

Transition to online learning by a teacher education program with limited 4IR affordances

Maria Tsakeni

University of the Free State, School of Mathematics, South Africa

E-mail: tsakenim@ufs.ac.za

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Abstract

This study used the community of inquiry (CoI) framework and the affordances of Internet of things (IoT) to explore how the faculty of education of a rural campus of a university transitioned from face-to-face to online modes of instruction. In this qualitative interpretive study, data were collected through open-ended questionnaires from four purposely selected teacher educators and five final-year bachelor of education preservice teachers. Thematic content analysis techniques were used to analyze the data collected. The findings indicated the tensions experienced by the teacher educators as they negotiated the limited IoT affordances to ensure effective teaching, cognitive, and social presence in the newly formed online classrooms. Some of the tensions included the choices that were made on whether to use synchronous or asynchronous modes of instruction and the selection of effective communication modes. The teacher educators used a combination of the official learning management system (LMS) tools of the university and a social media platform as way of navigating the limited 4IR environments experienced by the preservice teachers.

Key words: community of inquiry; COVID-19; Internet of things; online learning; teacher education

Introduction

Although the transformation of learning in educational institutions was inevitable due to the increased pervasiveness of technologies inherent to the Fourth Industrial Revolution (4IR) (DeNoyelles et al., 2014; McGinnis, 2018; Schwab, 2016), the advent of the COVID-19 pandemic forced the institutions to abruptly embrace the change. Carrillo and Flores (2020) confirmed that educators were forced to shift from face-to-face to remote learning, while Panergayo and Almanza (2020) described the change as a shift from conventional to flexible learning. COVID-19 came at a time when literature such as Saadatmand et al. (2017) had been observing a

growing trend in the use of online learning in higher education institutions. On the onset of the pandemic and the subsequent mitigation lockdown measures, one of the significant changes made by institutions of higher learning was to move from face-to-face to online modes of instruction. This move seemed to be the reasonable option given that 90% of the student population was out of school (Commonwealth of Learning, 2020). The compelled shift from face-to-face to online instructional modes in institutions of higher education came at a time when there was a notable breakthrough in the development of online learning.

The notable development in online learning was based on the use of learning management systems (LMSs) by institutions of higher education (Mershad & Wakim, 2018). Aldowah et al. (2017) confirmed that there has been a marked increase in the use of LMSs such as Blackboard and Moodle to facilitate online learning. In addition to the potential of LMSs to transform online learning is the use of social media and online tools that provide learners with expanded opportunities to interact, share content, and connect (Saadatmand et al. 2017). As Scott et al. (2016) explained, the use of Web 2.0 tools, which include social media and web-based office tools, expands the teaching and learning opportunities because learners can create, edit, and share content and communicate and view content posted by instructors and other learners. The growth of online learning is made possible by the Internet of things (IoT), one of the 4IR technologies.

The IoT is a technology that enables the interaction between real and virtual objects, creating an ecosystem capable of supporting numerous applications, including online learning (Abbasy & Quesada, 2017). As Hernandez et al. (2018) elaborated; the IoT is an intersection of people, processes, data, and things, creating connections with more capabilities and enhanced experiences. Swarts (2020) reiterated that technologies have enabled educational interaction and connection at local and global levels. The sudden shift from face-to-face to online learning due to the COVID-19 pandemic opened opportunities and the need to study the affordances of the IoT infrastructure supporting online learning and to explore ways of improving instructional strategies. Shea and Bidjerano (2012) suggested that studying through online learning should be framed by appropriate models that assist in determining how to improve instructional strategies. The community of inquiry (CoI) framework by Garrison et al. (2000) is one of the most widely used frameworks to study online learning.

The CoI framework portrays online learning as a collaborative process defined by three components: teaching presence, cognitive presence, and social presence (Thompson et al., 2017). Some of the factors influencing online learning stem from how the three forms of presence are facilitated (Szeto, 2015). In addition, the affordances of the IoT also influence online learning and one of the highlighted issues is that of equitable access by the students (Cutri et al., 2020). Catalano et al. (2021) observed that students in high-needs schools struggled to complete assignments in online classrooms created due to the COVID-19 pandemic. This study explored how one teacher education program transitioned to online learning as prompted by the advent of the COVID-19 pandemic at a rural campus of a South African university. The study sought to address the question: How did a teacher education program in rural South Africa transition to online learning during the COVID-19 pandemic? The study contributes insights on the experiences of online learning during the COVID-19 pandemic by teacher education programs.

