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FACTORS ASSOCIATED WITH THE PROBLEMS IN TEACHING MATHEMATICS THROUGH ONLINE MODE: A CONTEXT OF NEPAL

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ABSTRACT

Online teaching became an alternative approach for the teacher to run the teaching-learning activities during the COVID-19 pandemic. In this context, this study aimed to identify the issues of mathematics teachers in teaching mathematics through online mode during the pandemic where issues represented the problems and challenges. Altogether 415 mathematics teachers from different levels participated in this cross-sectional survey. A self-constructed tool consisting of six categories of problems as Skills and training related problems (STP), learner related problems (LRP), course management and evaluation related problems (CMERP), resource using skills and infrastructure related problems (RUSIP), teaching related problem (TRP), and support and collaboration related problem (SCP) was employed in the study. T-test, ANOVA, correlation, and multiple linear regression were the major statistical techniques used to analyze the data. The findings indicate that the technical skills and digital resources with the learners and teaching figures and curves were major challenges of mathematics teachers in online mode of instruction. Additionally, gender, number of available devices, institute types, teaching levels, ICT training, and types of job were explanatory factors to determine the challenges of mathematics teachers in online teaching during the pandemic.

Contribution/Originality: The study contributes to providing a new perspective on the problems of mathematics teachers at the school to university levels in teaching mathematics online. It highlights problems related to teaching, learning, skills development, training, course management, evaluation, infrastructure, support, and collaboration faced by mathematics teachers in online instruction.

1. INTRODUCTION

After the outbreak of COVID-19, educational institutions shifted teaching and learning activities from physical to online mode globally. Teaching through online mode and developing digital material for online teaching and learning activities became a mandatory task for the teachers due to the COVID-19 pandemic. This situation created both opportunities and challenges in education sector. A meta-analysis of Basnet, Basnet, and Bhattarai (2021) summarized that this pandemic situation offered an opportunity to shift to online learning, webinars, podcasts, and

advancing academic careers across any part of the country despite some challenges such as unequal access, internet quality, affordability of digital devices or limited interaction. Similarly, a survey analysis of Mushtaha, Dabous, Alsyouf, Ahmed, and Abdraboh (2022) showed the flexibility in place and time, assessment-accessibility and effectiveness, communication methods in e-learning as the strengths during COVID-19. Moreover, the blended mode (face-to-face and online mode of learning) was also preferred by the students. Among the weaknesses were the problems of mental health and socialization that learners experienced during the pandemic.

There are evident several common and subject-specific problems and challenges in previous literature such as institutional, pedagogical, psychological or technological problems due to this transition to virtual, digital or distance mode of education. A common issue and problem was that teachers must be equipped with knowledge and skills of digital technology, or adapt or modify themselves to implement an innovative and new model of education in a very short duration (Long, Bouck, & Jakubow, 2021; Sánchez-Cruzado, Santiago Campión, Teresa Sánchez-Compaña, & Jeong, 2021).

Transforming teaching and learning activities instantly into a new digital environment was indeed problematic. Problems on the part of teachers, institutions, and students possibly prevented teachers to form a conducive learning environment. Some of these problems are sensitive to online education such as weak ICT skills of teachers, lack of confidence, deprivation of technological and pedagogical teacher training, limited access to the resources, and the rigid structure of curriculum and assessment (Buabeng-Andoh, 2012). Teaching experiences, specialized knowledge, teacher's demographical location, and gender are also strongly correlated with the readiness to adopt an online education (Alea, Fabrea, Roldan, & Farooqi, 2020). Moorhouse (2020) argues that more research is needed for the replacement of face-to-face with online teaching because instructional approaches adopted by teachers in one context may not work for others. This issue of building an effective online learning environment is a matter of research and investigation.

Specifically, even more challenges and issues might have been faced in mathematics teaching because of students' anxiety in mathematics or math-phobia (Abdelfettah, 2021; Maqableh & Alia, 2021). In Nepali school context, mathematics achievement is underrated as compared to others (Education Review Office (ERO), 2019). A systematic reviewed revealed three key factors such as teaching methods, teachers' attitude and students' attitude towards mathematics as affecting factors on mathematics achievement (Ayebale, Habaasa, & Tweheyo, 2020). Besides these problems found in conventional mode of teaching and learning activities, mathematics teachers also have problems and challenges in online mode such as learners' perception, readiness, expectation, ICT-related problems such as internet quota limitation, and identity, teachers' role and interaction with students, their interest in study, time management, the problem of communication, curriculum structure, and digital pedagogy (Isnawan, Suryadi, Turmudi, & Marfuah, 2022; Joshi, 2016). Researches on these areas have not been carried out despite their importance to improve online teaching. In this context, the present study uncovers novel challenges of teachers in teaching mathematics at different levels of education in Nepal to cope up with the changing scenarios. Moreover, the study provides insight to school teachers, leaders, policymakers, and other practitioners contributing to creating a suitable e-learning environment.

