your life."

It is a recurrent finding in the literature that doctoral researchers entering online PhD programmes lack familiarity with the doctoral processes and have unadjusted expectations regarding issues such as difficulty, workload, or isolation (Jameson et al., 2023). This adds uncertainty to the adaptation process and hinders satisfaction and persistence (Skakni, 2018). Therefore, online universities should proactively manage students' expectations, ideally before enrolment (Fawns et al., 2021), by providing clear guidelines on what is expected, the challenges they typically encounter, and the available support resources.

Soon into the doctoral journey, our participants realised that the online PhD programme was more demanding and isolating than anticipated. Laura was expecting a "more systematic experience," Vicent missed more "personal support and for the programme not to be so e-mail-based," while Pedro initially expected it "to be like the master's [only to discover that] it's not, neither in terms of demands nor in structure. When you pass the first year, you hit a wall, and that can make you burn out."

Previous research confirms Pedro's observation. Jameson and Torres (2019) noted that the transition from first year, or coursework stage of the online PhD, to a more unstructured dissertation stage, is often experienced as a shock and a crisis. During this period, candidates must adjust their expectations and build confidence in their ability to carry out the research. Therefore, it is especially important for them to have external support from supervisors, peers, or the institution to minimise the risk of frustration and dropout.

During the interviews, we frequently encountered expressions of perplexity and bewilderment regarding insufficient supervision or institutional support, as illustrated by the following excerpts:

> The doubts are immense. I don't know where the limit is for what I can ask or not. What happens? I don't know if it's normal. I honestly have no idea, but in the end, I've gotten used to it. (Josep)

> I feel that I'm not only alone, but I'm also struggling at an official level. If everyone feels the same, I don't know. (Anya)

Indeed, candidates did not anticipate experiencing such high levels of loneliness and isolation during their part-time online doctoral journey. When contact with the supervisor is sporadic, there is no interaction with peers or research groups, and communication with the institution is primarily e-mail-based, a realisation of being on your own becomes apparent. As Josep put it, "what you wonder is: Is there anyone else? No, there's no one else. It's just what it is." Moreover, isolation only intensified as candidates progressed in the programme, moving from the relatively structured first three semesters to the unstructured remainder of the degree.

A slightly different issue arose around autonomy. Several participants felt the autonomous work that was expected from them sometimes served as an excuse for low accompaniment by supervisors. Juan, in his second year, was expecting to work on his own, "but not to this extent!" The bar was so low that he fondly remembered when in his first year he had three or four videoconference meetings with his supervisor. Ana, beginning her third year, opined that the very phrase "autonomous work" was used as a euphemism for a supervisor adopting a hands-off approach. She felt that this, combined with the "vague resources provided by the courses" generated uncertainty and a sense of having to fend for yourself.

Jameson et al. (2023) also found concern among their on-campus doctoral participants about navigating what they perceived as excessive autonomy. However, their participants were in the later stages of the PhD, while we found the same concern from our participants, even at the beginning. Indeed, one of the distinctive features of doctoral studies is the expectation of increasing autonomy aimed at training for independent research. However, this autonomy should be scaffolded and supported by the supervisor in a way that nurtures the candidate's sense of competence and intrinsic motivation (Jameson et al., 2023). Under no circumstances should alleged autonomy mask neglect by the supervisor or the institution, particularly if we consider the distance factor our participants dealt with.

Part-time online doctoral researchers employed various strategies to address the challenges described. At the most basic level, faced with the absence of institutional funding opportunities, they had to self-fund everything, from essential tools such as analysis software to attending conferences or research stays. Attending these events, however, proved highly beneficial. Sofía, for instance, took a flight from Argentina to Barcelona to spend several weeks with her supervisor and research team. "It was like you felt a part of it. . . . Then I came back with a lot of energy to write. That visit served as a push for my thesis, and I said, 'Now, yes!'" Conversely, Matteo turned to an academic social media platform to try to establish a peer network and enhance his visibility, "I've understood that while you study, you have to learn how to build connections. You have to, in a good way, create networks and collaborate with other authors who may have more opportunities than you." Finally, several participants sought external guidance as a substitute for inadequate supervision. A few, such as Sarah mentioned earlier, Pau, or Maria, actively sought support from scholars from other universities to fill the gap left by inadequate supervision, particularly concerning methodological matters.

Limitations and Future Research

This study shares some of the typical limitations of a single case study qualitative research. While we cannot claim generalisability, our results are consistent with previous literature on the subject (Lee, 2022; Melián et al., 2023; Rainford & Guccione, 2023). Some form of transferability (Braun & Clarke, 2021, pp. 143) of our findings to similar contexts and populations is, therefore, probable. Additionally, our sample of 24 participants is quite substantial by the standards of interview-based qualitative investigations.

Another limitation is that our participants were all currently enrolled online doctoral researchers. This can cause our results to be skewed by survivor bias. We lacked the perspectives of candidates who discontinued their studies, which would certainly offer valuable insights to complement the experiences shared by their persisting colleagues. Given the striking scarcity of research on online PhD dropouts, future studies should collect their testimonies. We also obtained intriguing, albeit limited, results from specific demographic groups, such as international students from the Global South. Similarly, we observed gender differences regarding the impact of parenthood on online PhD experiences. Both populations warrant further exploration.

Conclusions

"You feel like a satellite, a loose thing out there. . . . It's like, 'What on earth is this university?'" (Sofía).

Our participants' experiences extended beyond Savva and Nygaard's (2021) depiction of a peripheral doctoral candidate in terms of remoteness and heightened barriers to resource access. Participants in our study pursue their PhDs part-time, online, and often from their native countries, aligning them more closely with an ultraperipheral group in the academic landscape. We draw a parallel with ultraperipherality—a term used in the European Union to describe remote, isolated regions facing persistent obstacles regarding representation, participation, and access to funding and resources. This emphasises the need for specific measures to facilitate their integration (Kochenov, 2011).

The doctoral journey is a bumpy road for everyone. However, pursuing a doctorate part-time and online introduces additional challenges that stack the odds against these research learners. For online candidates, everything becomes distant. They often feel invisible and neglected by the institution. While most are generally satisfied with supervision, a significant part is not, and we found one case of a toxic experience. Peers are a faraway reality too, with most online doctoral candidates unable to form lasting alliances with peers. Despite these challenges, part-time online candidates proved resilient. Their main coping strategy involved breaking the mould, not only of the purely online format but also of the exclusive online supervisory relationship. They incorporated occasional forms of synchronous and face-to-face interaction to seek guidance and participation. Additionally, some compensated for insufficient supervision by seeking external scholarly support.

This study offered a rare look into the lived experiences of part-time online candidates leading complex lives while carrying out their PhD research. As a result, we derive several recommendations. Online PhD programmes can do more to support these research learners. First, they need to provide a welcoming and

supportive environment for non-traditional doctoral candidates, who represent most of their student population. This means tailoring the design of the programme to these candidates' needs. In this regard, it is crucial to continually provide opportunities for them to connect with their cohorts and build peer networks throughout the PhD journey. Gathering proposals, while primarily online and synchronous, should also consider incorporating occasional face-to-face interactions. Furthermore, the transition from the coursework stage to the dissertation stage is critical and needs particular attention. Regarding the supervisory relationship, candidates need to have clear expectations, ideally even before enrolling, about what it entails and what their respective rights and obligations are. Supervisors also require guidelines, training, and accountability. Finally, we must not underestimate the importance of supporting well-being among online doctoral researchers. As our study participants have shown, pursuing a doctorate is not only an intellectual endeavour but also an emotional one.