Research Questions

The main research question for this study is: How did a teacher education program in rural South Africa transition to online learning during the COVID-19 pandemic? The main question was addressed using the following subsidiary questions:

1. What IoT technology affordances were used by the rural education program to support online learning?
2. How was teaching presence ensured by the rural teacher education program in online classrooms?
3. How was social presence ensured by the rural teacher education program in online classrooms?
4. How was cognitive presence ensured by the rural teacher education program in online classrooms?

Review of Literature

The transition to online learning in this study is viewed as the rapid move to build and use online classrooms in place of the traditional face-to-face classrooms as prompted by the COVID-19 pandemic. Cutri et al. (2020) point out that the transition to online classrooms was done with little or no preparation by the instructors and the learners. Cutri et al. (2020) also point out that the transition was conducted under traumatic conditions since there was no indication of how long it would be necessary to continue with online learning. As a result, teachers and teacher educators experienced intensified workloads caused by uncertainties that characterized the sudden shift to online classrooms (Allen et al., 2020; Subedi & Subedi, 2020). A study conducted in Nepal by Lemay et al. (2021) showed that during the transition to online learning, the instructors lacked experience and received little guidance. The instructors also worked with few resources which was compounded by the economic hardships and threats to their health. Due to the challenges experienced by both the learners and the instructors in online classrooms during the COVID-19 pandemic, Baran and AlZoubi (2020) proposed a human-centred approach to facilitate the transition to online learning. The approach is based on three pillars: the building of empathy, pedagogical problem-solving, and the establishment of online communities of inquiry.

The building of empathy is important because as Williams et al. (2021) observed, there are inequitable access to technology and limited digital efficacy issues experienced by learners in online classrooms. One of the challenges for teacher education is to determine ways in which the preservice teachers can fulfil the work-integrated learning requirements of the teachers' qualification when face-to-face learning is not possible (Mutton, 2020; Isidro & Teichert, 2021). Carrillo and Flores (2020) concluded that teacher education needs to adapt by developing new pedagogies in the wake of online learning.

Online learning is supported by the pervasiveness of the fourth industrial revolution (4IR) environments in the society. The 4IR according to Melville and Robert (2021, p. 1) refers to the "productivity-enhancing industrial innovations enabled by rapid technological progress and combinations of digital technologies." Online learning relies on the 4IR environments and tools which unfortunately are limited for learners from poor communities. In order to explore

transition to online learning this study used the Col framework as lens to explore online learning and the IoT as a lens to explore the limitations of the 4IR.

Community of Inquiry and Online Learning

Research on online learning started well before the start of the COVID-19 pandemic. Nonetheless, before the pandemic, there was a notable underutilization of technological tools to facilitate online learning (Arroio, 2020). One of the models widely used to study and inform online learning is Col attributed to the work of Garrison et al. (2000). DeNoyelles et al. (2014) pointed out that the Col framework was initially developed to serve as a framework for asynchronous text-based discussions but was later adapted to study online learning.

The Col framework is defined by three crucial components that underpin online learning experiences, which are teaching presence, cognitive presence, and social presence. Teaching presence is defined by Anderson et al. (2001) as what instructors do to design, facilitate, and direct the other two forms of presence (cognitive and social) in order to achieve educational objectives. The teaching presence is further broken down into three components, which are instructional organization, facilitating discourse, and direct instruction. DeNoyelles et al. (2014) explained that instructional organization entails the structure, process, facilitation, and evaluation of online learning interactions. In facilitating the discourse, the discussions aim to explain the main ideas, seeking clarity, and misconceptions are identified. Lastly, through direct instruction, the instructor, tutor, or any participant in the discussion who is more knowledgeable in the subject articulates what is important to learn.