1.1. Online Education: Issues and Challenges

Online education and its success lie on the part of the instructors, learners, system, and instructional design (Cutri, Mena, & Whiting, 2020; Mahmood, 2021). The study by Paudel (2021) found that teachers' and learners' skills on time management, internet connectivity, autonomy and monitoring, feedback management, and plagiarism are major challenges of online education in the context of Nepal. This study also suggested that the course currently practiced in school and university seemed incompatible with the ICT environment. For successful online learning, it is necessary to restructure the conventional curriculum. Besides, the barriers related to students such as self-efficacy, confidence, compatibility, instructors-related barriers such as beliefs, facilitating conditions, training,

gender, and infrastructure-related barriers should be addressed appropriately (Siswono, Kohar, & Hartono, 2017; Solangi, Al Shahrani, & Pandhiani, 2018). Student and instructor characteristics, access, and facilitation, and training are also critical factors found by Alhabeeb and Rowley (2018) for successful e-learning. Particularly, learners' expectations, readings, and participation are the issues related to students, instructors' role transitioning from face-to-face to online, time management, and teaching style are the issues related to teachers, and content development, multimedia integration, the role of instructional strategies in content development, and consideration are the issues related to content for successful online courses (Kebritchi, Lipschuetz, & Santiague, 2017). Level of confidence in students, barriers of online assessment, lack of knowledge about continuous assessment, and absence of planned instructional design are also existing problems on online mode of education (Brown & Lally, 2018). Besides, a flexible and sophisticated mentoring process is also required for the enhancement of the potentiality of new spaces for teaching and learning and to mitigate the problems of the online environment (Assunção & Gago, 2020).

Hill, Ball, and Schilling (2008) argued that knowledge of content is different from knowledge of teaching. Teachers might have strong content knowledge but are weak in the delivery of content. As a result, students are unable to learn. The important aspect of teachers' knowledge in teaching is to transform the knowledge when necessary to support students' learning (Chapman, 2013). It is also argued that the way of teachers responding about the externally generated content and competencies and beliefs in the integration of technology in the classroom may determine the success or failure of the online environment (Chand, Deshmukh, & Shukla, 2020). Teachers' beliefs also have a strong relationship with the knowledge of teachers about problem-solving. The study of Downing and Dyment (2013) recommends that sufficient time is needed for teachers to develop appropriate pedagogical and technical skills.

Similarly, Mahmood (2021) suggested some instructional strategies for teachers to teach in an online environment. These include teachers should maintain slow voice speech, develop interactive online classes, share resources, enhance students learning abilities, think critically and practically, provide feedback and flexible assessment, convert large class lectures into smaller modules, etc. Maintaining such an environment and continue teaching, and learning activities are challenging for the teachers particularly in the Nepalese context. Tabach and Trgalová (2020) suggested that the development of standards and competency framework to expand the professional knowledge and skills oriented towards the use of digital technology is essential for effective online learning.

Challenges due to the lack of access to ICT, internet, power supply, and digital resources are persisted in low-income countries as found by Adarkwah (2021) in the context of Ghana, but Nepal is no exception. It is also found that the lack of face-to-face interaction with students and sudden change in the setting of the classroom mostly affected the learners' learning process (Sepulveda-Escobar & Morrison, 2020). Dong, Cao, and Li (2020) found that implementation of online learning during COVID-19 in the Chinese context was found problematic and challenging due to the negative beliefs and attitudes of parents. Teachers in the online environment faced challenges in the use of technology in teaching, provision of suitable instructional technology, effective training (Rasheed, Kamsin, & Abdullah, 2020). Issues of robustness and reliability of the tools and lack of technical skills of teachers, poor integration of the technology with curriculum, lack of sufficient time to prepare digital lessons are major challenges for teachers (Comas-Quinn, 2011). Lack of embodiment of teaching and learning in an online environment can affect the relationship with students and response to the problem (Fletcher & Bullock, 2015).

Hong & Chai (2017) suggested that the in the online mode of learning, curriculum should be flexible enough for adaptive teaching and learning practices. Teaching should be less prescriptive, curriculum should encourage students to develop a strong sense of lesson ideas, such practice be adopted like learning by group, and constructivist rather than pre-structured knowledge collaboration approach should be used for adaptive teaching and learning practices on the online mode (Hong & Chai, 2017). To enhance the ICT skills of teachers, professional

development activities could be helpful. Participation in the program such as online interactions with learning communities and periodic training programs might raise the productivity and professional learning skills of teachers (Alt, 2018). Collaborative workshops can help to enhance the proficiency in teaching, for that institution should conduct intervention programs for teachers (Copriady, Zulnaidi, Alimin, & Albeta, 2021).

The purpose and context of technology adoption should be clearly articulated by the institution. Such facilities like cyber security, accessibility, connectivity, digital resources, and digital literacy levels are important (Dhawan, 2020; Palvia et al., 2018). It has also been suggested that the comprehensive idea of online pedagogy to integrate technology for teaching and learning is essential. On the other hand, a critical issue of empowerment of teachers to adapt to the online system, critical self-reflection on teachers, and integration of technology into a pedagogy may be lacking in the teacher preparation and training program (Baran, Correia, & Thompson, 2011). The professional development training for online teachers deserve to be endorsed by institution to make tutors creative, reflective, and engaging (Hampel & Stickler, 2005). In the first decade of the twenty-first century, changes in the teachers' beliefs about the effectiveness of online learning could be seen but in practice, the conventional way of teaching and learning process was still in dominating position (Mills, Jass, & Gong, 2019).

1.2. Teaching Mathematics in Online Mode: The Nepalese Context

In the Nepali school curriculum, mathematics is a compulsory subject up to grade 10 and interested students also can take one additional mathematics in grades 9 and 10. The average achievement of students in mathematics at the school level is very poor (Education Review Office (ERO), 2015). Additional effort should be given by teachers and institutions to improve the performance in mathematics. During the time of the COVID-19 pandemic, the teaching and learning process of every subject in all levels of education including mathematics shifted online despite the insufficient preparation and access to technological devices in teaching. Online classrooms became the means to reach the students. Even though ICT motivates learners to learn, increases learners' knowledge, attainment, and mathematical skills (AI-Harbi, 2014; Cox, Webb, & Abbott, 2004) there are several challenges regarding online modes of teaching in Nepal. Instructors need to have the knowledge to transform their academic content knowledge into the mathematical content that should be taught in the classroom at the school level (Dreher, Lindmeier, Heinze, & Niemand, 2018). Teachers of mathematics need to have extended expertise on what mathematical content should deliver, how the mathematical language is used, how to choose, use and make mathematical representation and justify the mathematical ideas (Ball, Thames, & Phelps, 2008). These qualities of teachers are even more demanding in the online mode of teaching.