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Identifying Pedagogical Design and Implementation of Synchronous Virtual Classrooms

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Abstract

This study aimed to systematically compile the activities and applications to be used by instructors to conduct synchronous virtual classrooms effectively. Using specific keywords in various databases we examined the literature to discover the activities and applications associated with effective synchronous virtual classrooms. A total of 70 studies were included in the study, based upon pre-determined criteria. A total of 53 activities and applications for conducting synchronous virtual classrooms effectively were obtained and classified according to Gagné's nine events of instruction (GNEI). These activities and applications were sorted within 11 themes dimensions: technical control, environment control, clarity, introductory activities, technological tools, course materials, interaction, feedback, summarizing, time management, and self-assessment. Synchronous virtual classrooms conducted according to this classification will serve as a guide for instructors to conduct synchronous virtual classrooms effectively.

Keywords: distance education, virtual classroom, synchronous virtual classroom, synchronous course, quality course design, videoconferencing

Identifying Pedagogical Design and Implementation of Synchronous Virtual Classrooms

In recent years, information and communication technology advancements have led to a transformation of distance education. This change has seen distance learning shift from a one-dimensional learning approach, where students interacted independently with learning materials, to a multi-dimensional one. Students now engage with learning materials, instructors, and their peers (Alenezi, 2023; Borel, 2013; Rovai & Downey, 2010). These learning environments have been delivered both synchronously and asynchronously, using the opportunities presented by digital technologies. They are tailored to the specific needs, scope, and structure of the education being delivered (Borel, 2013; Romiszowski, 2004).

Synchronous virtual classrooms are learning environments where instructors and learners come together in an online environment at the same time, communicate with each other through audio and video, and share experiences; teaching activities take place via Internet technologies (Akyurek, 2020; Moallem, 2015; Watts, 2016). Synchronous virtual classrooms have been seen as similar to physical classrooms in many ways (McBrien et al., 2009; Tyrväinen et al., 2021). Physical classrooms for face-to-face learning and virtual synchronous classrooms have both allowed for instant feedback, instructor and peer communication, and guided practice to motivate learners and increase their learning (Yilmaz, 2015). As in a face-to-face classroom environment (Stewart et al., 2011), the structure and use of synchronous virtual classrooms in distance education environments have offered a contextual and interactive learning environment with improved collaboration and communication, convenience, and efficiency (Basaran et al., 2021; Wang, 2005), as well as learner control, personalization, and reduced feeling of isolation (Racheva, 2018). They have also offered opportunities for collaborative or group activities (Chowdhury, 2020; Maanvizhi et al., 2020; Mueller & Strohmeier, 2011), as well as discussion and question-answer sessions (Fasso, 2013). In a well-structured synchronous virtual classroom, instructors encourage learners to change their perspectives, increase their continuous and dynamic interaction, while strengthening teaching, social, and cognitive presences (Choppin et al., 2020; Szeto, 2015).

Synchronous virtual classrooms consist of components with both instructional potential and technical possibilities. They have involved student participation, interaction, as well as many tools and activities such as (a) offering explanations about pedagogical terms, (b) explaining the relationships between different concepts and terms, (c) visualizing the content, and (d) giving and receiving instant feedback (Bouhnik & Carmi, 2012; Green et al., 2010). Planning synchronous virtual classroom activities have addressed educational aspects as well as the sensory, social, and motivational feelings of learners in the target audience (Northey et al., 2015). Activities that attracted learners' attention, enhanced dialogue, and ensured learners' active participation were also important (Alfuqaha, 2013). Synchronous virtual classroom platforms have consisted of interfaces with (a) audio, text, and video participation; (b) whiteboards; (c) material and screen sharing; (d) discussion, question and answer, and surveys; and (e) collaborative group work or research. In addition, these platforms provided an effective and productive learning environment thanks to their assessment applications (Aydın & Yuzer, 2006; Martin et al., 2012).

When the problems in synchronous virtual classrooms were examined in the literature, it was found that instructors experienced problems due to a lack of technological literacy, procedural knowledge, and techno-

pedagogical perspectives, as well as a significant gap in verbal and written communication with students (Lahaie, 2007; Lee, 2018). When examining studies that aimed to solve these problems, general recommendations included using technology based on pedagogy (Bigné et al., 2018; Bouhnik & Carmi, 2012), integrating instructional design elements, including various multimedia elements (Kuo et al., 2014), and using diversified learning methods to conduct synchronous virtual classrooms effectively and efficiently (Alfuqaha, 2013).

This study identified a technical/teaching activity and application framework for the effective delivery of synchronous virtual classrooms. It was anticipated that the framework, which was intended to help fill the current gap in the literature, would form the basis for further research. We expected that the effective and efficient implementation of synchronous virtual classroom environments would (a) reduce the problems of students separated from instructors by time and space, (b) address the issue of students' isolation, and (c) improve the quality of education. In addition, the activities and applications developed in the study were intended to enable instructors to recognise the problems experienced in synchronous virtual classrooms, and to acquire new skills and benefits by combining the pedagogical and technical competences required by these environments. The aim of the study was to identify the activities and applications by which instructors can carry out synchronous virtual classrooms effectively. We reviewed the literature to seek answers to the following research questions:

1. What factors improve the effectiveness of synchronous virtual classrooms?

2. What activities and applications are associated with effective implementation of synchronous virtual classrooms?

Theoretical Framework

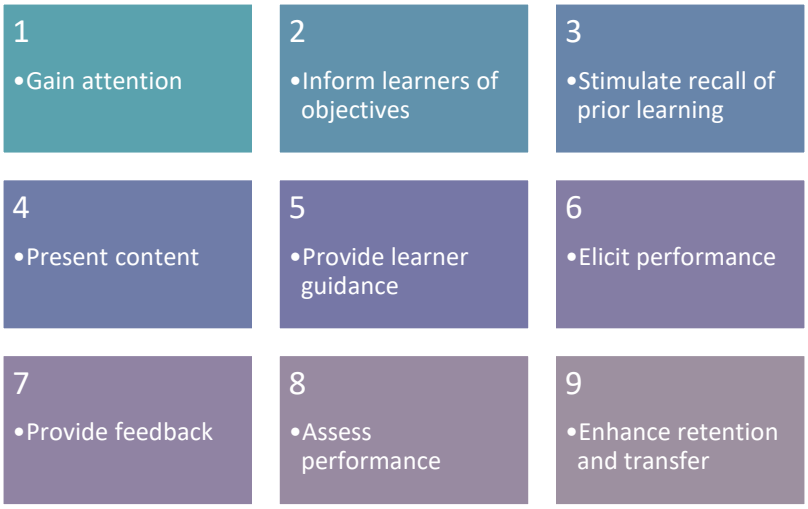
Simonson's equivalency theory emphasized the necessity for appropriate distance education applications to provide equivalent learning experiences for both traditional and online learners (Simonson, 1999). Despite the inherent differences between traditional and distance education processes, this theory emphasized the importance of instructional designs that allowed students to experience equivalent learning experiences, considering the unique characteristics of each learning environment, in order to achieve the expected learning outcomes and goals (Simonson et al., 1999). The importance of synchronous virtual classrooms in providing learning experiences equivalent to traditional education has been considered crucial. Instructors played a key role in transferring instructional activities from traditional settings to synchronous virtual learning environments. Instructors who design synchronous virtual classroom environments have significantly influenced learners' (a) participation levels (Acosta-Tello, 2015), (b) development of positive attitudes towards the class (Bower, 2016), (c) satisfaction, and (d) attainment of efficient learning outcomes. To transform synchronous virtual classrooms into effective teaching environments, instructors integrated the technological features of the platforms where classes were conducted with instructional activities using appropriate methods. Synchronous virtual classroom platforms have generally offer technological features such as (a) content sharing, (b) screen sharing, (c) audio, (d) chat, (e) drawing and annotation tools, (f) polling, (g) instant feedback, and (h) grouping into

small teams (Christopher & Hyder, 2014). When planning, delivering, and evaluating synchronous virtual classrooms, it has been important to consider the technological features available in order to support participation, interaction, and collaboration that aligns with the instructional purpose (Christopher & Hyder, 2014). In addition, Dixon et al. (2019) highlighted the interactive features of virtual classrooms as well as the various communication tools available for synchronous engagement. These tools increased the potential of synchronous virtual classrooms to create interactive and engaging learning environments, further providing an equivalent learning experience regardless of individuals' learning styles.