Cognitive presence refers to the experiences of meaning-making through the interactions in the online classroom. Thompson et al. (2017) posited that cognitive presence experiences are where the hard work of knowledge construction happens. Cognitive presence is sustained and made possible through four progressive phases, starting with a triggering event, followed by exploration, integration, and, finally, resolution (DeNoyelles et al., 2014). Face-to-face learning by default presents a social setting in which the instructor and the learners are physically present engaging in activities to achieve the educational goals. Online classrooms lack dynamic face-to-face interactions (Shea & Bidjerano, 2012), although social presence can nonetheless be built.

Social presence is viewed from the sense that the individuals engaged in online learning are part of a group (Thompson et al., 2017). Through social presence, learners project themselves as real people in environments mediated by online tools by interacting and communicating (DeNoyelles et al., 2014).

From the literature reviewed, it is noted that learners need to demonstrate a certain degree of active participation for learners to be successful in online learning. Shea and Bidjerano (2012) propounded that learner self-regulation, which they call learner presence, is an important requirement for online learning. Consequently, Chang et al. (2019a) observed that learners who are active in discussion forums are more likely to be successful in online learning. Similarly, Chang et al. (2019b) posited that for learners to be successful in large online courses, they need to possess qualities that help them to learn with little assistance from the instructors. These qualities are encapsulated in self-regulated learning, which Cho et al. (2017) explained is the process in which learners manage their own learning to achieve set goals using motivational

qualities that include personal goal setting, self-confidence, beliefs in ability to learn, and high task value. However, Szeto (2015) highlighted the importance of teaching presence for the success of online learning because of the leadership role it plays, but the author quickly pointed out that the experiences of the three components of presence are context specific. Hajibayova (2017) confirmed the leadership role of the teaching presence upon concluding that learners appreciate the flexibility of online learning, instructor timely feedback, and frequent engagement through various media. Multimedia is also used to enhance social presence in online learning (Borup et al., 2012; Krutka et al., 2017; Lowenthal, 2010). The multimedia used include social media, videos, and digital storytelling. However, Krutka et al. (2017) observed that the use of social media pedagogies may result in shortcomings in course structure and facilitation due to mismatches between instructor and learner expectations.

Internet of Things and Online Learning

The IoT is an emerging technology that is increasingly having an impact on our everyday lives, including education (Kortuem et al., 2013). As such, there have been several attempts to provide a definition of the technology in literature. This includes that the IoT is a connection of virtual and physical objects that are able to communicate with each other through sensing and other interactions (Abbasy & Quesada, 2017; Hernandez et al., 2018). One of the areas impacted by the IoT technology is higher education, including teacher education. In education, the IoT supports the interaction of physical and virtual objects embedded with instructional technologies, mobility applications, and cloud computing (Aldowah et al., 2017; Kalimullina et al., 2021). The instructional technologies include LMSs such as Blackboard, Sakai, and Moodle. IoT technologies also enable the integration of mobile learning applications used by learners to manage learning and used by instructors to administer assessments and teach through simulations. An example of where teaching through simulations was achieved was the development of a module with smart features that consisted of a smart backpack, IoT school check-in, smart desk, and whiteboard (Bayani et al., 2017). The smart module provides a virtual and flexible learning environment supported by the IoT.

The IoT is noted for enriching opportunities and experiences in education. Abbasy and Quesada (2017) used the concept of IoT to explain a model in education coined as Internet of education things (IoET). The IoET model comprises several affordances, including the promotion of engaged learning by improving the learners' degree of attention, motivation, interest, and curiosity. The IoET environments allow learners to engage in creativity as they use skills to observe the world in new and diverse ways when interacting with virtual and physical objects. E-learning is possible through the IoET through the use of electronic tools, applications, and web-based tools. Among the affordances enabled by the IoET is the capability of self-learning in which learners are motivated to self-educate in informal and flexible environments.

Furthermore, remote collaborations are enabled among people in different locations. LMSs and Web 2.0 tools such as social media and web-based office tools such as Google and Microsoft are some of the IoT-enabled technologies used to build online learning ecosystems (Scott et al., 2016). Makamure and Tsakeni (2020) observed that the WhatsApp social media platform played a significant role in building online classrooms during the COVID-19 pandemic. The advent of online learning has also influenced teacher education. For teacher education, the

implications of online learning are far-reaching because the students use online learning for their education and are also being prepared for online classroom practice.