According to Ball et al. (2008), teachers must have two domains of mathematical knowledge for teaching: subject matter knowledge and pedagogical content knowledge. Subject matter knowledge includes common, specialized content knowledge, knowledge at the mathematical horizon and pedagogical content knowledge contain knowledge of content and students, content and teaching, and content and curriculum. Teachers of the post-pandemic also should have sound technical knowledge with pedagogical content knowledge. Online classes, though is the demand of pandemic time, incorporation of ICT in teaching-learning has been becoming the challenge in the context of Nepal. Teachers' motivation to use ICT in the classroom is, at present, adversely influenced by several constraints including lack of time to gain confidence and experience with technology; limited access to reliable resources; assessment that requires no use of the technology; and a lack of subject-specific guidance for using ICT to support learning (Joshi & Bhandari, 2016). Technological or digital devices have not been highly developed in Nepal where various difficulties such as financial, awareness, availability of resources at home and school, appropriate policies, and integration-related problems arise (Joshi, 2016).

During pandemic, technology integration in the teaching and learning became primary so main concern of this research is which types of the problems are faced by mathematics teachers on their instructional practice during COVID-19 that justifies the significance of the research. The studies are though confined to examining the status

and challenges of using technology in teaching mathematics in Nepalese and global context during pre-COVID period. However, a matter of greater concern are the issues related to teaching and learning in this pandemic.

Despite the wealth of literature available in the field, there is still a lack of studies discussing problems such as (1) Support and collaboration related problems (2) teaching-related problems (3) resource using skill and infrastructure-related problems (4) skills and training related problems (5) learners related problems, and (6) course management and evaluation related problems. Resources using skills and learner related problems are newly identified issues in this research. Additionally, Nepalese context and results based on sample characteristics like gender, experience, qualification, job type, number of available devices, types of institutions, ICT training and teaching level are also newly identified variables in this research. This research intends to identify the existing challenges in teaching mathematics through the online mode during the COVID-19 pandemic in Nepal focusing on following research questions:

1. What is the level of problems of mathematics teachers in teaching mathematics through online?
2. What is the role of sample characteristics (gender, experience, qualification, job type, number of available devices, types of institutions, ICT training and teaching level) on problems of mathematics teachers in teaching mathematics through online?
3. What is the relationship between the problems of mathematics teachers while teaching mathematics through online?

2. RESEARCH METHODS

2.1. Study Settings

A cross-sectional online survey under a quantitative research design was adopted for the current study. A list of 1572 mathematics teachers (from basic to university level) was collected from the Society of Technology Friendly Teachers, Nepal and Nepal Council of Mathematics Education. These teachers had participated in different training programs organized by these organizations and comprised the population of the current research. Both the organizations are public, non-profitable, and are related to mathematics teachers as they have organized training programs on different mathematical content, pedagogy, and technology-related topics. During the pandemic, these organizations conducted varieties of technology and digital pedagogy-related training online. Hence the participants of this study were digitally trained, and had the access to the internet and digital devices. The results of the study are therefore assumed to be generalized among digitally trained teachers only.

Because of the pandemic, it was difficult to collect data physically hence online survey technique was employed. The tool was shared among all teachers; however, only 415 teachers participated in the survey during the five-month period (August to December, 2020). Calculator.net (2020) shows that 309 is the appropriate sample size for the study population by taking 95% confidence level, 5% margin of errors, and 50% population proportion, and by adding 20% non-response errors. Therefore, 371 was the appropriate sample size. However, the sample size of 415 in this study satisfied the probability sampling. Additionally, the tool was shared with all the population through their email, hence the sample also satisfied the property of the randomized sampling.

2.2. Research Instrument

The data were collected by a self-constructed tool titled "Mathematics Teachers Problem Measurement Scale". The tool was piloted among 60 mathematics teachers (20 from each level) for establishing the reliability and the Cronbach's Alpha value was found to be 0.81 which was at the level of acceptance (Muijs, 2004). The content validity was established by sharing the tool with four experts in Mathematics Education. The questionnaire was developed into Likert five-point scales from strongly disagree to strongly agree. Furthermore, the value of item total correlation (Table 1) exceeded the threshold criteria of 0.30 to 0.70 (Carmines & Zeller, 1974; Tapsir, Nik, & Zamri, 2018) hence validity of the tool was ensured by itemized total of correlation method.

2.3. Sample Characteristics

Eight sample characteristics namely gender, experience, qualification, job type, number of available devices, types of institution, ICT training status, and teaching level of the teachers were used as independent variables in the study. Where gender was categorized as female (11.8%) and male (88.19%), experience as ≤ 10 years (49.4%) and >10 years (50.6%) aged teachers, and qualification as up to bachelor (23.86%) and above bachelor (76.14%). The job type had two categories as permanent (57.59%) and temporary (42.41%). The number of available devices had four categories as one (12.53%), two (46.75%), three (26.75%), and four (13.98%) where devices represented digital devices like mobile, computer, laptop and TV. Additionally, one device represented mobile only, two devices represented any two devices from mobile, laptop, computer and TV similarly three and four represented that number from these devices. The types of the institution had three categories based on the government rules as public (15.66%), private (21.93%), and government (62,41%). ICT training had two categories as 'no' (31.08%) and 'yes' (68.92%) where 'no' represented untrained and 'yes' represented trained teachers in the case of ICT. Teaching level had three categories based on current practices in Nepal as basic (26.75%), secondary (62.41%) and university (10.84%) level whereas basic level represented class 1-8, secondary represented class 9-12 and university represented college and university levels.

