Mediating Digital Devices in Post-COVID-19 Classroom: An Exploration of Teachers' Adaptation Process in Nepal

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Article

Mediating Digital Devices in Post-COVID-19 Classroom: An Exploration of Teachers' Adaptation Process in Nepal

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Abstract: This qualitative study explores the implementation and conformation process of digital devices in teaching and learning before, during, and after the COVID-19 pandemic in Nepal. Using Rogers' Diffusion of Innovation Theory as a framework, the study examines the adoption and adaptation of digital devices by in-service secondary mathematics teachers (n=62) and their perceptions and preferences towards instructional modality. The findings suggest that despite the increased reliance on digital devices during the pandemic, there is a less likelihood of using them in face-to-face classrooms in developing countries like Nepal. The adoption of online learning has not yet reached the confirmation stage, even after the onset of the COVID-19 pandemic. Prior to the pandemic, online learning was not widely implemented or confirmed by teachers in developing countries societies. The study also provides important insights into the challenges and opportunities of using digital devices in post-COVID-19 classrooms, and its implications for policymakers and educators in Nepal.

Keywords: COVID-19; mathematics; digital tools; digital skills; teacher; e-learning

Introduction

The COVID-19 pandemic has resulted in a worldwide transition from face-to-face classes to online learning. This shift has brought about a significant transformation in education, with e-learning experiencing particular growth. E-learning involves delivering lessons through various online and digital platforms, as noted by Hodgen et al. (2020) and Pokhrel & Chhetri (2021). Digital resources are increasingly being used in online classes to aid students when lockdowns are necessary, as pointed out by Videla et al. (2022). This situation has provided teachers with an opportunity to use digital tools, even if they had never done so before, and has led to unexpected benefits for digital natives (Pozo et al., 2022). Schools with an established infrastructure for online learning have been better equipped to transition to remote instruction than those without (Hodgen et al., 2020).

During the COVID-19 pandemic, teachers have been able to acquire new knowledge and digital skills in online teaching, which could prepare students to transform themselves, especially in developing countries such as Nepal (Dawadi et al., 2020). The skills that teachers acquire in online teaching during this pandemic may lead to the development of strong digital skills and technology capacities, particularly in areas with connectivity (Daumiller et al., 2021). Furthermore, the use of digital resources in the classroom has opened up opportunities for introducing digital technology and for continuous use of social media for networking and advancing novel practices (Haleem et al., 2022).

Zhao and Watterston (2021) predicted that education would change after COVID-19 to incorporate both synchronous and asynchronous learning in all subjects, including mathematics. Prior research has provided insights into how mathematics teachers use digital resources for online learning during the pandemic (Videla et al., 2022; Alabdulaziz, 2021; Khanal et al., 2022; Lemmo & Maffia, 2022). However, the key issue for practitioners is how to make informed decisions about the use of digital resources after the pandemic to promote their effective utilization in teaching. Digital

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technologies have become popular due to their scalability and cost effectiveness in education. With the shift away from traditional classrooms, researchers, practitioners, and policy makers are questioning whether the use of digital tools for online teaching will continue post-pandemic and how it will impact classroom teaching worldwide (Li & Lalani, 2020). The use of online teaching with digital resources has become a new innovation for mathematics teachers in Nepal (Graham, 2006). Rogers' theory suggests that the adoption of new approaches depends on individuals' decisions to continue using new ideas. Limited research exists on the possibilities and continued use of digital resources in the mathematics classroom after COVID-19. While the use of virtual classes and social media platforms like Facebook Messenger, Google Classroom, Team for Virtual Classes, Google Docs, and WeChat may have been novel practices for Nepali mathematics teachers,

To address this gap, a study was conducted among school mathematics teachers in Nepal to understand the determinants of perceived usefulness and ease of use of digital devices and tools, and their attitudes towards continuing their use in the post-COVID-19 situation. The findings have important implications for policy makers, teachers' educators, and educational administrators on integrating digital technology in mathematics education and its implementation in classroom teaching. This study is particularly relevant to developing countries. The research questions guiding the study were: 1) what digital resources did mathematics teachers use in online teaching before and during COVID-19 in Nepal? and 2) how did mathematics teachers use these digital resources after COVID-19 in face-to-face classroom teaching in Nepal?

Context of the Study

Before the COVID-19 pandemic, traditional face-to-face instruction was the norm for teaching and learning mathematics in Nepal, with limited use of technology. In Nepal, where education is mostly limited to traditional classroom settings with rote learning, memorization, and paper-and-pencil tests, policymakers and planners should consider blended learning approaches to transform the teaching and learning processes. Critical thinking is necessary for internalizing the curriculum contents, but it is often discouraged, and textbooks are the main sources of learning materials. Learning should involve more than just listening to lectures and doing assignments (Ministry of Education, Nepal, 2014; Baeten et al., 2013). However, the pandemic resulted in a full lockdown and school closures, which forced a transition to online learning similar to other countries. This shift was challenging for students and presented multidimensional and complicated challenges. The need for innovative teaching methods and digital resources has become more critical.

In response to school closures due to COVID-19, schools adopted various approaches to reach their students, with many opting for online and distance learning through digital resources and classic technologies like radio and TV (Dawadi et al., 2020). However, this shift required teachers to develop new skills in designing online pedagogy, integrating digital resources, and utilizing digital tools (Albrahim, 2020). To teach math online, teachers require basic computer skills and access to digital resources (UNESCO, 2016), but effective online math teaching may require specialized digital resources and expertise (Cevikbas & Kaiser, 2020). Although awareness of digital tools has increased among math teachers, it remains unclear to what extent they used these resources during COVID-19 and how they plan to use them in post-COVID classrooms (Joshi et al., 2021; Khanal et al., 2021).

