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Research Article

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Factors Associated with the Challenges in Teaching Mathematics Online During COVID-19 Pandemic

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ABSTRACT

The aim of the research was to study the status of challenges in teaching mathematics online during pandemics and the factors associated with challenges. The study was based on a cross-sectional online survey and 442 mathematics teachers of school level have participated in this research. Mann Whitney and Kruskal Wallis tests were employed to find the significant result and path analysis was used to calculate the effect of socio-demographic characteristics on the challenges in teaching mathematics online. The results indicate that the level of challenges in teaching mathematics online was found to be significantly high. The relationship between the challenges found to be positively significant and the qualification, time of taking online classes, teaching level, and tools used for taking the online class are significant factors to determine the challenges in teaching mathematics online.

Keywords: online class, teaching mathematics, challenges, pandemic, Nepal

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INTRODUCTION

Nepal confirmed the first case of COVID-19 on January 13, 2020 (Bastola et al., 2020). The World Health Organization (WHO) proclaimed COVID-19 a global emergency on January 30, 2020, and also declared it a global pandemic on March 11, 2020 (WHO, 2020). Social distance is a preventive measure of COVID-19 (Bekele et al., 2021); hence, almost all educational institutions have been closed for a long time (Abidah et al., 2020). Regular physical classes of schools and universities and their other activities were entirely disturbed by the pandemic (Ali, 2020; Barrot et al., 2021). United Nations Educational Scientific and Cultural Organization [UNESCO] (2020) estimates that over nine million (8,796,624) pupils in Nepal were affected by school/university closures due to the pandemic up to the second week of May 2020 (Dawadi et al., 2020). However, education is an ongoing process (Guyotte et al., 2015), hence the virtual mode of instruction has been under practice during the pandemic. These events have sparked the digital transformation and pushed all institutions to relocate to the online platform (Adedoyin & Soykan, 2020). That provides the opportunity to manage digital devices and practice using digital resources in pedagogical practices as an alternative solution (Basilaia & Kvavadze, 2020; Taha et al., 2020). Therefore, depending on their resources, many countries have taken a variety of tactics to combat the pandemic (Capano et al., 2020). Technologically advanced countries, such as Italy, France, Germany, Australia, the United Kingdom, and the United States have used distance learning to compensate for the loss (Tomasik et al., 2021). They immediately upgraded their e-learning platforms (Moodle, LMS, cloud systems, and so on) to develop common distance learning center portals and provide students with mobile access to e-content and the repository (Dawadi et al., 2020). On the other hand, those countries that have poor digital infrastructure practice traditional technologies like radio and television to compensate for the loss (International Association of Universities, 2020).

The Nepalese government announced to promote online and technology-based education and started to run classes through radio and television however only 80% of Nepalese people have access to these mediums (Bista, 2011; Dawadi et al., 2020). It indicates the challenge to follow the decision of the ministry of education for starting online classes. Indrawati Rural Municipality conducted a random survey among school children and parents and the result showed that less than 10% of the students had internet access to their homes (Ghimire, 2020). The finding of the study may not be the same for all regions of the country, but the situation of internet connectivity and access to the digital device is almost similar in the other parts as well (Dawadi et al., 2020; Laudari et al., 2021). The economic survey presented in the parliament of Nepal on 28 May 2020 also found that among the 29,707 public schools, only 8366 have computers (MoF, 2020). The number of schools that can offer information technology-based study with internet connectivity was found to be 12% only in 29,707 public schools (Ghimire, 2020). Digitalization is not a new

phenomenon in higher education (Kopp et al., 2019); it has been with us for some years. The National ICT policy 2015 focused on ICT literacy, e-learning, and ICT integration in classroom activities, as well as ICT-based teacher training (MoCIT, 2015). The impact of ICT-based teaching-learning practices was highlighted in the school sector development plan 2016-2023 (MoE, 2016). All of these regulations have the goal of integrating and implementing current technologies into classroom practice (Joshi et al., 2021). Policies are developed and mandated to schools by government of Nepal however it does not commit funding for infrastructure and ICT-based teacher training (Rana et al., 2020) hence it does not seem to have implemented properly.