2.4. Problems of Mathematics Teachers

Problems of mathematics teachers to teach mathematics in virtual mode was the dependent variable. The problems were categorized in six domains based on the nature of items, and which were separated under six categories as Skills and training related problems (STP), learner related problems (LRP), course management and evaluation related problems (CMERP), resource using skills and infrastructure related problems (RUSIP), teaching related problem (TRP), and support and collaboration related problem (SCP). The details of the items are presented in Figure 1 as the conceptual framework of the study.

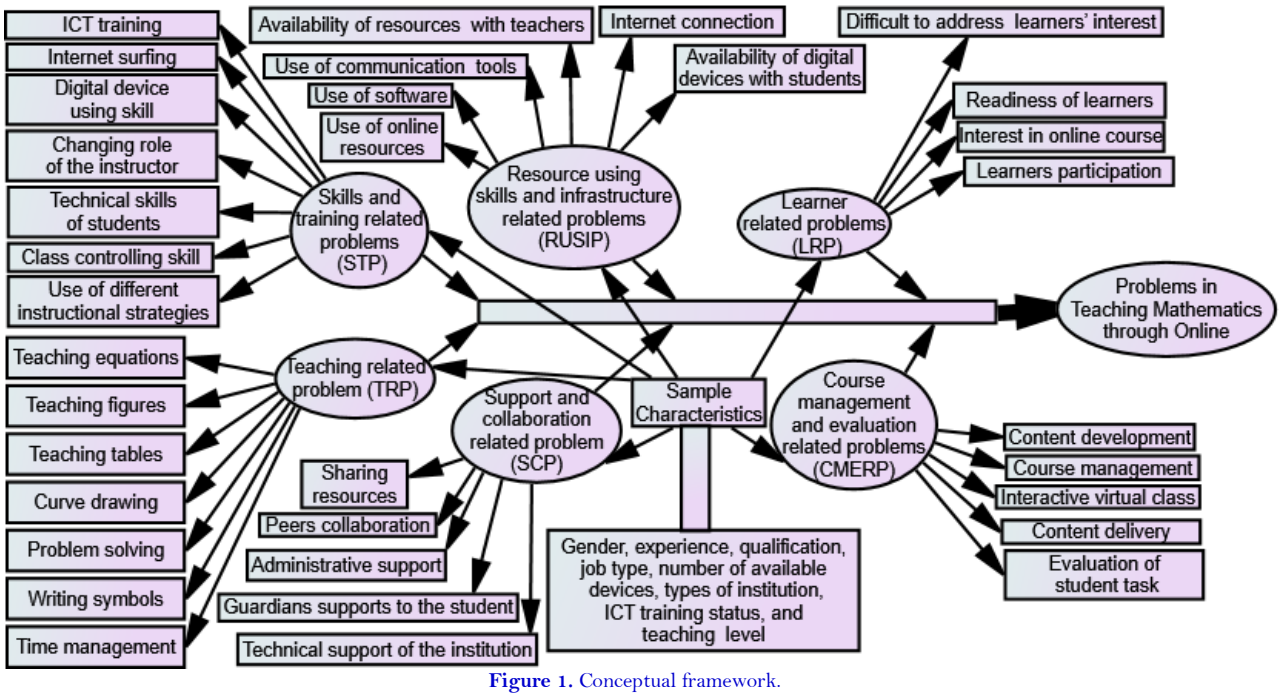

Figure 1. Conceptual framework.

2.4.1. Skills and Training Related Problems

The items related to skills and training of teachers were considered under this category as ICT training, Internet surfing, digital device using skill, changing role of the instructor, technical skills of students, class controlling skill and use of different instructional strategies. Problems of ICT training represented the training

focusing on the use of digital tools in instructional practices which were highly important during instructional practices. Problems of internet surfing represented the challenges faced by mathematics teachers while searching course related books, articles, tutorials, and professional development related online courses. Problems of digital devices using skills represented issues faced by teachers while using digital devices as mobile, laptop/computer, and digital boards in their instructional practices and problems on changing role of tutor represents the role of teachers while they forcibly transformed their instructional activities from face-to-face to online without readiness cause of immediate pandemic. Additionally, problems of technical skills of students represented their skills for the use of digital devices and resources including to handle minor errors or problems for their learning practices, class controlling skills representing the unnecessary noise and disturbance related issues during online classes, and use of different instructional strategies representing the challenges faced by teachers using learner centered and project-based learning.

2.4.2. Resource using Skills and Infrastructure Related Problems

Internet connection, availability of resources with teachers, availability of digital devices with students, use of software, online resources, and communication tools are considered under resource hinting at skills and infrastructure related problems. Problems of internet connection represents the connectivity issue while running virtual classes, availability of digital resources with teachers represents the available resources as software, online resources and mobile application for mathematics teaching, use of software, online resources, and communication tools represent the problems of teachers for using those tools in their virtual instructional practices.

2.4.3. Support and Collaboration Related Problem

Problems of guardian's support represents the support of parents for managing a separate room, and providing digital devices and internet connection for taking online classes. Sharing resources represents the challenges of mathematics teachers for sharing digital resources with their students whereas problems of administrative support represent the issue faced by teachers from institution like freely manage digital devices or manage digital device with subsidy, support for subjective digital resources, and paying internet charge. Problems in peers' collaboration represents the issue faced by teachers for sharing and collaborating with their colleagues focusing on teaching experiences and technical support of instruction represents the digital training, technical support, and virtual classroom management.