Gagné's nine events of instruction (GNEI) constituted a teaching framework developed by Robert M. Gagné in the 1960s (Richey, 2000). The nine events were a fundamental part of a foundational instructional theory that has been used for planning instruction for over 30 years and are widely used today as key elements In many instructional design approaches in all levels of instructional design. Gagné stated that the processes in the GNEI do not necessarily follow each other and can be sequenced differently depending on the structure of the course (Gagné et al., 1988; Richey, 2000). Figure 1 illustrates Gagné's nine events of instruction.

Figure 1

Gagné's Nine Events of Instruction



These nine events do not necessarily occur in sequence, though some of them have been used as steps to build up to the introduction of a new topic. The implementation of GNEI in synchronous virtual classrooms has been shown to improve several aspects of teaching and learning. Studies have shown that the integration of GNEI into synchronous virtual classrooms increased cognitive processing, student engagement, and overall instructional effectiveness (McNeill & Fitch, 2022). The model's comprehensive framework and adaptability have made it valuable in designing and delivering effective instruction in virtual educational environments. Synchronous virtual classrooms have often been perceived as an education model with the classroom environment transferred to a digital space. The in-class activities and strategies that instructors have devised based on the GNEI approach positively affected the effectiveness of the teaching offered in these environments (Bickle et al., 2019; Franklin, 2017; Lee et al., 2019).

Method

In this study, a systematic literature review method was used. The systematic literature review included (a) comprehensive screening to select studies that offered a solution to an application-related problem, (b) evaluating the quality of the studies based on pre-determined inclusion and exclusion criteria, (c) determining which studies will be included in the review, and (d) synthesising the findings of the studies included in the review (Kowalczyk & Truluck, 2013). Within this study, published scientific studies on the structure and functioning of synchronous virtual classrooms were systematically reviewed following the steps laid out in the preferred reporting items for systematic reviews and meta-analyses (PRISMA; Moher et al., 2010). PRISMA provided a standard peer-accepted methodology that used a guideline checklist which was strictly followed.

Data Collection

The screening process was completed for this systematic review on October 9, 2022, through the Web of Science, ERIC, Taylor & Francis, ProQuest Theses and Dissertation Database, and Turkey Higher Education Institution Theses and Dissertation database. These databases were preferred because they contained a significant number of studies on education. Studies carried out at higher education level were included in the review. The individual search terms and their combinations are presented below. Search terms as well as search strings were used to conduct the search.

- Synchronous course OR virtual classroom OR synchronous virtual classroom/course OR videoconferencing OR lecturer/tutorial/faculty roles OR quality course OR course design

  AND

- Distance education OR online learning OR e-learning OR open learning

Data Collection and Analysis

Two of this study's authors analyzed the studies included in this systematic review. To ensure inter-rater reliability, the researchers examined each other's analyses. Content analysis method was used for a comprehensive and specific assessment of studies. This method has been widely used for categorizing and comparing text data (Fraenkel &Wallen, 2000). A Microsoft Word form was created to document the title of the research, quality indicators of virtual classrooms, and specific aspects of synchronous virtual classrooms such as (a) structure and functioning, (b) activities and applications, and (c) competences and roles of instructors and students. The form was also used to record the theoretical frameworks and findings of selcted studies.

To begin, full texts of all selected studies were read and related information was entered into the form. Then, codes and categories were created within Microsoft Excel. In the content analysis process, the authors grouped the codes and categories from the 70 studies under examination according to the GNEI framework. These codes and categories, as adapted to the GNEI framework, were presented to four experts in the field for review. Two of the experts each had a PhD in open and distance learning; the other two each had a PhD in computer education and instructional technology. The themes and final version of the activity and applications for effective synchronous virtual classrooms were created in line with the recommendations of

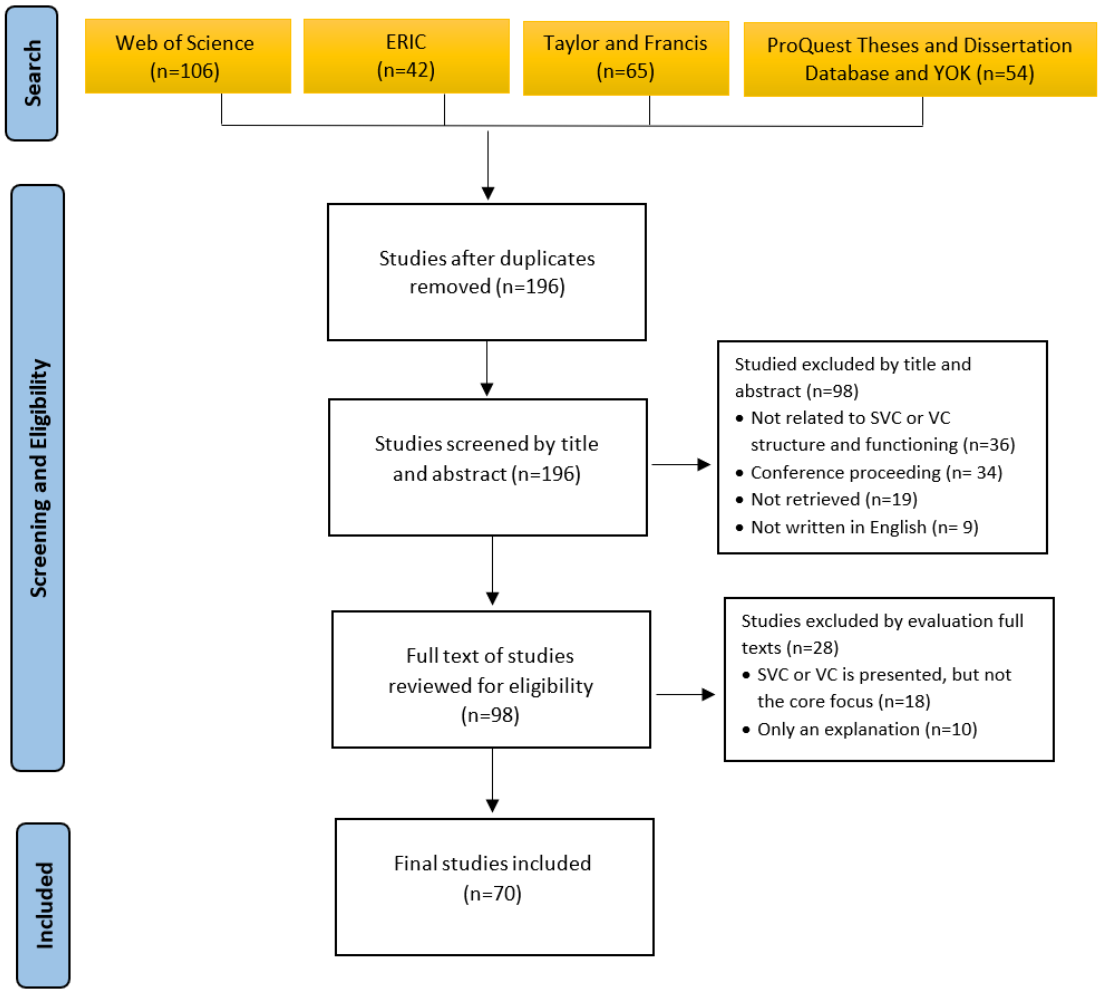
these experts who checked the validity and reliability of the activities and applications drawn from the listerature at this stage.