Methods

Research design

The research design comprised a qualitative study guided by an interpretive paradigm using rural campus of one South African university as a research site. The interpretive paradigm allowed for the understanding of the findings of the study as subjective experiences of the study participants (Kivunja & Kuyini, 2017). Qualitative research gave voice to the participants and the researcher only made meaning of how they (the participants) viewed the phenomenon under study (Creswell, 2014). The phenomenon under study entailed the subjective experiences of a transition to online learning by a faculty of education.

Context

The university has two other campuses in urban settings. Literature regards rural contexts as non-urban areas that have fewer civic and commercial amenities and are characterized by social justice issues, which includes poor service delivery (Manly et al., 2020; Nelson et al., 2021). The poor service delivery includes poor access to electricity and the internet. This study was conducted in a context in which a significant number of the students enrolled at the campus lived in rural communities of the Eastern Free State and KwaZulu-Natal provinces of South Africa. However, the university campus is not affected in the same way as the rural community by the intermittent electricity supply and internet access because it has a backup electricity generator and reliable internet infrastructure. However, the transition to online learning happened at the time both the students and educators were studying and working from home, respectively, due to the COVID-19 pandemic.

The participants

The participants consisted of 4 teacher educators who taught education courses attended by all fourth-year BEd students. Two of the teacher educators taught a general education course, while the other two taught the teaching practice course, as shown in Table 1.

Table 1. Teacher-educator Participants

Teacher-educator participant	Course taught	Gender	Home environment
T1	General education	Male	Rural community
T2	General education	Male	Rural community
T3	Teaching practice	Male	Rural community
T4	Teaching practice	Female	Rural community

Five fourth-year preservice teachers from a BEd program also formed part of the participants that was purposely selected from different specializations, as shown in Table 2.

Table 2. Preservice-teacher Participants

Preservice-teacher participant	BEd specialization	Gender	Home environment
PST1	Primary school social sciences	Female	Rural community
PST2	Primary school science and mathematics	Female	Rural community
PST3	Secondary school science and mathematics	Male	Rural community
PST4	Secondary school history and languages	Male	Rural community
PST5	Secondary school business studies and economics	Male	Rural community

An invitation was sent to all teacher educators who had participated in the transition to online learning and taught all the preservice teachers in the BEd program. Purposive sampling was further used to select teacher educators who lived in the rural communities around the university campus. Purposive sampling was also used to select five final-year preservice teachers from different BEd specializations but attended the mass courses teaching practice and general education taught by the teacher-educator participants. The selected preservice teachers lived in rural communities during the time that the online learning was implemented. The pseudonyms T1–T4 were assigned to the teacher educators, while the preservice teachers were assigned the codes PST1–PST5. T1–T3 were male teacher educators and T4 was a female teacher educator. PST1 and PST2 were female preservice teachers and PST3–PST5 were male preservice teachers.

Data Collection Instruments

Two open-ended questionnaires, one for the teacher educators and another for the preservice teachers, were designed to elicit insights of the transition to online learning. The first section of the teacher educators' questionnaire elicited biographical data in terms of gender, course taught, and place lived during the online learning. Similarly, the first part of the preservice teachers' questionnaire elicited information on gender, BEd specialization and place lived during online learning. The second part of the questionnaire elicited the IoT tools that supported the online learning as experienced by the teacher educators and the preservice teachers respectively. The third part of the teacher educators' questionnaire elicited how they facilitated the three components of Col, teaching presence, social presence, and cognitive presence, in online learning and the IoT tools that were used. The third part of the preservice teachers' questionnaire probed the experiences they had of teaching presence, social presence,

cognitive presence, and the IoT tools used. Therefore, the questions on the questionnaires were under the three headings: biographical data, IoT tools used, and the Col experiences.

Data collection procedures

The study was conducted in November 2020. An email with the open-ended questionnaire were sent to the fifteen teacher educators who had participated in the transition to online learning in the faculty of education. Ten completed questionnaires were returned. However, four were selected purposefully according the participant selection criteria explained under the description of the participants. Similarly, an email with the questionnaire was sent through the Blackboard LMS of the teaching practice course and general methods course to the fourth-year BEd preservice teachers. Five questionnaires were selected according to the criteria explained in the section describing the participants. The questionnaires were labelled T1-T4 and PST1-PST5 accordingly.