2.4.4. Learner Related Problems

Education is the fundamental right of the students and they are core focal individuals in education system. Hence such learner related problems were included in this study like difficulty in addressing learners' interest, lack of readiness among learners, lack of interest in online courses, and learners' weak participation in online classroom learning. The practice of online classes in Nepalese context was new hence issues faced by teachers to address learners' interest were also included under this domain. There were several other issues related to students like internet connectivity, digital devices and resources that also affected the participation of learners.

2.4.5. Course Management and Evaluation Related Problems

Course management and evaluation are important part of online instruction hence content development, course management, interactive virtual class, content delivery, and evaluation of student task were considered under this dimension. In this context content development represents content related notes, PowerPoint presentation, and tutorials whereas course management represents the use of learning management system (LMS) like Google Classroom, Moodle, Edmodo and others for accessibly management of learning resources for students. Similarly, problems on interactive virtual class represents the challenges of teachers to interact with the students who were in

the habit of taking face-to-face physical classes; and content delivery represents the issues faced by teachers while delivering content during taking virtual classes. Furthermore, the evaluation of student tasks represents the challenges of teachers who were in the habit of evaluating their students (classwork, homework, and assessment) in face-to-face mode of instruction.

2.4.6. Teaching Related Problem

Teaching equations, figures, and tables, curve drawing, problem solving, writing symbols, time management are considered under teaching related problems. There are several equations, figures, tables, curves, and symbols in mathematics of basic to university level different from simple writing hence the teacher's perception towards teaching this content were included under the study. Additionally, there are verities of problems in different domain of mathematics like arithmetic, algebra, trigonometry, statistics, geometry, mensuration and others. Hence, challenges faced by mathematics teachers in teaching different problem solving were included in the research. Furthermore, time management is also an issue in face-to-face classes and the perception of mathematics teacher towards the problem of time management was a concern of the current research.

2.5. Data Analysis Techniques

Regarding the methods of data analysis, frequency and percentage were used to calculate the status of sample characteristics. The mean and standard deviation (SD) were used to show the status whereas one-sample t-test was used to test the significant level of problems in teaching mathematics by assuming 3 as population mean. A correlation diagram was used to show the relationship among the problems of mathematics teachers. T-test and ANOVA were used to test the significant results of sample characteristics with the dimension-wise problems. The multiple linear regression was used to find the contribution of sample characteristics on the problems of mathematics teachers in teaching mathematics through the online mode. The assumptions of multiple linear regression were tested before analysis as standardized residuals to evaluate for assumptions of normality (Figure 2), homoscedasticity, linearity, independence of errors, and absence of outliers (Tabachnick, Fidell, & Ullman, 2007). The tolerance and values variance inflation factor (VIF) was found to be greater than 0.02 and less than 10 respectively showing that the data did not have any collinearity problem (Field, 2018).

3. RESULTS

3.1. Status of Problems of Mathematics Teachers in Teaching Mathematics through Online

Table 1 shows the details of the items and dimensions including the status of the problems explained in mean and SD. The level of problems of mathematics teachers to teach mathematics through virtual mode was found to be significant in nineteen items out of thirty-four (See Table 1). Based on the dimensions, the level of problems was found to be significantly high in SCP and RUSIP whereas significantly low in CMERP. Based on items, the level of problem was found significantly high only in technical skills of students under STP and similar results were measured in all cases except in the use of software and communication tools under RUSIP. Additionally, guardians' support to the student and technical support of the institution as significantly high and sharing resources had a significantly low level of problems.

Similarly, the level of problem found to be significantly high in active participation and readiness of learners was significant under LRP whereas that level found to be significantly low in all items except in interactive virtual classes under CMERP. Finally, the level of problems was found to be significantly low in teaching equations and tables, and problem solving whereas the level was significantly high in teaching figures, curve drawing, and time management.

Table 1. Items and categories wise mean and standard deviation (n=415).

Items with categories	Mean	SD	t-value	ITC	Items with categories	Mean	SD	t-value	ITC
STP	3.04	0.63	1.30		LRP	3.03	0.75	0.90	
ICT training	3.03	1.24	0.55	0.32**	Difficult to address learners' interest	2.97	1.12	-0.57	0.40**
Internet surfing	2.93	1.17	-1.18	0.31**	Readiness of learners	3.19	1.16	3.35*	0.20**
Digital device using skill	2.90	1.19	-1.69	0.42**	Interest in online course	2.96	1.17	-0.72	0.42**
Changing role of the instructor	3.00	1.13	-0.04	0.37**	Learners' participation in the classroom	3.01	1.20	0.25	0.29**
Technical skills of students	3.47	1.23	7.89*	0.28**	CMERP	2.78	0.75	-6.02*	
Class controlling skill	2.99	1.29	-0.23	0.35**	Content development	2.75	1.15	-4.40*	0.46**
Use of different instructional strategies	2.95	1.14	-0.82	0.39**	Corse management	2.71	1.12	-5.24*	0.44**
RUSIP	3.16	0.63	5.24*		Interactive virtual class	2.91	1.11	-1.64	0.38**
Internet connection	3.14	1.33	2.22*	0.37**	Content delivery	2.65	1.08	-6.61*	0.42**
Availability of resources with teachers	3.43	1.25	6.98*	0.36**	Evaluation of student task	2.87	1.24	-2.19*	0.44**
Availability of digital devices with students	3.14	1.13	2.52*	0.33**	TRP	3.01	0.70	0.36	
Use of software	3.10	1.19	1.66	0.46**	Teaching equations	2.88	1.21	-1.99*	0.47**
Use of online resources	3.19	1.13	3.43*	0.39**	Teaching figures	3.24	1.16	4.28*	0.43**
Use of communication tools	2.98	1.15	-0.39	0.38**	Teaching tables	2.85	1.16	-2.67*	0.41**
SCP	3.08	0.66	2.39*		Curve drawing	3.22	1.22	3.72*	0.49**
Guardians supports to the student	3.15	1.19	2.61*	0.42**	Problem solving	2.75	1.27	-4.03*	0.50**
Sharing resources	2.88	1.20	-1.96*	0.44**	Writing symbols	3.02	1.20	0.37	0.48**
Administrative support	3.09	1.14	1.68	0.38**	Time management	3.12	1.11	2.21*	0.47**
Peers' collaboration	3.07	1.08	1.27	0.47**					
Technical support of the institution	3.19	1.18	3.32*	0.35**					