Conceptual Framework: Diffusion of Digital Resources in Mathematic Teaching

The aim of this article is to explore the uses of digital resources by teachers before the pandemic or during COVID-19 as they made the transition from a face-to-face classroom system to an online mathematics teaching. To examine the adoption of e-learning in higher education institutions, the most important success factors are leadership and strategic alignment, committed change agents among staff and students, staff and student recognition of the value of e-learning, innovation in teaching, a suitable organizational and support structure for staff and students, technical infrastructure, and e-learning quality assurance (Bates, 2011). We focused on Rogers' Diffusion of Innovation Theory (DOT) to understand the adaptation and adoption of new ideas in the field of education due to its wider range of innovation adaptation characteristics and processes, including

the knowledge, persuasion, decision, execution (implementation), and confirmation stages (Miller, 2015; Venkatesh et al., 2003). Roger's Diffusion Theory of Innovation, a well-known empirical framework that conceptualizes the five stages of the innovation adaptation process (Raman et al., 2021). This theory has been used to comprehend the adaptation and acceptance of mobile learning in teacher education and the adaptation of online proctored exams (Frei Landau et al., 2022).

The adoption and continuous use of digital resources by mathematics teachers in online classes involve various stages of adaptation. According to Rogers' theory of the diffusion of innovation (1995), there are five stages involved in this process, including awareness, persuasion, decision, implementation, and confirmation. Several studies have shown that mathematics teachers in Nepal have already used digital tools to communicate with students during the COVID-19 pandemic. This suggests that they have completed the first three stages. However, the final two stages, which are crucial for the sustained use of digital devices and resources even after the pandemic, have not been adequately studied in online learning, particularly in developing countries, as noted by Grgurovic (2010). These stages can help determine whether the adoption of digital resources in mathematics teaching takes time or is quickly embraced and consistently used by teachers. In this case, mathematics teachers who have tested digital resources and engaged in online learning are considered innovators. The analysis of interviews presented in the findings section will utilize these two stages.

The Implementation Stage

The implementation stage of diffusion theory involves the process of putting the innovation into practice and making it widely available. However, those who are exposed to innovation must have a fundamental comprehension of what it is and how it functions (Dearing & Cox, 2018). On the other side, people are more inclined to maintain a constant attitude as opposed to often changing it (Wang et al., 2021). This change is therefore not seen as either favorable or bad. When regarded in this context, implementation helps and supports learners' efforts to rearrange and modify their schemata. It is apparent that for students to fully benefit from an online environment, they must engage with it (Bernard et al. 2014). Contrarily, due to several circumstances, student engagement in blended learning may be difficult (Holley and Oliver 2010). In most circumstances, once a decision to adopt a product has been made, the consumer will use it. This is the point at which the adopter decides whether or not the innovation or new ideas will be beneficial to them. They may also look for additional information to help them use the product or to better understand it in context. An innovation, on the other hand, brings newness, and "some degree of uncertainty is involved in diffusion" (Rogers, 2003, p. 6). An individual (teachers) in social system (class) can have challenges and certain degree of issue. Thus, the implementor (teachers) may require technical assistance from change agents and others. Supportive environment, ease of use and usefulness could be the major factor for acceptance (Okocha, 2019). When individuals doubt the ease and usefulness of technology (e.g., due to technology anxiety), they might reject it entirely (Rogers, 2003). Rogers (2003) also clarified the concept," "adoption" is "the process of using an existing idea continuously" (Rogers, 2003, p. 181). The more perceived ease and usefulness of technology is, the faster an innovation is adopted and entrenched. Digital resources as computer technology are more accessible since they are tools with many possible prospects and applications.

One of the key factors affecting the implementation of innovations is the compatibility of the innovation with existing systems and practices. Research has shown that innovations that are compatible with existing systems are more likely to be adopted and implemented (Rogers, 2003). In addition, the complexity of the innovation and the ease of use are important factors in determining its success. Innovations that are simple to use and understand are more likely to be implemented successfully (Venkatesh et al., 2003). Another important factor is the availability of resources, including funding and support from stakeholders. Innovations that have adequate funding and support are more likely to be implemented successfully (Damanpour, 1991). The involvement of stakeholders, such as end-users, in the implementation process has also been shown to be important in ensuring success (Greenhalgh et al., 2004). Research has shown that the involvement of leaders

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and managers in the implementation process can help to overcome resistance to change and increase the likelihood of success (Meyer et al., 2010). However, Despite the potential benefits of innovation implementation, there are many barriers that can hinder the process. One of the most common barriers is resistance to change. Research has shown that people are often resistant to change and may be reluctant to adopt new ideas and technologies (Damanpour, 1991). This resistance can be particularly strong in organizations with entrenched cultures and traditions. There are also many barriers that can hinder the process, including resistance to change and a lack of resources. Future research should focus on identifying strategies for overcoming these barriers and increasing the likelihood of successful implementation.

The Continuation of Use of Digital Resources

Confirmation is the final stage of the process, in which individuals assess the effects of adopting the innovation and seek confirmation from other decision-makers that the decision to embrace the innovation was correct (Rogers, 1995). The confirmation stage was explored in this study since all the mathematics teachers are professional teachers who conducted online classes to reach out to the students and use digital resources to continue their teaching. Even if the decision had already been made by schools, individual might have exposed to conflicting cues regarding the innovation" (Rogers, 2003, p. 189), they might reject it. Some individuals, on the other hand, may avoid conflicting cues and favor only supportive ones that affirm their decisions. As a result, at the confirmation stage, attitudes become even more important. One of the key factors affecting the confirmation stage is the perceived relative advantage of the innovation. Research has shown that innovations that are perceived to offer significant advantages over existing systems and practices are more likely to be confirmed (Rogers, 2003). Depending on the level of support for the invention and the individual's attitude, delayed adoption or even discontinuance might occur during this stage (Rogers 2003). Another important factor is the complexity of the innovation and the ease of use. Innovations that are easy to use and understand are more likely to be confirmed (Venkatesh et al., 2003). The involvement of stakeholders in the confirmation process is also important. Stakeholders who are involved in the evaluation and feedback process are more likely to continue using the innovation (Greenhalgh et al., 2004).