Trustworthiness

The trustworthiness of the data, which is a measure of credibility and authenticity, was ensured through theory triangulation. The data collection and analysis were based on the Col and IoT frameworks. Participant triangulation was also used because the questionnaire was applied to the teacher educators and the preservice teachers to elicit the two sides of the story of how transition to online learning occurred.

Data Analysis

The textual data collected from the open-ended questionnaires were subjected to thematic content analysis following the steps suggested by Nowell et al. (2017). The steps entailed reading completed questionnaires repeatedly in order to be familiar with the data. The read texts were subjected to a coding process. The researcher developed codes to identify the subsidiary research question, participant and the theme into which the data must be classified. For example, as shown in Table 3 pieces of data may be labelled as SQ1-T1-IoT-1 or SQ1-T1-IoT-2 to show that the pieces of data address the subsidiary research question 1 and have been extracted from T1's completed questionnaire and that the data falls under the IoT broad theme but they are different and therefore are labelled 1 or 2 at the end of the code. The following labels were used to build the codes, SQ-subsiary question, IoT-Internet of Things, TP-teaching presence, SP-social presence, CP-cognitive presence, and the T1-T4 for teacher educators and PST1-PST5 for the preservice teachers. Table 3 only shows a few examples and not all the data that were analyzed. The coded data was placed into categories that were further grouped in the predetermined themes that addressed the four subsidiary questions.

Table 3. Excerpt from the Open-ended Responses Codebook

Broad theme	Instructor-learner activities	Categories
IoT affordances	LMS tools Social media tools Online office tools Other multimedia	Connectivity challenges Use of Blackboard Use of WhatsApp
Example	I used online learning, which included Blackboard and WhatsApp. These assisted me to reach many students, especially those from remote areas without adequate access to resources and internet connectivity. SQ1-T2-IoT-1	Use of LMS and social media
Teaching practice	Instructional organization Facilitating discourse Direct instruction	Asynchronous online instructional strategies
Example	I staggered my presentations and assignments in such a way they will keep my students busy when doing entire unit. My students will be studying and doing various parts of the assignments alongside my PowerPoint presentation with a voiceover. On weekly basis, I also sent reminders and allowed students to submit for me to give comments. SQ2-T1-TP-1	The leadership role of teaching presence
Social presence	Discussions Interactions Communications	
Example	I allowed students to form groups in some activities and submit their work as groups. In addition, in one module I also allowed them to give one another a mark that would contribute about 5% of the promotion mark. This was an acknowledgement/penalty of the [non-]contribution of each member of the group from the perspective of members of the same group. SQ3-T1-SP-1	Learner-learner interactions through groupwork and peer evaluation
Cognitive presence	Triggering event Exploration Integration Resolution	
Example	Recorded lesson and video lesson don't form that active teaching and learning so much; one	Self-regulated learning

	will listen to the lesson at his or her own time, which is one of the advantage to some. SQ4-PST1-CP-1	
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Findings of the Study

The findings of the study address the following main question: How did a teacher education program in rural South Africa transition to online learning during the COVID-19 pandemic? The findings are presented under four themes that correspond to the four subsidiary questions of the study. The four themes are: IoT technology affordances to support online learning, strategies to ensure teaching presence, strategies to ensure social presence, and strategies to ensure cognitive presence. The verbatim data excerpts used in this section were selected on the basis that they represented the views of all the participants.

Internet of Things Technology Affordances to Support Online Learning

Discussion of this theme provides insights into the technologies used to support online learning, the issues of access to technologies, and the instructional strategies used to teach in online classrooms. The Blackboard LMS and the WhatsApp social media platform were identified as the IoT-enabled technologies used to support online learning. T2 explained how he used a combination of the LMS and the social media platform. He said:

I used online learning, which included Blackboard and WhatsApp. These assisted me to reach many students, especially those from remote areas without adequate access to resources and internet connectivity.