Currently, developing countries have been facing problems with limited ICT infrastructure including human resources and internet connection (Pham & Nguyen, 2020). Limited learning space at home due to this reason learners can make unnecessary noise which disturbed the classes (Adarkwah, 2021). As a result, the learning environment and learning resources were rated as the most difficult to control the class which creates an inequity in education (Adarkwah, 2021; Barrot et al., 2021). Judge (2013) pointed out that our curriculum, teacher characteristics, training and development, infrastructure, and supportive framework are interrelated factors to integrate with ICT an instructional practice. The ability to utilize ICT in all aspects of life is on an incremental level (Asian Development Bank & Australian Agency for International Development, 2014), thus colleges must be up to date on the responsibility of preparing potential professionals to meet issues and deliver solutions (Bond et al., 2018). Academics are generally sluggish to adopt e-learning however they are positive to adapt technological developments in order to remain competitive (Flavell et al., 2019). It focused to foster instructor training and improving student self-efficacy (Zhang et al., 2021). Student characteristics such as gender, motivation in learning, and learning strategies are also important factors in online learning (Wang et al., 2008, 2013). The personal attention of students in learning activities is also a contributing factor to online learning (Dhawan, 2020). That means disengaged students in the learning process can create problems in running online classes smoothly. The students who are unwilling to engage in groups will be problematic in an online class (Jenna, 2017).

Mathematical concepts are developed through action learning using physical tools and further developed through computational experiments supported by online technologies (Abramovich et al., 2019). Cavanaugh et al. (2009) outlined the barriers to online learning implementation in the available literature, as well as the benefits and challenges of online learning. Higher motivation, wider educational access, high-quality learning opportunities, improved student outcomes and abilities, educational choice, and administrative efficiency are all advantages of online learning (Barbour & Reeves, 2009; Cavanaugh et al., 2009). Meanwhile, the expensive cost of starting a business, concerns with the digital divide, governmental approval, and student preparation are all obstacles to online learning implementation. In a recent study, Aziz et al. (2020) identified the barriers to effective online learning such as feelings of the people towards online learning, technology skills, and personal skills. Moreover, they suggested that to address these barriers effective online practices should be better ways. Baticulon et al. (2021) identified that personal, institutional, community, and technological barriers interrupted learning during the COVID-19 pandemic. However, whether or not these constraints are related to mathematics online classes remains unknown (Bringula et al., 2021). Furthermore, in the present guidelines on improving mathematics online education, the mathematics learning setting is not taken into account (Lee & Kung, 2018). The capacity to solve mathematical problems is an important aspect of the learning objectives in mathematics (Simamora et al., 2017). Student involvement is a key factor influencing student achievement in an online setting which is the best indicator of student learning and maintaining consistency in student learning of effective online teaching (Ayouni et al., 2021). The semantic Web was created as a data-processing Web—one in which computerized agents might collect, integrate, trade, and reason over enormous amounts of disparate digital information (Shadbolt et al., 2006). Ting (2006) stated that online learning inspires students to use higher-order skills such as collaboration, problem-solving, and stimulation. According to researcher recommendations for instructors, teachers must be able to develop learning activities from home that are lighter, more creative, and yet successful, by utilizing the appropriate instruments or medium for the information to be delivered. In these contexts, the current study focused to find the answer of following research questions

1. What is the status of challenges in teaching mathematics online during the COVID-19 pandemic?
2. What is the association among the challenges in teaching mathematics online?
3. What is the contribution of qualification, teaching level, types of institution, the Internet access, time of taking online class, and tools for online classes of mathematics teachers in challenges in teaching mathematics online?

METHODOLOGY

Study Setting

The study was carried out among mathematics teachers of Nepal who were participated in virtual training based on the use of digital technology. Because of the pandemic situation, physical meeting with mathematics teachers was not possible hence the study employed a cross-sectional online survey design. According to flash report 2017-2018, there are 54,253 mathematics teachers teaching at secondary schools in Nepal (MoEST, 2021) hence it is considered a study population however the study was carried out among digitally trained 1,572 mathematics teachers; hence, it is considered as the sampling frame. The email address of mathematics teachers if the sampling frame was collected from different mathematics teachers' professional development related organizations such as Technology Friendly Society (TFS), Council for Mathematics Education (CME), and Try for Learn Pvt. Ltd. Whereas TFS and CME are non-profitable organization and Try for Learn Pvt. Ltd. is a private institution working in the field of teachers' professional development.