Despite the potential benefits of innovations, there are many barriers that can hinder the confirmation stage. One of the most common barriers is a lack of perceived relative advantage. If stakeholders do not perceive the innovation as offering significant advantages over existing systems and practices, they may be less likely to confirm it (Rogers, 2003). Another common barrier is a lack of compatibility with existing systems and practices. If the innovation is not compatible with existing systems and practices, stakeholders may be reluctant to continue using it (Venkatesh et al., 2003). In addition, the complexity of the innovation and the difficulty of use can be a barrier to confirmation (Venkatesh et al., 2003).

Methods

The research employed a qualitative design and data was collected through structured interviews from the mathematics teachers of two district. Nepal Mathematical Society (NMS) provided the list of teachers and their email ID to us. We emailed the structural interview through google form to 90 mathematics teachers requesting the participation. Among them only 62 mathematics teachers provided the complete answer of our questions. Among 62 mathematics teachers, 56 of whom were male and 6 were female, from a rural municipality with internet access. All interviews were recorded during data collection, and participants transcribed the recorded data voluntarily as part of their subject "Research Methodology". Before the pandemic, 47 teachers had laptops, while 15 did not. However, all participants had Android mobile phones. The teachers came from 62 schools across two districts and were all in-service teachers who had been working in community schools in Nepal. The data were coded using Atlas Ti software based on the interview guidelines. As the Nepali language was used during data collection, the researchers translated the transcribed information into English before analysis.

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To begin, recruitment invitations were sent via email to MPhil students at NOU, providing information about the voluntary nature of their participation in the study. Their consent was obtained through email responses. Deductive analysis was used to confirm that the data arrangement was consistent with the expected pattern of the two stages of the diffusion theory of innovation and in accordance with the participants' responses. Thus, the two stages of the diffusion theory of innovation were taken into consideration when interpreting the interview responses. The transcripts were read to obtain a general sense of them, and related text segments were assigned to the two stages of the decision-making process, as suggested by Creswell (2012). Throughout this process, the ideas were constantly compared both within and across stages to reduce overlapping and draw clear conclusions. Figure 1 and 2 depicts the interview questions and answer regarding instructional activities and use of digital resources in mathematics teaching in high schools in Nepal before, during, and after the COVID-19 pandemic, and the analysis is presented in separate subheadings.