Note: *p<0.05, **p<0.01, ITC-Item total correlation.

3.2. Role of Sample Characteristics in the Problems of Mathematics Teachers in Teaching Mathematics through Online

Table 2 shows that the level of skill and training related problems was found to be comparatively high among the teachers having one and four devices at the basic level. But this problem was found to be low among teachers working at private institutions (Mean=2.84, SD=0.62). The problems related to the resource using skills and infrastructure were found to be comparatively high among females (Mean=3.33, SD=0.70), the teachers having only one device (Mean=3.29, SD=0.61), teaching in public institutions (Mean=3.32, SD=0.62) and university level (Mean=3.29, SD=0.63) and low in private institution's teachers (Mean=3.00, SD=0.61). In the teaching related problems, the level of the problem was found to be high among the teachers at university level (Mean=3.28, SD=0.77) and low among private institution's teachers (Mean=2.78, SD=0.56).

Table 2 also shows significant results on skill and training related problems based on job type and types of the institution at a 95% confidence interval. Teaching related problems were significantly different based on gender, job type, types of institutions, ICT training status, and teaching level. Additionally, significant results were found in resources using skills and infrastructure related problems based on job types, institution type, and ICT training status of mathematics teachers.

Table 2. Result of the skills and training, resource using skills and infrastructure, and training related problems with sample characteristics (n=415).

Variables	Categories	Frequency	STP		RUSI		TRP	
			Mean	SD	Mean	SD	Mean	SD
Gender	p-value		0.54		0.07		0.02*	
	Female	49(11.81)	3.09	0.57	3.33	0.70	3.22	0.64
	Male	366(88.19)	3.03	0.63	3.14	0.62	2.98	0.70
Experience	p-value		0.21		0.74		0.42	
	≤ 10 years	205(49.4)	3.08	0.63	3.15	0.62	2.98	0.70
	>10 years	210(50.6)	3.00	0.62	3.18	0.65	3.05	0.69
Qualification	p-value		0.89		0.76		0.85	
	Inter and Bachelor	99(23.86)	3.06	0.67	3.14	0.55	2.98	0.70
	Master and above	316(76.14)	3.03	0.61	3.17	0.66	3.02	0.69
Job Type	p-value		0.03*		0.02*		0.04*	
	Permanent	239(57.59)	3.10	0.60	3.23	0.64	3.09	0.71
	Temporary	176(42.41)	2.96	0.65	3.08	0.62	2.91	0.66
Available devices	p-value		0.20		0.11		0.08	
	One	52(12.53)	3.14	0.65	3.29	0.61	3.12	0.70
	Two	194(46.75)	3.03	0.60	3.20	0.65	3.05	0.71
	Three	111(26.75)	2.96	0.61	3.06	0.62	2.90	0.69
	Four	58(13.98)	3.14	0.68	3.14	0.62	3.00	0.65
Types of Institution	p-value		0.00*		0.01*		0.00*	
	Public	65(15.66)	3.12	0.67	3.32	0.62	3.06	0.73
	Private	91(21.93)	2.84	0.62	3.00	0.61	2.78	0.56
	Government	259(62.41)	3.09	0.60	3.18	0.64	3.08	0.72
ICT Training	p-value		0.38		0.05*		0.01*	
	No	129(31.08)	3.09	0.56	3.27	0.65	3.13	0.61
	Yes	286(68.92)	3.02	0.65	3.11	0.62	2.96	0.72
Teaching Level	p-value		0.28		0.21		0.00*	
	Basic	111(26.75)	3.14	0.62	3.20	0.54	3.08	0.67
	Secondary	259(62.41)	3.00	0.63	3.12	0.67	2.94	0.68
	University	45(10.84)	3.04	0.59	3.29	0.63	3.28	0.77

Note: *p<0.05, STP: skills and training related problems, RUSI: resource using skills and infrastructure related problems, and TRP: teaching related problem

Table 3. Results of skills and training, course management and evaluation, support and collaboration, training, and resource using skills and infrastructure (n=415).