As shown in Figure 2, 70 studies were examined for systematic review within the content analysis. The following describes how these 70 articles were selected. Five different databases were searched (Web of Science n = 106; ERIC n = 42; Taylor & Francis n = 65; ProQuest Theses and Dissertation Database and Turkey Higher Education Institution Thesis Center n = 54) and total of 267 articles were found. Of these 267 studies, 71 were eliminated because they were duplicates. After reviewing the titles and abstracts, a total of 98 studies were excluded; 36 were not related to the structure and operation of synchronous virtual classrooms, 34 were conference papers, 19 were not accessible, and 9 were not written in English. Another 28 studies were excluded from the study, as 18 did not fully focus on synchronous virtual classrooms or virtual classrooms, and 10 were only descriptive studies with no analysis of activities and applications. As a result, after the processes mentioned above, 70 studies were found to be suitable for examination and were included in the study.

To ensure inter-rater reliability, 20 of these studies were analyzed separately by the researchers; Cohen's kappa coefficient value was found to be 0.79. According to Viera and Garrett (2005) a value between 0.61 and 0.80 is an almost perfect agreement level between the researchers. Two authors analysed the remaining 50 studies after adequate inter-rater reliability was achieved.

Figure 2

Diagram of the Selection Process for Systematic Literature Review



Findings

Factors Related to Effective Synchronous Virtual Classrooms

The studies we reviewed on synchronous virtual classrooms stated that these classrooms can be effective if the design, organization, teaching methods and strategies, and the instructors' and students' motivation are considered as a whole. The factors that were frequently focused on in these studies are summarized in Table 1.

Table 1

Factors Most Frequently Focused on in Studies of Effective Synchronous Virtual Classrooms

Factor	Sample article
Interaction, method, content, success, satisfaction, perception, communication	Kidd and Stamatakis (2006)
Support, interaction, communication, presentation, active participation, technical issues, materials, motivation	Ng (2007)
Technical support, learning activities, materials, pedagogical teaching, method, technical issues, interaction, control, group cohesion, content	Tipton et al. (2011)
Cooperation, interaction, satisfaction	Brodie et al. (2013)
Student opinions, satisfaction, feedback	Sae-Khow (2014)
Cognitive engagement, cognitive effort, motivation, emotional and behavioral engagement	Northey et al. (2015)
Pedagogical perspective, technology integration	Duraku and Hoxha (2020)
Collaboration, interaction, easy access, group discussions, materials	Chowdhury (2020)

When the factors in Table 1 that focus on revealing the effectiveness of synchronous virtual classrooms were examined, it became apparent that there was a general trend from a teacher-centred to a student-centred approach to education (Chowdhury, 2020; Kidd and Stamatakis, 2006; Northey et al., 2015; Tipton et al., 2011). In recent years, with the different technological opportunities offered by synchronous virtual classroom platforms, teaching activities that center on learners in the form of collaboration, group work, interaction, and feedback have become increasingly common. Similarly, it is noteworthy that in recent years, there has been a direct focus on pedagogical perspective, technology integration, and interaction factors with individuals or groups, with almost no focus on content (Chowdhury, 2020; Duraku & Hoxha, 2020; Northey et al. 2015).

Activities and Applications in Effective Virtual Classrooms

To evaluate the experiences and expectations of students and instructors regarding activities and applications in synchronous virtual classrooms, this study conducted a content analysis of 70 scientific studies. The analysis aimed to determine the functioning and structure of synchronous virtual classrooms, as well as the activities and applications that were effective there. The activities and applications from 70 studies were classified according to Gagné's nine events of instruction model. The authors' classification was also presented to field experts for their opinions, and feedback was obtained on its suitability. Field experts recommended dividing the numerous activities and applications from synchronous virtual classrooms into three categories—before lesson, during lesson, and end of lesson. In addition, the field experts stated that the five themes dimensions (i.e., technical control, environment control, technological tools, time management, and self-assessment) obtained from the 70 studies differed from the GNEI model and were specific to synchronous virtual classrooms. Accordingly, technical and environmental control were identified as belonging to the before lesson category, technological tools and time management were

placed in the lesson itself, and self-assessment (since it takes place outside the lesson) was placed in the end of lesson part. The final version of the classification, as approved by the field experts, is presented in Table 2.

Table 2

Categories and Themes Associated with Effective Synchronous Virtual Classrooms

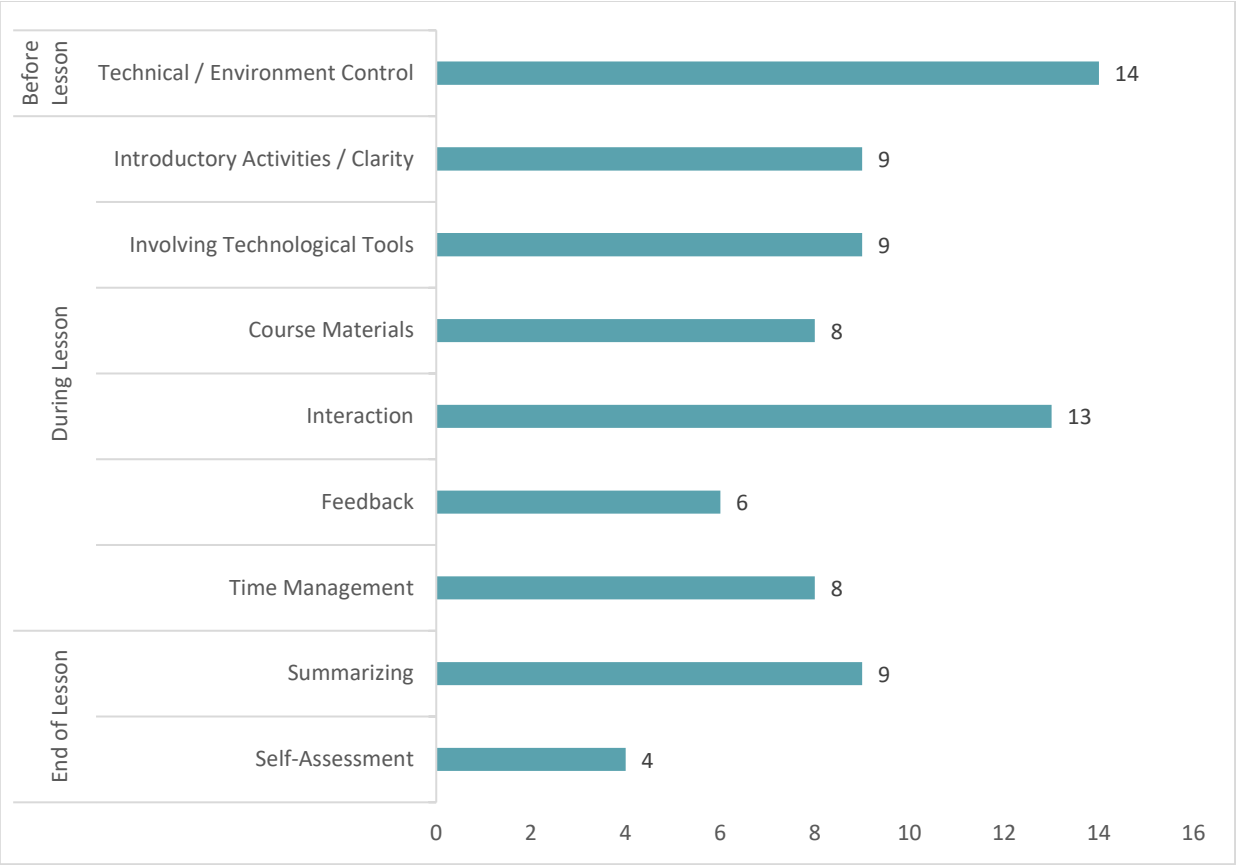
Category	Theme	Number of activities/applications
Before lesson	Technical control	3
	Environment control	3
During lesson	Clarity	4
	Introductory activities	3
	Involving technological tools	5
	Course materials	6
	Interaction	11
	Feedback	4
	Time management	6
End of lesson	Summarizing	5
	Self-assessment	4