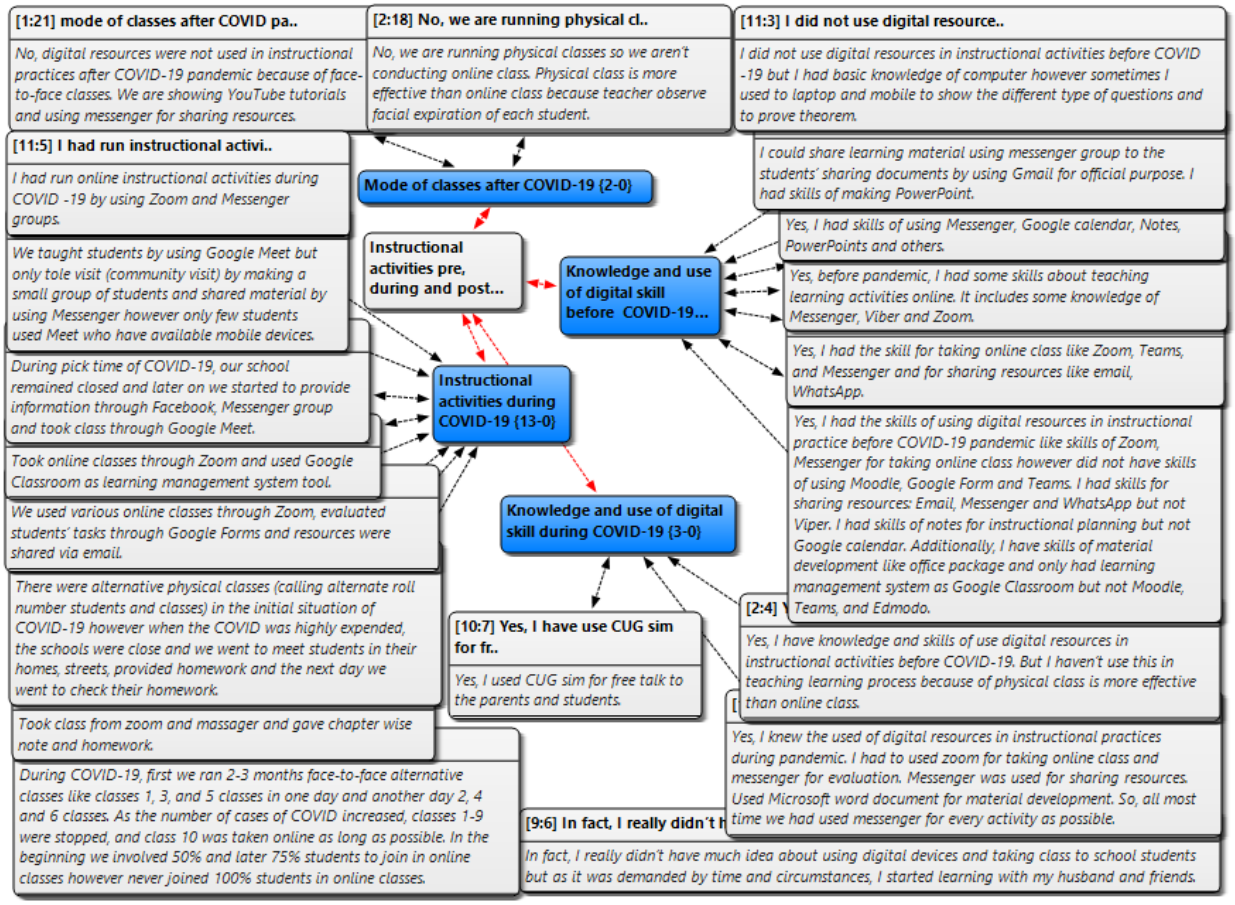

Figure 1. Instructional activities of mathematics teachers before, during, and after COVID-19 pandemic.

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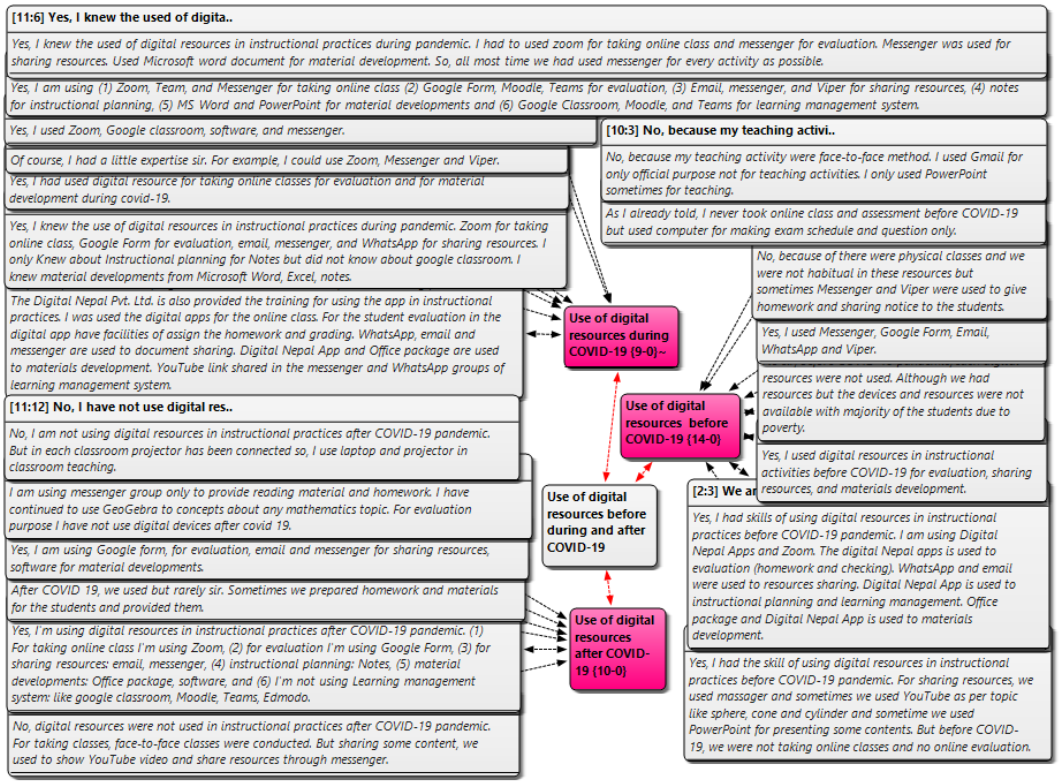

Figure 2. Use of digital resources pre, during, and post COVID-19 pandemic.

Findings

Findings are organized in three main pre-determined themes. The implementation and conformation stages before COVID-19, during COVID -19 and after COVID-19 pandemic.

Implementation and conformation of digital resources during pre-COVID-19

Teachers lacked experience and knowledge in using digital devices before COVID-19, and had no prior experience with online classes or evaluations. They did not feel it was necessary in face-to-face classrooms and did not realize the importance of digital resources in teaching. A teacher from Kaski District said:

We didn't have any experience with online classes or evaluations. We didn't have any practice with conducting classes or evaluations online

The knowledge and skills required to use digital resources were crucial for their implementation. Before the COVID-19 pandemic, nearly all teachers had an Android mobile phone, and 47 of them owned a laptop, and all of them had android cell phone . Teachers used their mobile phones to make calls and browse Facebook but did not use these devices for instructional activities. A few of them, however, used group messenger apps to share information. Classes were conducted in physical classrooms, and there was no use of online classes or digital devices to evaluate students. A teacher from Lalitpur district stated:

Yes, I have knowledge and skills to use digital resources for instructional activities before the COVID-19 pandemic. However, I did not use them in the teaching-learning process. But sometimes I used Viber to send the group message to the students.

However, almost all participants had no prior knowledge of Moodle, Google Forms, or Teams. Out of the sixty-five participants, only fifteen teachers were familiar with PowerPoint, while half of them had no knowledge of other digital resources. Among the teachers who owned personal computers, they only used them to create PowerPoint presentations and display YouTube videos for students to answer examination questions. For example, teachers from Kaski District said:

Before COVID-19, I owned an Android cell phone and a laptop. While teaching mathematics, I occasionally used YouTube to demonstrate mathematical shapes such as spheres, cones, and cylinders. I also created PowerPoint presentations for classroom use.

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As seen another teacher, they did not even try or had not a desire to use whatever digital devices they have. But he made adjustment to face-to-face classroom without digital devices. Making adjustment in lecturing and chalk and duster classroom decrease the implementation and desire to use digital resources in the future. Another teacher from Lalitpur added:

Computer and Laptop were less needful in face-to-face mode. Some apps were used for sharing learning materials. Computer was used basically for official purpose.