The use of the WhatsApp social media platform was confirmed by PST5 when he said:

This method of interaction and communication was very effective compared to emails as lecturers responded quickly and were able to attend [to] every student's problems. It also enabled lecturers to do voice notes, send extra study materials and images to clarify other information. Lecturers also used this social media platform to remind students about assessment tasks and due dates. It can be used ...easily and does not require lot of training.

The LMS was the official university platform for the facilitation of online learning, but the teacher educators and the preservice teachers made decisions to include the use of the social media platform. One of the issues raised by PST3 was that some preservice teachers did not have computers, laptops, and other gadgets that would enable them to engage in online learning effectively. He also mentioned that the limited access to data was a hindrance to the use of IoT-enabled online learning applications. He said:

There was a lack of access to technological devices and data. There was discrimination and an assumption that all students who are not funded by the National Student Financial Aid Scheme (a government-funded scheme to provide loans to university students) can afford to purchase their own laptops and data.

PST4 mentioned the issue of poor internet connectivity experienced in the rural communities as one of the factors that hindered online learning. He said:

The unavailability of network (internet connectivity) due to geographical barriers. In locations (rural communities), there is a huge gap of strong connectivity and no connectivity in some areas situated near mountains, whereas our peers in towns suffer less from connectivity problems.

The challenges mentioned above are some of the factors that led to the use of both synchronous and asynchronous modes of online learning. Distance learning through the sending of printed materials to preservice teachers who had limited access to the internet was also used as a strategy of making sure no student was left behind. T1 said the following when explaining the strategies that he used:

The printed material for the rural campus students, PowerPoint presentation with a voice, Blackboard Collaborate, as well as the low-tech (low technology) TEACHON (university online learning support for instructors) and LEARNON (university online support for students) platforms. Other platforms included WhatsApp groups.

Among the online strategies were the use of recorded lectures such as PowerPoint presentations with voiceovers posted on the LMS or the WhatsApp platform. In summary, the rural campus used the university LMS and a social media platform to facilitate online learning. The limited access to the internet due to the lack of data, suitable devices, and poor connectivity by the preservice teachers led to the use of synchronous and asynchronous online learning strategies. Printed material was also sent to some preservice teachers who needed them as one of the distance learning strategies in addition to online learning.

Strategies to Ensure Teaching Presence

Although there was a possibility of using synchronous online classrooms through the LMS application, there was more evidence that the teaching presence was ensured through the use of asynchronous strategies. The asynchronous strategies included posting content on the LMS for the students to download. T3 said:

I posted lecture slides (PowerPoint presentations) and content on Blackboard. I would have loved to use Blackboard Collaborate (synchronous online learning classroom), but with the large classes it is almost impossible.

T4 explained that she made sure to use the LMS at least once a week (possibly posting content) and also used emails to explain points that needed to be clarified. She said:

I contact my students via Blackboard weekly and make sure that I reply to their emails whenever they need some clarity.

Similarly, T2 ensured teaching presence by posting audio recordings of the content that he needed to teach. He said: "I ensured teaching presence through the use of slides with notes and voiceovers, and WhatsApp voice notes."

In addition to the voice recordings and posting of content, T1 sent constant reminders to the preservice teachers to ensure they stayed focused on their tasks, and provided feedback on the submissions made. He said:

I staggered my presentations and assignments in such a way that will keep my students busy when doing the entire unit. My students will be studying and doing various parts of the assignments alongside my PowerPoint presentations with a voiceover. On weekly basis, I also sent reminders and allowed students to submit their work for me to give comments.

PST2 confirmed that clarifications and explanations of concepts were sent through emails to preservice teachers. She said: "The use of emails was effective as the lecturers gave feedback to each student that made enquiries."

PST4 confirmed that the teacher educators used presentations with voiceovers and video attachments that showed demonstrations of practical work activities. He said:

A PowerPoint-presentation slide with a voice recorded on each slide providing explanations. A PowerPoint presentation with a video attached for demonstration of practical work.

The teaching was ensured by frequent (weekly) posting of content, which included presentations with voiceovers, voice notes through WhatsApp, and texts containing explanations and clarifications sent through emails.