The study identified 53 components of effective synchronous virtual classrooms, divided into 11 themes (Appendix).

Gagne's events of gaining attention, informing the learner of the objective, and stimulate recall of prior learning overlapped with the seven activities and applications under the clarity and introductory activities theme in this study. This study includes the presentation of the content and its principles, which are part of the GNEI model. We found 11 activities and applications principles under the two categories of involving technological tools and course materials. Gagne's events of providing learner guidance, eliciting performance, providing feedback, and assessing performance were included under our two categories of interaction and feedback; these two categories contained a total of 15 activities and applications principles. In this study, Gagne's event of enhance retention and transfer overlapped with the four activities and applications principles in the summarizing category. Themes Activities and applications such as technical control, environmental control, time management, and self-assessment, while outside the GNEI model, are inherent in synchronous virtual classrooms, so they were categorized accordingly. Details about themes, activities, and applications for an effective synchronous virtual classroom, derived in this study, are presented in the Appendix. The frequency values of the themes related to effective synchronous virtual classrooms in the literature we reviewed are presented in Figure 3.

Figure 3

Frequency of Themes



The items in the technical control and environment control themes carried out by the instructors before the lesson, consisted of instructors testing the operability of technical equipment and devices before the synchronous virtual classroom, and taking measures to eliminate distracting environmental arrangements and the situations that caused trouble in image transfer to the other party. In our review of the literature, the activities/applications in these themes were found in 14 studies.

In the clarity and introductory activities themes, suggestions included introducing the lesson by drawing attention, motivating the students regarding the lesson, and starting the subject by associating it with the previous lessons. In our review of the literature, the activities/applications in these themes were derived from nine studies.

In the involving technological tools theme, there were recommendations for the use of existing technologies (e.g., whiteboard, text/video chat panel, screen sharing, group/collaboration tools) available on the platforms used in synchronous virtual classrooms. In the literature, activities/applications related to this theme came from nine studies.

The course materials theme included items that should be found in the materials to be used in synchronous virtual classrooms at a basic level; suggestions were made to enrich these basic materials with (a) multimedia elements, (b) practical content-specific materials suitable for the course and the subject, and (c) examples and activities. In the literature, the activities/applications within this theme were derived from eight studies.

The theme of interaction included activities to enable students to participate actively such as methods to increase interaction in synchronous virtual classrooms and encourage students to interact. These included applications and activities to support students' interactions with teachers and peers, as well as group/cooperation, question and answer, and brainstorming activities. In the literature, the activities/applications in this theme came from 13 studies.

Items in the feedback theme suggested that instructors provide effective, regulative, varied, and timely feedback on the type of answers students gave as a result of their active participation in the lesson. In the literature review, the activities/applications in this theme were found in six studies.

The time management theme included items such as (a) planning the duration of synchronous virtual classrooms in advance and ending lessons during this period, (b) carrying out planned activities at appropriate times, (c) presenting activities at short intervals, (d) clarifying the duration of the activities in advance and complying with this time during the lesson, and (e) carrying out and ending all activities within the planned time without prolonging the lesson. The review of the literature produced activities/applications in this theme from eight studies.

At the end of the lesson, within the summarizing theme, the literature suggested activities such as (a) providing a summary of the main points in each topic, (b) including question and answer interactions at the end of the topic, (c) giving information about the topic to be covered in the next lesson, and (d) reminding students about the learning and tasks coming in the next lesson. In our review, the activities/applications in this theme came from nine studies.

The self-assessment theme included the suggestion that instructors improve themselves by examining their own synchronous virtual classroom recordings after the lesson, thereby assessing themselves and recognizing areas for improvement. In the literature, activities/applications related to self-assessment were found in four studies.

Discussion

Synchronous virtual classroom environments have been mentioned in the literature as a strong distance education alternative to face-to-face learning environments (McBrien et al., 2009). For this reason, the structure of synchronous virtual classrooms have often reflected the education-teaching applications found in face-to-face learning (Setiawan & Fauzi, 2022).

In the literature, effective synchronous virtual classrooms differed from face-to-face teaching in terms of technical control, environment control, and technological tools specific to the synchronous virtual

classroom environment. Students and instructors who will participate in the synchronous virtual classroom learning environment are expected to have the skills to use these technologies effectively and smoothly, as well as access to existing technological infrastructure (Ozkok & Bulutlu, 2020). Moreover, instructors should (a) ensure that their cameras and microphones are functioning properly during the technical check, (b) adjust the camera angle to fully capture their face, (c) avoid wearing distracting clothing, (d) ensure adequate background lighting, and (e) remove any distracting elements that may appear in the camera's field of view. However, while the instructors control the technical (LeRoy & Kaufmann, 2022) and environment (Dahmen et al., 2016) before the synchronous virtual class begins, it also is important for the students should ensure they come to the lesson with their technical tools and surroundings ready and on time.

The effective use of synchronous virtual classroom technologies to strengthen interaction and communication in that environment, and ensure students' active participation and social presence, has been a key factor in increasing the efficiency of synchronous virtual lessons (Martin et al., 2012). In fact, Akyurek (2020) emphasised that the effective use of technological tools that support students' active participation in synchronous virtual classroom environments is the most important part of helping students establish strong communication with their peers.

The use of technological tools in accordance with the teaching purposes, and according to the structure and functioning of the course, also support the active use of interaction and feedback in the educational processes inherent in synchronous virtual classroom environments (Cao et al., 2009). Similarly, Johnson et al. (2015) emphasized that a regular and efficient interaction is very important in obtaining the desired learning outcomes in an online learning environment.

It is important to provide opportunities for students to interact directly with learning materials so that technologies that support students' active participation can be used effectively in synchronous virtual classroom environments (Cankaya & Durak, 2020). When synchronous virtual classrooms were examined in general, the lessons were generally taught through at least one material object (e.g. a .pdf, presentation, video). For this reason, while preparing course materials, instructors should consider students' needs, learning levels, their ability to put the skills they have learned into practice, and their satisfaction with the learning process (Stewart et al., 2011).