None of the teachers who participated in this study reported experiencing success with the use of digital resources in mathematics teaching, and they were not motivated to adopt digital devices and resources in Nepali schools. Participants' feedback suggested that face-to-face classrooms do not require digital devices and resources. For instance, only a small number of teachers (7) reported having prior experience with digital resources, while the majority stated that they lacked ideas for incorporating them into their classes and were not motivated to use them for classroom teaching. A teacher from Kaski reported,

Yes, sometimes in a year, I took my students to the ICT room. If I needed to demonstrate the relationship of a math topic such as spheres, cones, and cylinders, or help them with any other problem. We enjoy making such shapes in whiteboard.

As a result, the implementation and conformity processes led to limited usage of digital devices and resources in classroom teaching due to a lack of both internal and external motivation. This lack of motivation is reflective of the limited implementation and conformity stages in the adoption process of digital resources and devices prior to the COVID-19 pandemic.

Implementation and conformation stages during COVID-19

The information provided by the participants appears to be indicating initial lack of knowledge about using digital devices to teach school students. However, due to the COVID-19 situation or demand for remote learning, the participant was motivated to learn and adapt. They mentioned learning alongside their husband and friends, indicating that they were able to seek support and guidance from others to acquire new digital skills. This quote highlights the importance of adaptability and continuous learning, especially during times of change and uncertainty. A teacher from Lalitpur shared:

Initially, I had limited knowledge about utilizing digital devices to teach school students. However, as the situation demanded it, I began to learn alongside my husband and friends.

Zoom became a popular tool for conducting classes as physical distancing measures during the pandemic forced teachers to generate ideas for online instruction. Most of the time, Messenger was used for every possible activity." They also utilized Zoom and Google Meet for classes and shared materials via email. For areas where there was no internet, electricity, or electronic devices, teachers and students practiced Tole education as an alternative mode of instruction. A teacher from Kaski District shared:

I learned how to use digital resources in my instructional practices during the pandemic. I used Zoom for online classes and Messenger for evaluations and sharing resources. Additionally, I used Microsoft Word to develop course materials. Few of my friends used Google meet to conduct the classes.

Participants believe that face-to-face classes where the instructor writes on a whiteboard are more effective at making steps and processes clear, which leads to increased student understanding. However, when teaching online classes using slides, it can be more difficult to convey the same level of clarity and understanding to students. Additionally, the participants note that non-participation in online classes is a challenge they face, which suggests that students may not be as engaged in online classes as they are in face-to-face classes. Illustrating these challenges, an informant from Kaski shared:

When conducting face-to-face classes by writing on a whiteboard, we were able to make the steps and processes clear, which increased students' understanding. However, it was difficult to impart knowledge through slides in an online class. Sometimes we face non-participation in online classes is another challenge that they face.

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As there was no alternative to using digital resources during the COVID-19 pandemic, teachers began using platforms such as Messenger and Viber for sharing materials, conducting Zoom classes, and utilizing Google Forms for student evaluations. A teacher from Lalitpur shared:

I incorporated digital resources into my instructional practices during the pandemic. I used Zoom for online classes, Google Forms for student evaluations, and email, Messenger, and WhatsApp for sharing resources. Prior to this, I only knew about instructional planning for notes and was not familiar with Google Classroom.

Uncertainty during the implementation stage can be daunting, and therefore, it is necessary to be willing to receive assistance from agents of change. However, participants reported that they did not receive the opportunity for training to learn how to operate digital devices and acquire the skills needed to conduct online classes. As a result, they resorted to alternative approaches such as community learning, home learning, and online education. A teacher from Lalitpur stated:

I did not use any digital resources as I lacked both the devices and skills required for instructional activities. Instead, we conducted community learning, home learning, and tole education. Additionally, there were challenges in accessing internet and electricity to run digital classes in remote areas of the country.

It's great to hear that the government and local government started providing online training to the teachers for online teaching during the pandemic. It is essential to equip teachers with the necessary skills and knowledge to conduct effective online classes. It seems that the training has helped teachers in various aspects, such as learning how to join an online class, using a learning management system, developing material using digital tools like GeoGebra, and using different software for evaluation, resource sharing, and office work. Such training programs could be beneficial in the long run and prepare teachers for any future emergencies that may arise. A teacher from Kaski said:

Skills like taking online classes, using a learning management system, and developing materials were enhanced by trainings.

Similarly, a teacher from Lalitpur reported that various skills were enhanced by trainings, such as Zoom and Messenger for online classes, Google Forms and the school's software for evaluation, and email and Messenger for sharing resources. The trainings supported material development, software usage for offices, learning management systems like Google Classroom and the school's software. As per the demand of time, teachers developed digital skills from various sources, such as Google, through training, watching online tutorials, suggestions and support from staff and friends, studying the user guide, and self-practice," said a teacher from Kaski.

In the training, we learned how to operate the Digital Nepal App and conduct online classes, how to create groups, and how to evaluate homework assignments and check them through the app. Email and WhatsApp were used to share resources. Office packages were used for material development. The Digital Nepal App is used for learning management system and instructional planning. The messenger group is utilized for information updates.

Although it was impossible to reach out to all teachers who were in remote areas, some of them were trained by welfare organizations. However, it was clear that teachers who were unable to receive training had inadequate formulation of their role in adopting technology. They were uncertain, and based on their experiences of adopting digital devices and tools as teachers, they noted the need for training from the government or any other organization. Teachers who were not able to join the training had developed their skills through a self-learning process. A teacher from Kaski said, "I had developed my skills to use these tools by watching online tutorials and by self-practice." Similarly, a teacher from Lalitpur said, "We tried to conduct physical classes, but we could not conduct online classes." Some teachers received training organized by various organizations, but most of the teachers learned on their own with the support of Google and friends.