Strategies to Ensure Social Presence

The synchronous online classrooms were considered to present opportunities of enhanced social presence because the preservice teachers could interact with the teacher educators and among themselves. PST1 considered that the synchronous online lessons enabled the preservice teachers to engage with the teacher educators more and that the use of discussion forums and chat boxes enabled the preservice teachers to engage with one another. She said:

The effective online learning used was through live sessions because one had a chance to engage with others and the lecturer. During the online session, there was a chat box to communicate with classmates; in this way, we were also learning from each other. Discussion forums are also effective because one shares information and it gives one an opportunity of being a creative thinker and be able to help others with problem-solving. This also develops one's communication skills.

T1 encouraged the preservice teachers to interact with peers and participate in the online classrooms through the use of groupwork and peer evaluation. He said:

I allowed students to form groups in some activities and submit their work as groups. In addition, in one module I also allowed them to give one another a mark (evaluate each other) that would contribute about 5% of the promotion mark. This was an acknowledgement of the group members' contribution and penalty for not contributing from the perspective of members of the same group.

Similarly, T3 gave the preservice teachers groupwork activities and made use of discussion forums. He said:

I asked them to do assignments in groups so that they get to discuss the content amongst themselves. I opened discussion groups on Blackboard as well.

Groupwork activities, discussion forums, peer evaluation, and interactions in synchronous online classrooms were used where possible to build the social presence in online learning.

Strategies to Ensure Cognitive Presence

PST3 considered the discussion forums to be useful for the construction of meaning through collaboration. He described a situation where the preservice teachers would be required to have a minimum of five posts in the discussion forums. He said:

Blackboard Collaborate discussion rooms were the most effective for student-interaction. Here, the lecturer set up four discussion rooms with different topics, then students had to pick one topic and compile a discussion. Other students would respond in agreement or disagreement with justifications. There was a submission date for each response and students were expected to respond to a minimum of five posts; we were then graded on each response. This was the most effective and enjoyable tool for me and it should be used for group assignments in the future, as meeting up physically with groups is always a hassle.

PST1 agreed with the notion that discussion forums helped the preservice teachers in knowledge construction when she explained that although recorded lessons can be listened to at one's convenience, they are passive ways of learning. She said:

Recorded lessons and video lessons are not forms of active teaching and learning. However, one will listen to the lesson at his or her own time, which is one of the advantages to some people.

In this section, the evidence showed that the preservice teachers could learn actively through collaboration and knowledge co-construction in online social interactions or they could learn passively by listening to recorded lessons and videos.

Discussion

In this section, the discussion will begin by a summary of the findings in order to address the main question. The summary will be followed by a discussion focused on each of the subsidiary questions. This study set out to explore how a teacher education program at a rural campus of a South African university transitioned to online learning during the COVID-19 pandemic. As a contextual assumption, rural communities suffer social justice issues because they are marginalized in terms of limited access to civic and commercial amenities, and suffer poor service delivery, including limited access to education (Manly et al., 2020; Nelson et al., 2021). The study contributes insights on the online learning experiences in the context of the COVID-19 pandemic and the experiences of online learning in rural contexts

The findings of the study showed that there were limited IoT affordances that influenced how the online classrooms were built and the choice of the online tools used. The limited IoT affordances were mainly due to the unreliable internet connection. Williams et al. (2021) confirm that the different communities in society do not equitably access digital technologies.

The university LMS had to be complemented by a social media platform that was easily available and cheap in the transition to online learning. Social media platforms play a significant role in building online classrooms (Saadatmand et al. 2017; Makamure & Tsakeni, 2020). Therefore, the teaching presence was established mainly through recorded material posted on the LMS and the social media platform for the preservice to download at a convenient time when they connected their devices to the internet from both the LMS and WhatsApp.

In the absence of synchronous online classrooms, the due dates for assessment submission were one way to pace the teaching and learning and help the preservice teachers focus on their tasks. The social presence interactions were mainly between the teacher educator and individual preservice through emails and text messages through WhatsApp. Discussion forums through the LMS were also used, but as mentioned, the students could only participate when they were connected to the internet. The cognitive presence was defined by passive learning in which the preservice teachers interacted with the posted material most of the time to construct meaning. The reduced social interactions limited opportunities for the active co-construction of meaning.