The literature on synchronous virtual classroom environments has emphasized the importance of instructor's lessons with a summary. The most memorable points in a narrative are the ones conveyed in the introduction and closing, so in synchronous virtual classrooms, a good summary has been shown to be very important for students' permanent learning (Bower, 2016).

For students to benefit from synchronous virtual classrooms, instructors should pay attention to time management (Acosta-Tello, 2015; Dos, 2014). In our review, instructors stated that one of the problems they experienced in synchronous virtual classrooms, which highlighted its importance. As Koppelman and Vranken (2008) stated, it was very important to have an appropriate pedagogical approach and to have a tool that supported this approach in the organization of synchronous virtual classrooms. Managing time in synchronous virtual classrooms and being able to start and end the classroom activities at the appropriate

times, both depend on instructors' self-assessment, which is achieved through their watching their synchronous virtual classrooms after the fact (White, 2019).

Conclusion and Implications

The purpose of this study was to identify the activities and applications principles to be used by instructors in effective synchronous virtual classrooms. Within the study, a technical/instructional activity and application framework for effectively carrying out synchronous virtual classrooms was revealed. This framework, based on Gagné's GNEI model, consisted of 53 activities and applications under 11 themes—technical and environment control, clarity, introductory activities, technological tools, course materials, interaction, feedback, summarizing, time management, and self-assessment. The 53 activities and applications within the framework were classified and presented to cover all aspects of a synchronous virtual classroom (see Appendix).

This framework can serve as a guide for instructors who conduct synchronous virtual classrooms. Doing so will reduce the negative aspects of the temporal and spatial separation of students and instructors, including the feelings of isolation students experience, and will positively increase the quality of online education. The framework can also fill the existing gap in the literature on this subject, and form the basis for further studies. Using this framework as a guide or rubric to conduct effective synchronous virtual classrooms can also form the basis for further quantitative and mixed study designs.

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Appendix

Themes and Activities For Effective Synchronous Virtual Classrooms

These 11 themes and 53 activities and applications for effective synchronous virtual classrooms are organized by three categories: before the lesson, during the lesson, and at the end of the lesson.

Before Lesson

Technical Control

1. Keep the Web cam on during the lesson
2. Keep the microphone on during the lesson
3. Keep the screen camera at eye level, adjusting the entire face to be visible

Environmental Control

4. Choose appropriate clothes for during the lesson
5. Eliminate distractions in the image background
6. Adjust the appropriate backlight

During Lesson

Clarity

7. Specify the purpose of the lesson
8. Specify the purpose of in-class activities
9. Specify the rules of classroom activities
10. Specify expectations from in-class activities

Introductory Activities

11. Draw attention (e.g., present pictures, videos, cases, anecdotes)
12. Motivate students
13. Relate to prior learning

Involving Technological Tools

14. Use the whiteboard app
15. Use the text chat panel
16. Use the video chat feature
17. Use the desktop/screen sharing feature
18. Use the group/collaboration interface

Course Materials

19. Sort teaching materials in a suitable and consistent manner with the flow of presentation
20. Support teaching materials with various multimedia (e.g., picture, video, sound, graphic animation) tools in accordance with the subject being taught
21. Present examples suitable for the subject content
22. Support with real-life examples suitable for the subject content
23. Make practice sessions/demonstrations in lessons on subjects that require application

Interaction

24. Incorporate interactive activities
25. Encourage student participation in learning activities
26. Encourage student audio/video participation
27. Support active learning with learning activities
28. Organize question and answer sessions (with students or with the instructor)
29. Encourage students to participate in the lesson
30. Give a voice to all students who want to have a voice
31. Use group/collaboration activities
32. Ensure student-teacher interaction
33. Ensure student-student interaction
34. Ensure student-content interaction

Feedback

35. Provide timely feedback to students' answers to questions
36. Provide appropriate feedback to students' answers to questions
37. Use different types of feedback according to learning styles
38. Provide feedback that reinforces learning

Time Management

39. Organize course activities in advance according to the number of students and the duration of the course
40. Include various activities every five to eight minutes during the lesson
41. Adjust the duration of the activities that students do among themselves or with their peers
42. Summarize the subject when moving away from the focus of the subject during activities
43. Terminate organized events in a timely manner
44. Ensure the lesson is not less than 35 minutes and not more than 120 minutes

End of Lesson

Summarizing

45. Summarize the main points of the topic at the end of each session
46. Provide question and answer session at the end of the lesson (15–20 minutes)
47. Inform students about the topic that will be taught in the next week
48. Remind students about the tasks that will be taught in the next week
49. Make a closing speech at the end of the lesson

Self-Assessment

50. Be familiar with the synchronous virtual classroom system and use its technical/pedagogical features
51. Evaluate time management

52. Evaluate the frequency and effectiveness of interaction and feedback with students during the lesson

53. Share experience and self-assessment by meeting with other distance instructors

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Book Review: Research, Writing, and Creative Process in Open and Distance Education: Tales From the Field

Editor: Dr. Dianne Conrad (Open Book Publishers, 2023, 222 pages). ISBN: 978-1-80511-094-1 (paperback, £18.95), ISBN: 978-1-80511-095-8 (hardback, £29.95), ISBN: 978-1-80511-100-9 (HTML: https://doi.org/10.11647/OBP.0356).

Reviewed by: Frank Senyo Loglo, Carl von Ossietzky Universität Oldenburg, Fakultät I - Institut für Pädagogik, Center for Open Education Research (COER), Germany. frank.senyo.loglo@uni-oldenburg.de

Introduction

The act of scholarly writing combines elements of both science and artistry, posing a particularly daunting challenge for early-career researchers who may be navigating a complex maze to forge their own scholarly identities and careers. Mastery of academic writing requires a process built on persistent effort, practice, and refinement. Hence, novice writers may find golden nuggets of wisdom in the guidance of experienced writers who have overcome many challenges throughout their careers.

In response to this need, Dianne Conrad has assembled an impressive list of scholars to publish the book titled *Research, Writing, and Creative Process in Open and Distance Education: Tales From the Field*. The book is a synthesis of personal, reflective narratives on academic writing by authors in the field of open, online, and distance learning (ODL). As described on the publisher's website,[i] the book is:

> a treasure trove of advice, reflection, and hard-won experience from experts in the field of open and distance education. Each chapter offers tried-and-tested advice for nascent academic writers, delivered with personal, rich, and wonderful stories of the authors' careers, their process, their research and their writing, and the struggles and triumphs they have encountered in the course of their careers.

This review, from an early-career researcher's perspective, aims to offer insights and spark a discussion among the community, and serve as a barometer for the intended impact of the book.

Book Structure and Organization

Upon reading the entire book, my impression is that the authors enjoyed considerable creative freedom in structuring their texts, leading to a departure from established scientific writing norms. This creativity was manifested in the choice and construction of the chapter titles, along with interesting anecdotes, many of which were written in first-person voice.

The open access book is structured into 15 chapters, including an introduction and a conclusion chapter, authored by the editor, and profiles of the contributors. All 13 reflection chapters are authored by single authors except Marguerite Koole et al.'s chapter which has four authors. Each chapter is unique and

does not follow a consistent structure or format. However, many of the chapters conclude with suggestions, guiding tips, or key takeaways for the reader. Nonetheless, I believe that each chapter could have benefitted from an abstract or summary. The authors included references at the end of each chapter, and a comprehensive index at the end of the book aids readers in locating specific content.