Teachers highlighted the benefits of digital training, including the ability to prepare materials for teaching, engage in collaborative learning, and conduct virtual classes on platforms such as Zoom and Facebook Messenger. The trainings covered topics such as online class management, materials creation, resource sharing, student assessment, and instructional planning. All teachers agreed on the

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necessity of digital training, with one teacher from Kaski emphasizing the importance of staying up-to-date and developing basic skills:

We must not be left behind in this digital world. At least basic skills should be learned by teachers.

During the implementation stage, it was crucial for teachers to be willing and able to make adjustments in their use of digital devices and resources for online classes, including adapting their methods for assessing students, assigning work, and communicating with students. However, some teachers reported that students struggled to adjust to online classes and were unwilling to actively participate, such as muting their microphones and refusing to answer questions. Both students and teachers faced challenges with screen sharing, whiteboard usage, and proper use of online meeting platforms. In the confirmation stage of Rogers' theory, users reflect on the process and outcomes and seek support for their decisions. Some teachers expressed a desire for more training to better prepare for similar emergencies in the future. One teacher from Kaski emphasized the importance of digital training in the age of computers, noting that it could help teachers prepare for future pandemics.

According to a teacher from Lalitpur district, quality online instruction requires equal participation and responsibility from all stakeholders including parents, teachers, administrators, government, SMC, and other organizations. Similarly, a teacher from Kaski Disctict emphasized that the continuity of online instruction depends largely on the support provided by stakeholders such as parents, teachers, administrators, government, SMC, and other organizations. Additionally, a teacher from Lalitpur suggested that SMC should provide opportunities for teachers to participate in online training and follow-up programs, and demand a budget from the government for such activities. However, the support provided in this regard was found to be inadequate. Lastly, a teacher from Kaski disctrict revealed that their school did not provide support for managing digital resources during the COVID-19 pandemic.

Regarding support, almost all teachers expect financial support from the local government, such as rural municipalities, and a few teachers have reported receiving support from the municipality." Additionally, in the example provided by the teacher from Kaski areas, it should be "The government has supported the management of online classes, while the SMC has supported the creation and overall management of online classes.

Most teachers expect funding facilities from federal and local governments. For example, some teachers from rural municipalities stated that the municipality provided free sim to the students, but no one provided a budget for buying digital devices like computers, laptops, or mobiles. Similarly, a teacher from Lalitpur reported that Digital Nepal Pvt. Ltd. provided a subsidy to the Digital Nepal App for school education management. The company provided the subsidy to only community schools for the promotion of the digital management system. An informant from Kaski said:

Not much, but a small amount is provided by the Municipalities for buying mobile data.

Two teachers' replies highlighted the issue of inadequate ICT training and digital resources. The government has a crucial role in managing online classes, and it should provide support by conducting ICT training for teachers, providing devices, and offering an excess of networking for every student. A teacher from a rural area emphasized that the government or administrators should make digital resources available and equip every school with sufficient ICT resources by providing a suitable budget and need-based training.

Teachers have emphasized the important role of parents in ensuring quality online education. However, they have also recognized that parents may face challenges in providing the necessary materials, equipment, and internet access for online classes. One teacher from Kaski suggested that schools and VDCs should provide economic support to help parents and schools equip students with the necessary tools for effective online learning. Another teacher emphasized the need for teachers to perfect their teaching skills for online classes and develop digital resources, while also cooperating with parents, students, and school administration.

Challenge faced in online classes

While some teachers have found success in implementing online classes, many have also faced challenges related to the use of digital resources in teaching and learning. These challenges are associated with the potential for both success and failure in online education. The teachers in the study identified several significant difficulties, including unstable internet connections, frequent power cuts, student absenteeism, background noise in virtual classes, and evaluating assignments.

Teachers in this study reported that lessons taught in online classes often had to be reviewed again in physical classes later, as students faced issues with unstable internet connections and frequent power cuts. Additionally, some students were absent or unresponsive during virtual classes, and background noise from their homes posed a problem. Teachers also faced difficulties with evaluating assignments, as some students were not submitting work or were copying from their peers. In some cases, students would even turn off their video and play mobile games during class. According to a teacher from Kaski,district:

Collaborative study is not possible as students are studying from home. Teachers are finding it very difficult to make students pay attention during online classes. It is also challenging to treat all students equally and provide individual feedback to each student.

A rural teacher shared an interesting story about digital skill-based training and instructional practices during the COVID-19 pandemic. The online class was disrupted by electricity outages and slow internet connectivity, which required multiple attempts to reconnect with students. This experience was memorable for online class interaction. The teacher faced challenges due to slow or no internet connectivity but has documents in email that may not be easily accessible to students.

An urban teacher also shared an interesting story related to digital skill-based training during the pandemic. The municipality conducted a two-month online ICT training where they learned many things. The teacher collaborated with friends on assignments and also taught them what they had learned.

Implementation and conformation of use digital devices, digital resources and digital skills after COVID-19

As COVID-19 restrictions gradually eased, schools reopened and teachers returned to the classroom to resume teaching in the new-normal situation. However, some teachers, like the one from Lalitpur disctrict, continued to use digital tools such as messenger groups and GeoGebra to provide reading materials and share mathematical concepts, respectively. Nevertheless, the same teacher did not use digital devices for evaluation purposes after the pandemic. Similarly, a teacher from Kaski stated that:

Digital resources were not employed in instructional practices following the COVID-19 outbreak.