The four findings according to the four subsidiary questions will be discussed next. The first finding was that contextual factors influenced the IoT affordances that supported online learning in the rural communities in which the study participants lived. The contextual factors included limited internet connectivity and preservice teachers who lacked appropriate devices and data to engage in online learning successfully. Cutri et al. (2020) confirmed that inequitable-access issues characterize online learning. Limited access to the internet led to the use of a mix of the university's official LMS (formal learning platform), emails, and a social media application (informal platform) to facilitate online learning. The informal platforms built by the use Web 2.0 tools expand the opportunities for online learning because they enable the sharing of content and facilitate easy and temporal communication (Scott et al. 2016). Synchronous online instructional strategies through the LMS were not always possible due to the poor internet connectivity and were complemented by the use of asynchronous "low-technology" approaches and social media instructional strategies. The asynchronous approaches included posting recorded lectures and other content on the LMS, which the preservice teachers would download in ways that utilized less internet data. The use of multimedia, including social media, support online learning (Borup et al., 2012; Krutka et al., 2017; Lowenthal, 2010).

The second finding shows that only in a few instances was the teaching presence facilitated synchronously by teacher educators in the online classrooms. The teacher educators had to find alternative ways to engage the preservice teachers and maintain a teaching presence. Therefore, in most cases, the teaching presence was facilitated through a weekly uploading of content on the LMS and the WhatsApp social media platform, using PowerPoint presentations with voiceovers, voice notes, and emails containing clarification and explanation of concepts. The uploaded material consisted of content to be studied by the preservice teachers and the guidance, orientation, and instructions, all of which comprised the learning discourse. Szeto (2015) recognized the leadership role played by teaching presence in online classrooms. The three components of teaching presence which are the instructional organization, facilitating discourse, and direct instruction, according to DeNoyelles et al. (2014), had to be adjusted to align with the asynchronous strategies. The teacher educators conducted the instruction

organization by systematically posting materials using pre-recorded multimedia that the preservice teachers could download. The educators facilitated the discourse through the texts, recorded audio, and video presentations which mainly served as direct instruction tools.

The third finding showed that the social presence was influenced by the nature of the IoT tools used and how the teaching presence directed it. The WhatsApp social media platform provided an opportunity for the teacher educators and the preservice teachers to form social groups for communication, discussions, and sharing of content. The WhatsApp platform was more accessible, cheap, and temporal, unlike the Blackboard LMS, which was more expensive for the preservice teachers regarding internet service costs. The WhatsApp groups formed an important tool to ensure that the preservice teachers felt that they were part of a social community where they could interact. Thompson et al. (2017) explain that social presence is facilitated when individuals feel they are part of a group. Groupwork was also facilitated because the preservice teachers could function as real people in the virtual environment because they could communicate and share ideas (DeNoyelles et al., 2014). The discussion forums on the LMS were also useful to enable interaction.

The fourth finding showed that although the preservice teachers mainly interacted individually with posted content, the cognitive presence was enhanced by collaboration activities enabled by the virtual groupwork and discussion forums. Whenever the social presence was enabled, the preservice teachers could co-construct meanings of what they were learning. After all, DeNoyelles et al. (2014) indicated that the three forms of presence are interrelated. The preservice teachers considered the recorded materials in the form of pre-recorded audio and videos as passive ways of learning. Passive ways of learning may require preservice teachers to employ increased self-regulated learning, which is a premise of success in online learning (Cho et al., 2017; Shea & Bidjerano, 2012).

Conclusion

The participating preservice teachers and teacher educators at the university rural campus lived in communities with limited internet connectivity. The teacher education program transitioned to online learning through the use of a mix of the university LMS, emails, and a social media platform due to the limited internet access. Asynchronous strategies of building teaching, social, and cognitive presence in the online classrooms were favored and used more than synchronous strategies, which were not supported by the limited IoT affordances. The study findings highlight the inequitable access to the teaching presence, social presence, and cognitive presence experiences of learners in rural communities due the limited IoT infrastructure. This study has limitations, including that the findings rely on the data from one case and could have been enhanced had a multi-case study design been used. The study recommends further studies to explore how to improve learning experiences of preservice teachers in communities with limited IoT affordances.

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