Analytical and Critical Commentary

Strengths

The book begins with a compelling foreword written by Terry Anderson, a prominent figure in the field, which I consider a valuable bonus chapter. Considering how the main chapters of the book are structured, I discuss overarching themes rather than employ a chapter-by-chapter review. Inspired by Paul Prinsloo's chapter, I take an analytical and critical perspective to categorize my key takeaways into three themes: *technical nuggets, psychosocial nuggets*, and *additional freebies*. According to Prinsloo, "what I bring, what I submit, is the result of my own sensemaking, often emerging from deep within myself" (p. 204).

The authors conveyed priceless information on technical aspects of writing, sharing *technical nuggets* about writing processes. Many of the authors highlighted how they approached idea generation, text structure development, effective language use, and audience engagement in their writing. For example, I found Jon Dron's concept of the *unwriter* particularly interesting, as he discusses how editing effort often takes longer than the actual text generation. He sums this up by stating that "the sense that you are making of what you are reading now is not, however, the same as the sense that I was making when I wrote it. … You are reading my words from the front; I am writing them from behind" (p. 33).

Further, authors emphasized the importance of effective language and audience engagement. Examples in the chapters by Pamela Ryan and Marguerite Koole et al. highlight the importance of understanding the cultural nuances of audiences in deciding appropriate registers for effective communication. Many authors advocated for using simple language, and I appreciate Aras Bozkurt's caution to early career writers against using metaphors until they have fully grasped what he calls "the anatomy of a scholarly paper."

Additionally, the authors stressed the importance of prior reading and background knowledge with Bozkurt stating that: "Before I begin to write, I sharpen my thoughts, develop a clearer vision of the topic, and build a cognitive map as I force myself to read more deeply on the topic" (p. 102). Mark Nichols, on his part, argued strongly for writing drafts as part of the literature review process, using the metaphor to "dance with" rather than "engage with" the literature. His advice to "treat literature as a conversation partner, not a library" (p. 160), is particularly instructive.

It was clear that certain affective, behavioural, sociocultural, and other personal traits influenced the creative writing process and scholarly personas of the authors. The lessons derived from these are what I call *psychosocial nuggets*. The book discusses the role of intrinsic drive, exemplified by personal traits such as passion, curiosity, commitment, and belief, as necessary ingredients for successful writing. Authors such as Junhong Xiao and Jennifer Roberts showed how resilience, agency, and ability to overcome self-doubt proved useful for their writing. Similarly, Paul Prinsloo, and Dianne Conrad in

thier authored chapters provided inspiring insights for individuals who may be venturing late into the scholarship space, with the sense of "coming from behind."

Themes on mentoring featured prominently for its role in moulding the writing skills of early-career academics. Likewise, the concept of stewardship, described by Junhong Xiao, advocates for established researchers "paying forward" what they had "taken from" their mentors to maintain quality within the discipline. The chapter by Tony Bates presents insights about the potential for serendipity, and how to effectively exploit networking opportunities.

The chapter by Koole et al. regarding how cultural identity influences one's writing style was enlightening. Janet's (co-author) discussion on how she manages the tension between her newfound Western "directness" and her African-rooted indirect communication style resonates with my own experience as an African undergoing scholarship training in a culture known for its very direct communication style. Furthermore, the book provides tips on developing one's research identity; for example, Pamela Ryan's chapter presents important lessons for researcher identity (or the lack of it).

The *additional freebies* are the unintended benefits novice writers stand to derive from the book. For instance, reading through the text enriches one's vocabulary warehouse, and there is a diversity of styles and approaches that the reader can reflect on and integrate into their own writing. More importantly, the references in the book provide a convenient catalogue for further reading. Two of my top picks include Ergin and Alkin (2019) on contextualization, and Ivanič (1998) on identity.

Limitations

While the book offers many nuggets for its readers, it is open to criticism in the following aspects:

- **The lack of consensus in terminology.** Throughout the book, the terms Open Online and Distance Learning (ODL), Open and Distance Education (ODE), Open, Distance, and Flexible Learning (ODFL) were used severally, ostensibly in the same context. This lack of consensus perhaps lends credence to the development of the umbrella term *Open, Distance, and Digital Education* (ODDE) to capture both the historical roots of distance education and recent digital media applications in education (Zawacki-Richter & Jung, 2023).

- **Scarcity on ground-breaking works and classical theories.** Considering the title of the book and the authors drawn from the ODDE field, it would have been insightful to highlight some ground-breaking works or classical theories and explore how they impacted the authors. Although sporadic references were made to some, the approach could have been more intentional.

- **No substantive discussion on ethics.** Although subtle ethical issues are contained in the book, I would have appreciated reading more insights about ethical dilemmas authors encountered and how they overcame them. More broadly, I would have liked to understand their axiological stances and how this reflects on their scholarly endeavours.

- **No reflections on artificial intelligence applications.** Considering the advancements in artificial intelligence applications over the period, I was eager to read reflections on any potential influences it might have had on the scholarly careers of the authors or, at the very least, their stances on its application in scholarly writing in general.

- **Not diverse enough.** While the attempt to achieve diversity among the authors is appreciated, authors from non-mainstream locations such as the Middle East, South America, and Sub-Saharan Africa (excluding South Africa) are noticeably absent. Including some excellent voices from these non-mainstream locations could hold empowering value.

Overall Impression

The book is captivating and compelling, featuring narratives that resonate emotionally. As an early-career researcher, some reflections in the book provided substance to phenomena I was vaguely aware of but had not fully grasped. While not intended as a manual, the book offers valuable practical guidance for honing the skills and crafts of early-career researchers and serves as a wellspring of counsel for those more established. The book provides profound insights into the authors' works and the influences shaping them, from which novice writers can derive lessons. Indeed, I concur with the editor's assertion that the book provides "extraordinary fodder for novice writers and scholars" (p. 16). Finally, although authored by researchers in the ODDE field, the book's value transcends the field. For these reasons, I recommend it without any reservations to anyone interested in scholarly writing.

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[i] From *Open Book Publishers*, 2023 (https://www.openbookpublishers.com/books/10.11647/OBP.0356#metrics).

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Book Review: Critical Digital Pedagogy in Higher Education

Editors: Suzan Köseoğlu, George Veletsianos, and Chris Rowell (AU Press, Athabasca, AB, 2023, 256 pages), **ISBN:** 9781771993647. https://doi.org/10.15215/aupress/9781778290015.01

Reviewed by: Mohsen Keshavarz* and Maliheh Ahmadian, *Department of E-Learning in Medical Sciences, School of Paramedical Sciences, Torbat Heydariyeh University of Medical Sciences, Torbat Heydariyeh, Iran, *Corresponding author*

Published by Athabasca University Press, *Critical Digital Pedagogy in Higher Education* has contributions from the United States, Saudi Arabia, England, Canada, New Zealand, Zimbabwe, and Palestine. The editors are established teachers and researchers in higher education.

We have used two approaches and methodologies to review the book. In the first step, based on a descriptive approach, we provide essential information about the content and structure of the book. The key features are then described with an analytical and critical perspective.

The book covers four parts and thirteen chapters. In Part I, Chapter 1 demonstrates how to develop relational trust in teaching by embracing Pacific Indigenous values and ways of knowing. Chapter 2 describes an ethics-of-care approach to online course design, including active listening, dialog, trust, and openness without judgment as core values in online teaching. Chapter 3 argues that an academic culture of distrust is incongruent with creating learning environments that promote "creativity, expression, synthesis, and dissent" (p. 58). Chapter 4 shows the careful pedagogical work required to "break down patterns of domination in the classroom" (p. 74) and essential for students to develop their critical media literacy and "interrogate normative representations of gender, sexuality, and race" (p. 72).