Sample and Sampling Technique

For the online survey, the Google Form was shared with all teachers of sampling frame through their email addresses hence the simple random sampling technique was employed in the research. However, out of all sampling frames, only 442 mathematics teachers have participated in the survey from 8/24/2021 to 9/17/2021 with a 26.85% response rate. The survey was carried out among digitally trained mathematics teachers of Nepal hence the result of this research will only be generalized among these teachers. Additionally, the online sampling

Table 1. Item wise status with one-sample t-test and correlation of the variables (n=442)

Items	Mean	SD	t-value	CTM1	CTM2	CTM3	CTM4	ITC
Difficult to control the class (CTM1)	3.43	1.12	7.96*	1				0.75*
Unnecessary noises disturb the classes (CTM2)	3.90	1.00	18.96*	.52**	1			0.81*
Challenge to monitor students' activities in an online class (CTM2)	4.08	0.80	28.58*	.23**	.38**	1		0.65*
Internet connectivity is the issue of online teaching (CTM4)	4.37	0.71	40.30*	0.09	.23**	.27**	1	0.50*

Note. *p<0.01, ITC-item total correlation

calculator shows that the appropriate sample size for 1,572 population is 309 with taking 5% margin of error and 95% confidence interval (https://www.smartsurvey.co.uk/survey-tools/sample-size-calculator) however our sample size is 442 hence the sample size satisfied representativeness property.

Participant Information

Qualification, teaching level, types of institution, Internet access, time of taking online classes, and tools for online classes were considered independent variables for the research. The qualification has two categories those having bachelor level qualifications (23.8%) and masters and higher qualifications (76.2%) indicating that almost all mathematics teachers have higher than minimum qualifications. Teaching levels have three categories basic (teaching up to classes 8) level (21.7%), secondary (teaching at classes 9 and 10) level (21.3%), and higher secondary (teaching at classes 11 and 12) level (57%) based on the nature of courses and the rule of the government indicating that more than half of the participants were from higher secondary level. The institution has two categories private (24.9%) and public (75.1%) whereas private institutions are affiliated by the government without any financial support and public institution indicates these institutions are supported and afforded by the government. Internet access has two categories as mobile data only (11.1%) and Wi-Fi with mobile data (88.9%) indicating that almost all of the participants have access to Wi-Fi which is accessible in an urban area of Nepal only. The practice of online classes in Nepal begins during the COVID-19 pandemic hence the time of taking online classes has two categories before less than one year (38%) and before more than or equal to one year (62%) indicating that around two-thirds of participants were taking online classes since more than one year. Zoom, Google Meet, Teams, Facebook Messenger, Google Handout, and other tools are major tools in the practices for taking online classes in the Nepalese context hence tools of online classes have four categories as Zoom (75.1%), Google Meet (13.3%), Teams (8.8%), and other (2.7%).

Research Instrument

The practice of online classes in school education in Nepal is new. Exploring the major challenges faced by mathematics teachers in online teaching is the main concern of this research. For that self-constructed instrument consisting of different demographic variables with four challenging measuring items was employed in the research. The items were measured on Likert's five-point rating scale from strongly disagree to strongly agree. The measured challenges in teaching mathematics online are difficult to control the class (CTM1), unnecessary noise disturb the classes (CTM2), challenge to monitor students' activities in an online class (CTM3), and internet connectivity is the issue of online teaching (CTM4). Additionally, six factors associated with these challenges as qualification, teaching level, types of institution, Internet access, time of taking online classes, and tools for online classes were included in the instrument as demographic variables of the participants.

Reliability and Validity of the Instrument

For the internal consistency of the measured variables, the Cronbach's alpha reliability was calculated and found to be 0.72, which exceed the threshold criteria (0.70) indicating that the instrument is reliable. The content validity was calculated by sharing a tool with mathematics education related three experts and managed their feedback as some language correction only and also the validity was ensured by the total item correlation method presented in **Table 1**.

Data Analysis

The data were analyzed by using descriptive and inferential statistics. Mean and standard deviation (SD) were used under descriptive statistics to show the status of challenges in teaching mathematics online whereas a histogram was employed to show the distribution of data in all measured items as CTM1, CTM2, CTM3, and TM4. One-sample t-test was used to test the level of challenges with an assumed population mean of 3. The correlation was used to calculate the relationship between the items. The nature of the items was in the form of a rating scale hence Mann Whitney U and Kruskal Wallis H tests were used to find the significant results based on independent variables such as qualification, teaching level, types of institution, Internet access, time of taking online class, and tools for online classes. Additionally, a path analysis model was used to calculate the effect of independent variables on the challenges in teaching mathematics online during the pandemic. The data were analyzed by using statistical package for social science (SPSS-23) and analysis of a moment structures (AMOS-23).