Despite the necessity of alternative modes of instruction during the COVID-19 pandemic, schools have now resumed physical classes in the post-COVID era. When teachers discussed their use of digital skills acquired during the pandemic in the classroom, they did not emphasize the importance of continuing to use these skills in the traditional classroom setting, which would enable them to maintain the same level of instruction as during the pandemic. Many teachers are accustomed to conducting face-to-face classes without relying on technology, but it is important to recognize the value of digital tools in enhancing and improving the quality of education. Almost all the teachers expressed a similar sentiment regarding the reluctance to continue using digital resources in the post-COVID period

We enjoy teaching in face-to-face classes and therefore do not believe that digital devices and resources are necessary for physical classes.

The face-to-face mode of instruction is the usual method in Nepali educational institutions, whereas online instruction is a new modality. There are significant differences between these two models. According to an informant from teacher of Kaski district, '

There are many differences between face-to-face and online instruction. Online classes can be difficult for students at different levels of proficiency, it is not possible to provide differentiated instruction to students with varying abilities, evaluation can be challenging, it can be difficult to develop instructional materials, and maintaining discipline among students in online classes is

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challenging. In contrast, these things are possible in face-to-face classes.' Therefore, in the informant's opinion, face-to-face instruction is more effective than online instruction.

An informant from Lalitpur District expressed:

I strongly believe that there are huge differences between face-to-face and online instruction, and that face-to-face classes are far superior to online instruction. If we consider the results of the SEE (Secondary Education Examination), we can easily see the difference in outcomes between these two modes of instruction

Teachers claimed that lessons taught in online classes had to be reviewed again in physical classes later. The data connection for students is often unstable, with frequent interruptions in class due to power outages. When questions are asked, students may either remain silent or leave the class. Background noise from home environments, homework assignments, and checking pose additional challenges. Some students may become disengaged, playing mobile games during class, turning off their video, or copying homework from their friends, thereby betraying the trust of their teachers. A teacher from Kaski stated:

Collaborative study is not possible with students at home. Teachers find it challenging to keep students engaged and attentive during online classes. Providing equal treatment to all students and individual feedback to those in need is also difficult.

Online teaching and learning are not the first choice of many participants, likely due to their familiarity and preference for face-to-face instruction which has been the norm for a long time. As a result, participants believe that the key competitive advantage of face-to-face classrooms is their ability to effectively deliver course content and conduct written examinations in school. Almost all the teachers shared the same opinion that face-to-face instruction is more effective because it enhances students' engagement, promotes regular attendance, and allows teachers to better understand the psychology of their students. A teacher from Lalitpur district expressed,

In face-to-face mode, we are able to evaluate students' activity and every type of student can learn effectively.' Similarly, a teacher from an urban area stated, 'Face-to-face instruction is more effective than online instruction because online classes are one-sided and students may engage in other activities like playing games or talking with friends.

However, a teacher from a Kaski district shared a different perspective, stating,

Both online and face-to-face modes are important. Online instruction is particularly beneficial for students who were not able to attend school regularly. Online instruction was especially useful during the pandemic.

It appears that the **participant** has not utilized digital devices and software in their teaching despite the resumption of face-to-face classes. He may not be taking advantage of the benefits that technology can offer in enhancing the teaching and learning experience. It also suggests that he may be more comfortable with traditional teaching methods and may need support and training to incorporate technology into their teaching practices.

No I have not using digital devices and software in teaching while face to face classes started.

Discussion and Conclusion

This study provides valuable insights into the adoption of online learning in schools located in technologically disadvantaged societies, particularly in the context of least-developed countries. The study examines the implementation and acceptance stages of online teaching during three different time periods: pre-COVID, during COVID-19, and post-COVID-19. To analyze the implementation and acceptance of online learning, the study applies Rogers' Diffusion of Innovation Theory (2003), specifically its implementation and confirmation stages. Based on the experiences of teachers, the study found that the adoption of online learning has not yet reached the confirmation stage, even after the onset of the COVID-19 pandemic. Prior to the pandemic, online learning was not widely implemented or accepted by teachers in these societies. During the pandemic, there was a limited implementation of online learning, but the study found that its effectiveness as a viable alternative to traditional classroom teaching had not yet been confirmed by teachers.

The findings of this study suggest that the implementation and confirmation stages of the diffusion theory of innovation were not fully realized in the context of mathematics education in

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Nepal. The COVID-19 pandemic provided an opportunity to use digital tools, which many teachers had not used before (Pozo et al., 2022). Prior to the pandemic, there was limited exploration and implementation of digital tools in classrooms, and stakeholders were not motivated to widely incorporate these innovations into the educational process. This is consistent with the implementation stage of the diffusion theory, which suggests that innovations must be adopted and utilized by a significant number of individuals to become established as mainstream practices. Teachers lacked exposure to innovation and did not have a fundamental comprehension of what it is and how it functions (Dearing & Cox, 2018). During the pandemic, Nepali mathematics teachers, like teachers in other countries, were required to deliver lessons through various online and digital platforms, such as Zoom, Google Meet, WeChat, and Google Docs (Hodgen et al., 2020; Pokhrel & Chhetri, 2021), but they failed to capture the unexpected benefits of being digital natives, contrary to the findings of Pozo et al. (2022). This indicates that teachers need motivation to learn and adapt to new technologies independently, which will help them keep up with the changing educational landscape. Furthermore, teachers in Nepal lacked exposure to and a fundamental understanding of digital innovation, indicating that they were not yet ready for the confirmation stage of the diffusion theory. In order to confirm the effectiveness and value of an innovation, it must be widely adopted and integrated into regular practices, leading to observable improvements in performance or outcomes. Without this confirmation, the potential benefits of an innovation may not be fully realized.