In Part II, Chapter 5 describes an interdisciplinary law and technology module driven by the ideals of social justice. Chapter 6 argues that critical digital pedagogy must include a reflective analysis of how learners perceive online learning within a neoliberal context. Chapter 7 critiques unequal access to technology and stresses the need to understand students' cultural and material contexts to inform institutional decisions about technology.

In Part III, Chapter 8 covers Indigenous knowledge systems, imagining, and putting into practice a liberatory pedagogy that disrupts digital hegemony. Chapter 9 discusses the demographic attainment gaps in higher education and provides practical suggestions for educators to use culturally relevant pedagogy. Chapter 10 presents "Black Twitter" as a site for engaging in critical visual pedagogy and the creation of ethical educational spaces that challenge "social stereotypes, hierarchies, and oppressive structures" (p. 93).

In Part IV, Chapter 11 states that "critical pedagogy needs to have hope, idealism, and inspiration" (p. 199). Chapter 12 states how technology can be used to form and sustain "interconnectedness with the more than human" (p. 209)

Part I (Chapters 1 to 4) describes the *talanoa* model, which includes four important values: *ofa* (love), *mafana* (warmth), *malie* (humour), and *faka'apa'apa* (respect). The model has evolved to take into account the differences of individual learners and provides cultural values to improve online learning experiences, build relationships, and enhance learning. It also emphasizes the necessity of the ethics-of-care approach to create the foundations of critical pedagogy for designing and providing online courses. The authors believe that feedback has two types—passive transmission and dialogic—and state that dialogic feedback provides a higher level of care in online courses, and digital technologies play a very important role in supporting critical pedagogy. In addition, in this part, academic integrity is criticized and a new frame for this term is proposed that presents students not as perpetrators of crime but as victims of high-risk environments.

Part II (Chapters 5 to 7) examines the interdisciplinary law and technology module, which takes a critical approach to inequalities in access to the legal system and argues that digital technology has the potential to resolve these inequalities and achieve social justice. It also claims that, with the COVID-19 pandemic, it has become clear that technology can exacerbate existing inequalities. Therefore, the critical awareness of students, which means the ability of students to evaluate the law, existing technologies, and their effects on people, should be developed.

The relationship between critical and online education and the important role of technology and interaction in the development of online critical education are also discussed in Part II. The authors believe that, despite the possibility of developing critical pedagogy through the Internet, critical pedagogy still has a pessimistic view of the virtual world, and this dichotomy has led to the emergence of critical digital pedagogy. This pedagogy should be avoided, as it is incompatible with online education methods. The authors state that communities with digital redlining have experienced higher levels of surveillance, and investigate minimal calculations in online education as an answer to digital redlining. A minimal computational approach helps teachers and learners develop a deeper understanding of the tools used, a greater acceptance of the learning opportunities, and a critical perspective on the use of technology. Since technology plays a role in the colonization of power and knowledge, the need to establish a conscious anticolonial digital education is essential, and critical digital pedagogy is better if it is adapted from Indigenous knowledge systems. Social media, such as Twitter, provides opportunities for marginalized communities to make their voices heard around the world. The authors discuss the Black Twitter subcommunity, an open platform interested in issues such as social injustices and economic disparities, and view it as an educational tool to bring the voices and perspectives of people in marginalized communities into the classroom, promoting critical conversations and critical visual pedagogy.

In Part III (Chapters 8 to 10), the authors explain how the TEFL-ePal project provides Indigenous teaching and learning through technology to create a flexible curriculum that is available to all learners in the form of face-to-face and online courses without restrictions. These chapters state that the link between education and technology is an opportunity and can be used directly to implement critical pedagogy in the online environment.

In Part IV (Chapters 11 to 13), project-based learning is explored as a critical digital approach, and the authors claim that there is an alignment between project-based learning and critical pedagogy. They also argue that critical digital pedagogy can provide educational responses to concerns related to climate change and environmental degradation, and challenge the concept of human exceptionalism through critical thinking from a posthumanist perspective. The contributors emphasize that critical digital pedagogy is a new field and a pragmatic approach closely related to education in outdoor settings, and that it cannot be done in the mind. They argue that it is more about creativity in using digital tools and expanding education in new directions, and that critical pedagogy can help recognize the confusion and complexity in learning that exists in the context and within the institution.

Critical education is rooted in the Frankfurt School of Education, which deals with social reform. Based on critical education, schools and universities should be places to cultivate critical thinking and teach students how to change their surroundings and treat each other. As Jesse Stommel says in his definition, "We're looking for solutions, what we most need to change is our thinking and not our tools" but critical digital pedagogy is more defined by its questions and the problems it poses than by its answers. Generally, in online learning environments, learning must be allowed to grow and applied in the real world.

Critical Digital Pedagogy in Higher Education provides the essential principles for critical pedagogy and is a unique book on the subject of critical pedagogy practice in higher education. If we want to make a final summary of all the chapters of this book, we must explain and analyze four concepts: shared learning and trust, critical consciousness, change, and hope.

The issue of truth includes the organizational structures of schools and universities in higher education, and building trust is of great importance for the initiation of critical educational practices. Students should know other students, and their teachers should feel comfortable in the classroom, communicate with them, and provide teaching and learning activities successfully in face-to-face and online classroom environments. A relaxed atmosphere in an online environment can foster constructive communication between learners and teachers and improve critical pedagogical practices. In online education, both teachers and students need critical awareness to deal with educational misunderstandings.

From the neoliberalist point of view, online education and emerging technology in the digital age, such as performance tracking or automation, should be redesigned in a broader framework, and learners should not be considered as customers, nor the courses as paid products. Instead, courses should be flexible, convenient, cost-effective, time-efficient, and self-driven components of educational design. Teachers and learners should learn how to be responsible and active citizens in their communities through activities in digital projects, and to increase critical awareness in online environments, more space should be provided for self-awareness, self-interrogation, and dialog for individuals to learn from one another.

One of the salient points of the book is the presentation of different teaching methods in critical education; critical education is considered a methodological orientation that guides educators in choosing appropriate learning methods and activities. From the perspective of the authors, the goal of critical education is to help educators and students become "critical, self-reflective, knowledgeable, and willing to make moral judgments and act in a socially responsible way" (p. 238). Hope and change are key concepts. From the authors' point of view, change is a complex concept that may not be immediately visible. It can be slow,

small, and intermittent, and it may take a long time for people to change their thoughts, beliefs, or the way they do things. In some cases, change begins simply as a glimmer of hope; hope is a precursor to change.

In the end, it must be said that this is a valuable open-access collection for both the public and those interested in the fields of online learning and critical pedagogy. The text is comprehensive, covers all areas of the subject appropriately, and reflects on all of the components and concepts of critical pedagogy—from the past to the present—in the fields of higher education and online learning. The topics in the text have been expressed in a rational, clear manner, and throughout the book, the authors have used fixed terminology. The content and sections of the book are very relevant and have a regular sequence, and there were no noted grammatical or spelling errors. The language of the book is pleasant and impressive, and interesting metaphors and examples are presented. References are provided at the end of each chapter with an access link, and each chapter is divided into subsections to create a concept map in the reader's mind. The book makes several theoretically important points and offers good examples of critical digital pedagogy without discrimination or prejudice in matters of culture, gender, ethnicity, national character, age, disability, or education.

In the end, it is suggested that the editors of the book use more images in the next editions to enrich the content and increase understanding and knowledge among readers.