RESULTS

Table 2 shows that the level of problems found to be significantly high in all cases however, the participants were highly agreed on issues of internet connectivity (mean=4.37, SD=0.71) and learners can deviate if the participants turn off the video (mean=4.08, SD=0.80) as compared to remaining items. The relationship between the variables was found to be positively significant among all items except for CTM1 and CTM4 (r=0.09).

Table 2 shows the significant result of independent variables (qualification, teaching level, types of institution, the Internet access, time of taking online classes, and tools for online classes) on the challenges in mathematics teaching. The qualification has a significant result on CTM2 and CTM3 in favor of the teachers having the above master qualification. The internet access and types of the institution have significant results on CTM1 and CTM3 in favor of having Wi-Fi with mobile data and public institutions respectively. Similarly, time of taking online classes and teaching level have significant results in CTM1 and CMT2 in favor of those taking online classes before more than one year and secondary school level respectively. The tool of taking online classes has significant results on CTM1, CTM2, and

Table 2. Significant results of independent variables of challenges of mathematics teachers in teaching mathematics online (n=442)

Variables	N	CTM1		CTM2		CTM3		CTM4	
		Mean rank	p-value	Mean rank	p-value	Mean rank	p-value	Mean rank	p-value
Qualification									
Up to bachelor	105	237.16	0.13	240.95	0.05*	240.50	0.05*	215.69	0.55
Masters and above	337	216.62		215.44		215.58		223.31	
The Internet access									
Mobile data only	49	253.62	0.05*	244.41	0.15	205.64	0.31	196.34	0.10
Wi-Fi with mobile data	393	217.49		218.64		223.48		224.64	
Time of taking online class									
Before <1 years	168	250.14	0.00*	246.27	0.00*	225.35	0.59	213.13	0.23
Before ≥1 years	274	203.94		206.31		219.14		226.63	
Teaching level									
Basic (class 1-8)	96	248.72	0.04*	247.16	0.05*	234.91	0.41	217.63	0.89
Secondary (class 9-10)	94	208.14		214.04		221.91		219.49	
Secondary (class 11-12)	252	216.11		214.51		216.24		223.72	
Tools for online class									
Zoom	332	229.43	0.00*	234.06	0.00*	226.86	0.22	226.18	0.02*
Google Meet	59	183.23		174.72		202.38		234.46	
Teams	39	190.44		180.62		197.71		178.87	
Others	12	291.29		236.92		244.54		166.96	
Types of institution									
Private	110	205.67	0.12	215.25	0.52	249.32	0.00*	249.32	0.09
Public	332	226.74		223.57		212.28		212.28	

Note. *p≤0.05

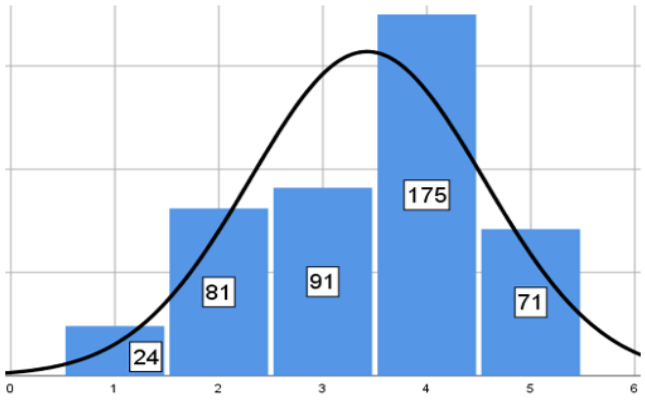

Figure 1. Distribution of difficult to control the class

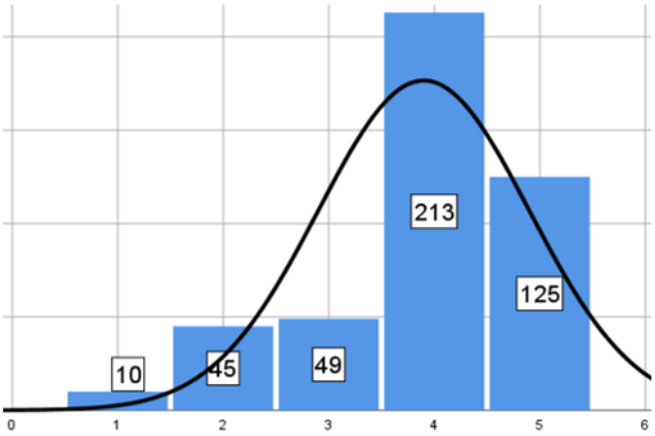

Figure 2. Distribution of sometimes unnecessary noise disturbs classes

CTM4 in favor of Google Meet in CTM1 and CTM2 and those using other tools in CTM4, respectively. However, the results were found to be insignificant in the remaining cases.