The COVID-19 pandemic has compelled teachers to adopt digital devices and online teaching methods. While many initially lacked the knowledge and skills to use these resources, the pandemic situation motivated them to learn and adapt. Consequently, many teachers utilized digital tools such as Zoom, Google Meet, and Google Forms for conducting online classes, sharing resources, and evaluating students. However, the participants noted that face-to-face classes were still considered more effective in making concepts clear and engaging students. Teachers who did not receive training had an inadequate understanding of their role in adopting technology, indicating a need for support from the government or other organizations. Overall, the study emphasizes the importance of adaptability and continuous learning, especially during times of change and uncertainty. It also underscores the need to equip teachers with the necessary skills and knowledge to conduct effective online classes through training programs. Such programs can prepare teachers for any future emergencies that may arise and benefit them in the long run.

Additionally, the study highlights the need for teachers' university education to promote independent learning skills, irrespective of other influences on the learning process, such as the teaching staff or the classroom environment (Smith, 2012). This is crucial because technology is rapidly evolving, and training may not be sufficient to keep teachers up-to-date. Therefore, teachers need to be equipped with the ability to learn independently and adapt to new technologies continuously. This approach will enable them to stay current with emerging trends and technologies in education and maintain their effectiveness in teaching students.

The study highlights the significance of online learning as a practical substitute for traditional classroom teaching in Nepal, especially during times of crisis such as the COVID-19 pandemic. However, the teachers involved in the study sought confirmation and support from various stakeholders, even though the government had already made the decision to adopt online classes. Despite acquiring new skills during the pandemic, the teachers did not perceive significant advantages over traditional teaching methods and seemed to be avoiding conflicting cues associated with online instruction. The study identified several challenges related to online instruction, such as difficulties in maintaining student engagement and participation, evaluation and feedback, and technical issues like unstable internet connectivity. To overcome these challenges and effectively implement online instruction, the study suggests that teachers need targeted training and support from relevant stakeholders. Overall, the study highlights the need for more focused efforts to promote the acceptance and adoption of online learning in Nepali classrooms.

The implementation of online classes during the COVID-19 pandemic was affected by the level of support from participants, and some teachers delayed or even discontinued their use of digital

resources and devices (Rogers, 2003; Bista & Nepal, 2020). This indicates a lack of confirmation of the benefits of these technologies. One important factor that influences the acceptance of innovation is the complexity of the innovation and its ease of use. Innovations that are easy to use and understand are more likely to be confirmed (Venkatesh et al., 2003). Stakeholders, including teachers, who were not involved in the evaluation or feedback process, were more likely to reject online learning in mathematics classrooms in Nepal (Greenhalgh et al., 2004). Teachers' attitudes and trust towards online teaching remain a major concern, particularly during and after the pandemic. As individuals in a social system, teachers may face challenges and issues. Thus, implementers may require technical assistance from change agents and others. A supportive environment, ease of use, and usefulness could be the major factors for acceptance (Okocha, 2019).

It is essential to address the concerns of teachers regarding the use of online technology in the classroom. Future studies could explore the factors that influence teachers' attitudes towards online teaching, as well as the strategies that could be used to increase their acceptance of this innovation. The findings of such studies could be used to develop policies and guidelines that facilitate the implementation of online learning in mathematics classrooms in Nepal and other similar contexts. When individuals doubt the ease and usefulness of technology due to technology anxiety, they might reject it entirely (Rogers, 2003). According to Rogers (2003), "adoption" is "the process of using an existing idea continuously" (p. 181). Therefore, it is crucial to consider contextual factors when deciding to integrate digital devices and tools in the classroom. Teachers' attitudes and environments can often impede the adoption of digital resources. For instance, teachers may initially adopt a new idea like online learning when the situation demands it, but may stop doing so once the environment returns to its pre-pandemic state, and this cannot guarantee its continuous implementation.

To address this issue, the government and policymakers should focus on enhancing teachers' knowledge and skills and building their trust in online learning and technology adoption. Personal development activities such as training programs and workshops can be organized to support teachers' continuous professional development in digital teaching and learning. Expanding the use of digital resources, particularly after the COVID-19 pandemic, can also help to build a more resilient and adaptable education system. By paying greater attention to teachers' knowledge and skills in digital teaching and learning, we can ensure that the adoption and implementation of online learning is sustainable and effective in the long term. Furthermore, teachers' education in the university must promote independent learning ability, regardless of any other influences on the learning process, such as the teaching staff or the classroom environment (Smith, 2012). This is important because technology is changing rapidly, and it may be challenging to update teachers through training. Teachers need to have the ability to learn and adapt to new technologies independently, which will help them keep up with the changing educational landscape.

The implementation and confirmation of the use of digital devices, digital resources, and digital skills after COVID-19 are increasingly crucial. The pandemic has forced many people to work, learn, and interact online, highlighting the importance of digital literacy for success in many areas of life. Therefore, individuals and organizations must continue to invest in digital technology and skill training to stay competitive in a rapidly evolving digital world. This will not only benefit individuals and organizations but also help bridge the digital divide and promote greater digital inclusion. Future research could investigate how to address the challenges associated with online instruction and improve its effectiveness classrooms. For instance, research could explore the impact of digital resources and technology on student learning outcomes, as well as the factors that facilitate or hinder the adoption of digital resources by teachers. Additionally, future studies could examine the best practices for integrating digital resources and technology into teaching practices in different context. This could involve exploring innovative teaching strategies and pedagogical approaches that support online learning. In conclusion, the COVID-19 pandemic has highlighted the importance of digital literacy and the need for investment in digital technology and skill training. The adoption and implementation of digital resources and technology in Nepali classrooms are crucial for building a more resilient and adaptable education system. By addressing the challenges associated with online

instruction, we can improve the effectiveness of digital resources and technology in teaching and learning, ultimately benefitting students and society as a whole.

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