Variables	Categories	Frequency	SCP		CMERP		LRP	
			Mean	SD	Mean	SD	Mean	SD
Gender	p-value		0.13		0.00*		0.88	
	Female	49(11.81)	3.20	0.68	3.08	0.71	3.03	0.69
	Male	366(88.19)	3.06	0.66	2.74	0.75	3.03	0.76
Experience	p-value		0.87		0.87		0.52	
	≤ 10 years	205(49.4)	3.07	0.66	2.77	0.74	3.02	0.79
	>10 years	210(50.6)	3.08	0.67	2.78	0.76	3.05	0.71
Qualification	p-value		0.93		0.16		0.74	
	Inter and Bachelor	99(23.86)	3.08	0.58	2.86	0.68	3.05	0.69
	Master and above	316(76.14)	3.08	0.69	2.75	0.77	3.03	0.77
Job Type	p-value		0.12		0.12		0.82	
	Permanent	239(57.59)	3.11	0.70	2.83	0.77	3.04	0.76
	Temporary	176(42.41)	3.03	0.61	2.71	0.72	3.02	0.75
Available devices	p-value		0.52		0.29		0.80	
	One	52(12.53)	3.20	0.54	2.92	0.74	3.10	0.74
	Two	194(46.75)	3.06	0.66	2.80	0.74	3.06	0.80
	Three	111(26.75)	3.09	0.71	2.76	0.78	2.97	0.71
	Four	58(13.98)	3.00	0.70	2.63	0.72	3.00	0.67
Types of Institution	p-value		0.01*		0.31		0.05*	
	Public	65(15.66)	3.05	0.67	2.82	0.75	3.09	0.82
	Private	91(21.93)	2.89	0.58	2.66	0.71	2.86	0.68
	Government	259(62.41)	3.15	0.68	2.81	0.76	3.08	0.75
ICT Training	p-value		0.00*		0.00*		0.17	
	No	129(31.08)	3.24	0.60	2.95	0.79	3.11	0.78
	Yes	286(68.92)	3.00	0.68	2.70	0.72	3.00	0.74
Teaching Level	p-value		0.00*		0.00*		0.59	
	Basic	111(26.75)	3.10	0.61	2.84	0.70	3.08	0.70
	Secondary	259(62.41)	3.01	0.66	2.70	0.78	3.02	0.78
	University	45(10.84)	3.43	0.70	3.08	0.65	3.01	0.70

Note: *p<0.05, LRP: learner related problems, CMERP: course management and evaluation related problems, and SCP: support and collaboration related problem.

Table 3 shows that the support and collaboration related problem was found to be high among teachers of university level (Mean=3.43, SD=0.70) and low among the teachers of private institutions. The course management and evaluation related problems were found to be comparatively high among females (Mean=3.08, SD=0.71) and university teachers (Mean=3.08, SD=0.65) and low among teachers of private institutions (Mean=2.63, SD=0.72) and those having four digital devices (Mean=2.66, SD=0.71). Learners related problem was found to be comparatively high among teachers having only one device (Mean=3.10, SD=0.74) and low with respect to private institution's teachers (Mean=2.86, SD=0.68). Table 3 also shows that support and collaboration related problems have significant results based on types of institution, ICT training, and teaching level. Course management and evaluation related problems showed significant results with respect to gender, ICT training and teaching level and learners related problems had significant results with respect to types of institution only.

3.3. Effect of Sample Characteristics on Problems of Mathematics Teachers in Teaching Mathematics through Online

Figure 2 shows that the dimension wise relationship was found to be positively significant in each case. The correlation value was found in the range from 0.12 (between RUSIP and LRP) to 0.54 (between STP and RUSIP). Table 4 shows the effect of sample characteristics on different categories of problems calculated using multiple linear regression model. The model explained 37%, 41%, 45%, 46%, 32%, and 24% variance with adjusted R^2 0.35, 0.39, 0.43, 0.44, 0.30, and 0.21 and significant ANOVA $F(15, 396)=15.43$, $F(15, 396)=18.69$, $F(15, 396)=21.39$, $F(15, 396)=22.27$, $F(15,396)=12.59$, and $F(15,396)=8.38$ in skills and training related problems (STP), resource using skill and infrastructure related problems (RUSIP), teaching related problems (TRP), support and collaboration related problems (SCP), course management and evaluation related problems (CMERP), and learners related problems (LRP) respectively. The basic level was excluded from the problems by SPSS during analysis.