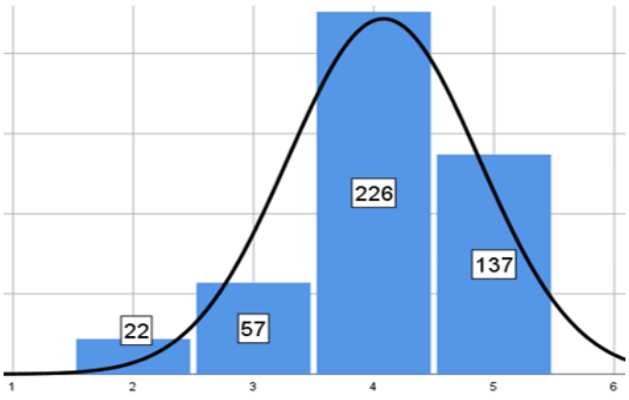

Figure 3. Distribution of learners can deviate if the participants turn off the video

Distribution of Data

Figure 1 shows that around one-fourth (24.88%) of mathematics teachers were disagree (sum of disagree and strongly disagree) towards difficult to control the classes whereas that rate is lower (**Figure 2**) in unnecessary noise disturbs the classes (13.03%). Additionally, number of disagreed found to be negligible (**Figure 3** and **Figure 4**) on that rate is poorest on learners can deviate if the participants turn off the video (5.21%) and Internet connectivity is the issue of online teaching (2.37%).

Figure 5 shows that the model explains 5%, 32%, 14%, and 2% variance in the difficult to control the class, unnecessary noises disturb the classes, challenge to monitor students' activities during the online class, and the Internet connectivity is the issue of online teaching respectively.

The types of institutions have a significant negative effect on monitoring students' activities during the online class indicating that the issue is found more in private institutions. The time of taking online

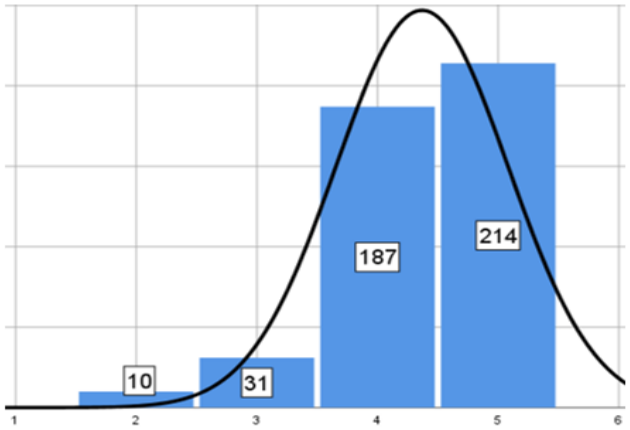

Figure 4. Distribution of the Internet connectivity is the issue of online teaching

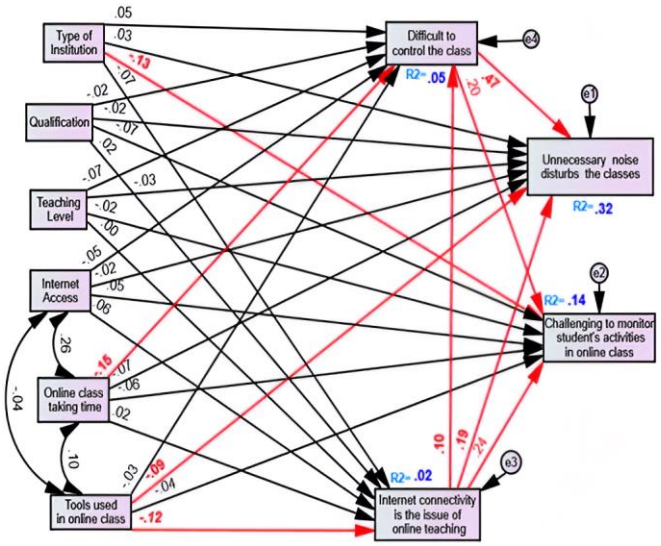

Figure 5. Effect of independent variables on challenges in teaching mathematics through online (red arrow represents significant result and black arrow represent insignificant results)

classes has a negative significant effect on the difficult to control the classes indicating that the issue of managing online classes is being reduced with the increase in online class duration. Tools for taking online classes have a negative significant effect on unnecessary noise disturbs the classes and internet connectivity is the issue of online teaching respectively indicating that the use of Zoom and Google Meet support to control such problems as compared to others. Additionally, the internet connectivity issue has a significant effect on difficult to control the class, unnecessary noise disturbs the classes, and challenging to monitor the student's activities during online class indicating that those having internet connectivity issues is problematic in remaining challenges. Similarly, difficult to control the class has a significant positive effect on unnecessary noise disturbs the classes, and challenges to monitor students' activities during online classes implies that controlling online classes supports managing other challenges.

CONCLUSION AND DISCUSSION

The research aimed to study the challenges in teaching mathematics online and the factors associated with these challenges. The level of challenges found to be significantly high in all cases as difficulty controlling the class, unnecessary noise disturbing the classes, difficulty monitoring student's activities during online class, and internet connectivity is the issue online teaching which may cause online teaching to be newly practiced in Nepal hence the learners are not aware and habituated to the use of online class taking tool. Hence, concerned stakeholders should develop and implement digital awareness for the students and guardians. These types of challenges may be common in other developing countries like Nepal hence those developed countries should share their ideas for managing such issues with developing countries (Adarkwah, 2021). Furthermore, the concerned technical expertise should add or develop additional features on video conferencing tools that can auto-manage the disturbance and unnecessary noise in online classes. The internet connection is the main challenge in the Nepalese context (Dawadi et al., 2020; Ghimire, 2020; Laudari et al., 2021); hence, government should have additional coordination with internet providers to manage this issue shortly and expand their brand width in each community level. On the other hand, choice marginalizes poor guardians who are from public institutions and the majority of participants of the research are from public institutions hence government should have extra support to the learners for managing the cost of internet and digital devices.

The qualification has a significant result on unnecessary noise disturb the classes, difficulties to monitor student's activities during online class and such challenges are less among the teachers having above master's degree qualification which may due to that almost teacher having above master qualification are teaching at secondary and higher secondary schools who may have skills to manage the online classroom effectively and in the other hand, the maturity level the students at this level is good as compared to lower level. Those teachers having Wi-Fi have significantly low challenges in controlling the class and difficulties monitoring students' activities during an online class. This finding indicates that the status of internet connectivity can play a significant role to manage an online class effectively (McDowell, 2020) hence concerned stakeholders should focus on expanding those services in a remote area of the nation. Similarly, those taking online classes for more than one year have significantly low challenges to control the class and unnecessary noise disturbs the class, hence the practice of online classes should be regular and government and other stakeholders should focus to transform current pedagogical practices into a blended model which is also the demand of this age (Rasheed et al., 2020). Similar results were measured in the case of teaching level hence special awareness and training programs are needed for minimizing such challenges to the teachers, students, and guardians. The majority of the teachers are using Zoom and Google Meet and the challenges are significantly low in using these tools which may be because that features of the controlling noise and videos are available in these tools and almost of the teacher's professional development digital training have been conducted through tools during pandemic hence the teachers may habit to use such features in these tools also.

The relationship between the measured challenges was found to be positively significant hence managing any type of challenge supports managing the remaining challenges in teaching mathematics online. The types of institutions are significant predictors of the effect of monitoring the student's activities during online classes in favor of private institutions, hence practices of a good private institution should follow by public institutions. The time of taking online classes is a

significant negative predictor of controlling classes, hence novel practitioners should have more regular practice in taking online classes to manage this issue. Furthermore, internet connectivity is a significant predictor to control of the class and unnecessary noise disturb the class; hence internet connection issue should be shuttled everywhere shortly. Similarly, difficulty to control the class is a significant predictor of unnecessary noise disturbing the class and difficulty to monitor student's activities during online class hence skills of teachers to control the unnecessary disturbance should be promoted.

Implications and Limitations

The findings of the research are important for the government and other concerned stakeholders for managing internet access-related issues and developing digital awareness programs for guardians, teachers, and students focusing on the online classroom environment. The study is also important for mathematics teachers and students to be aware while taking online classes and familiar with the challenges of online classes by which they can manage the learning environment which is useful to minimize the challenge. The study was conducted among digitally trained mathematics teachers hence the results will not generalize in face-to-face instructional mode and those teachers do not have a practice of taking online classes. Additionally, the study was limited to the mathematics teachers, online survey design, quantitative research hence further research can be carried out by taking other teachers, qualitative and mixed-method approaches among diverse countries. Furthermore, the study consists of only four challenges which were measured by teachers' perception hence further study is needed by taking other several challenges related to online teaching of mathematics through students.

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