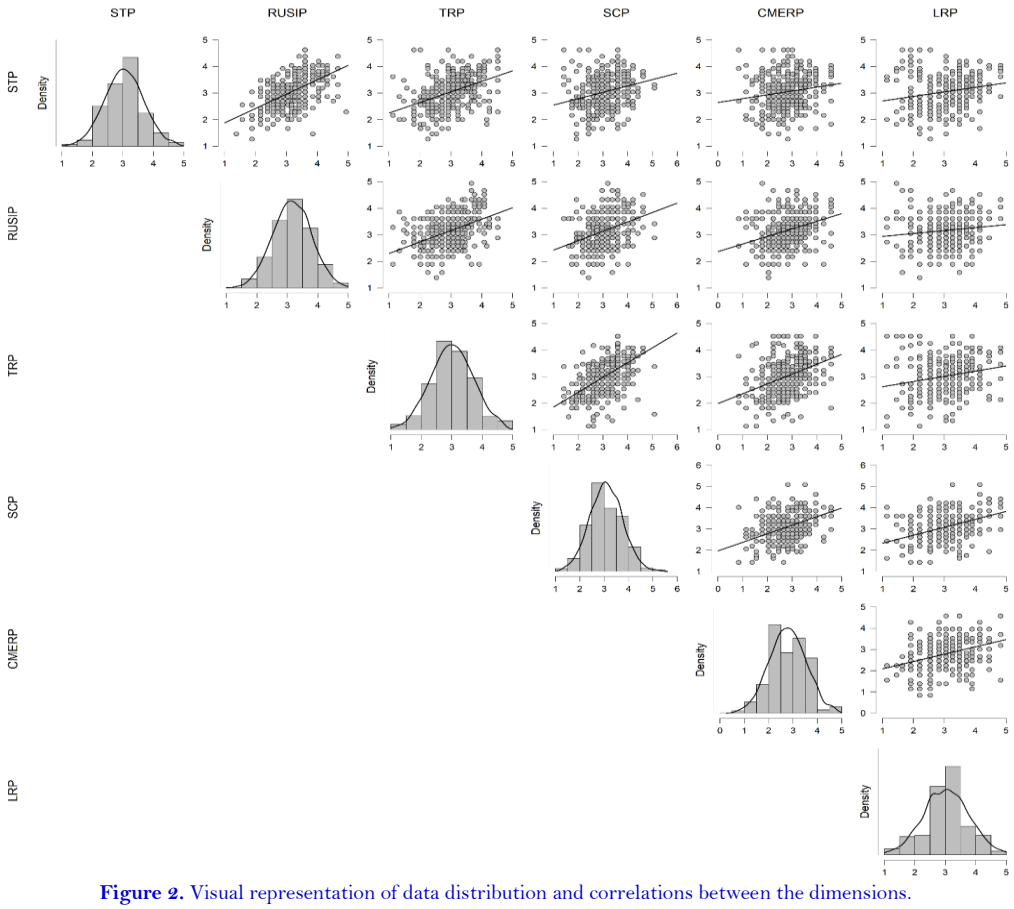

Figure 2. Visual representation of data distribution and correlations between the dimensions.

Table 4 also shows that RUSIP, TRP, SCP, CMERP, and LRP were significant predictors of STP where RUSIP with the highest beta value was found to be a main predictor to the STP however none of the sample characteristics were significant predictors. Similarly, all problems were significant predictors in RUSIP, where STP was found to be the main significant predictor with the highest beta value. Experience and all problems were significant predictors to the TRP however, SCP was found to be the main significant predictor with the highest beta value. Age, teachers of university level, experience, and all problems except STP were significant predictors in SCP however the TRP was found to be the main predictor. Gender and all problems were found to be significant predictors in CMERP. Additionally, all problems except TRP and teachers of university level were found to be significant predictors in LRP whereas SCP was found to be the main predictor with the highest beta value.

Table 4. Effect of sample characteristics on problems of mathematics teachers in virtual mode (n=415).

	STP		RUSIP		TRP		SCP		CMERP		LRP	
Variables	**B**	**Beta**	**B**	**Beta**	**B**	**Beta**	**B**	**Beta**	**B**	**Beta**	**B**	**Beta**
(Constant)	0.58		1.18		0.47		0.34		0.93		1.35	
Gender (male)	0.07	0.03	-0.05	-0.02	-0.08	-0.04	0.01	0.00	-0.20*	-0.09	0.09	0.04
Secondary Level	-0.07	-0.06	0.02	0.02	-0.06	-0.04	0.02	0.02	0.03	0.02	-0.04	-0.03
University Level	-0.16	-0.08	0.01	0.01	0.00	0.00	0.23*	0.11	0.20	0.08	-0.25*	-0.11
Experience	-0.01	-0.14	0.00	0.03	0.01*	0.15	-0.01*	-0.16	-0.01	-0.06	0.01	0.11
Qualification (master and above)	-0.05	-0.03	0.03	0.02	0.06	0.03	-0.03	-0.02	-0.14	-0.08	0.06	0.03
Age	0.01	0.14	0.00	-0.01	-0.01	-0.08	0.01*	0.15	0.00	0.05	-0.01	-0.09
Number of devices	0.04	0.06	-0.04	-0.06	-0.04	-0.06	0.01	0.01	-0.04	-0.05	-0.02	-0.02
Types of Institution	0.02	0.03	-0.05	-0.06	0.01	0.02	0.06	0.07	-0.02	-0.02	0.00	0.00
ICT training (yes)	0.01	0.01	-0.04	-0.03	0.01	0.01	-0.08	-0.06	-0.07	-0.05	-0.01	-0.01
Job Type (temporary)	-0.03	-0.02	-0.06	-0.05	-0.01	-0.01	0.03	0.02	-0.07	-0.05	0.03	0.02
STP	Ref.		0.41**	0.42	0.26**	0.24	-0.06	-0.06	-0.13*	-0.11	0.21**	0.18
RUSIP	0.45**	0.45	Ref.		0.18**	0.16	0.13**	0.13	0.22**	0.19	-0.16*	-0.14
TRP	0.25**	0.27	0.15**	0.17	Ref.		0.35**	0.37	0.19**	0.18	-0.10	-0.09
SCP	-0.07	-0.07	0.13**	0.14	0.39**	0.37	Ref.		0.22**	0.20	0.43**	0.38
CMERP	-0.09*	-0.11	0.13**	0.16	0.14**	0.15	0.14**	0.16	Ref.		0.24**	0.24
LRP	0.13**	0.15	-0.09*	-0.11	-0.06	-0.07	0.24**	0.27	0.22**	0.21	Ref.	

Note: *p<0.05, **p<0.01, STP: Skills and training related problems, LRP: learner related problems, CMERP: course management and evaluation related problems, RUSIP: resource using skills and infrastructure related problems, TRP: teaching related problem, and SCP: support and collaboration related problem.

4. DISCUSSION

The research aimed to study the problems of mathematics teachers in teaching mathematics via online mode during the pandemic period. The level of problems was found to be significantly high in support and resource using skills and infrastructure related problems whereas it was low in course management and evaluation related problems. These challenges were similar to the ideas of Alhabeeb and Rowley (2018) who focused on student and instructor characteristics, access, facilitation, and training. The challenges of knowledge of content, methods of delivery corroborate with lack of access to online resources as mentioned by Chapman (2013). The result revealed similar findings as the mathematics teachers of Nepal were not habituated to collaborate and exchange their experiences and problems. Similarly, infrastructure and resources were not sufficiently provided by the institution and concerned stakeholders. Additionally, they had fewer skills to teach mathematical concepts by using digital tools.

In relation to item-wise analysis, technical skills of students, availability of resources with students were major problems indicating that the Nepalese students still needed digital awareness programs and digital resources. Adarkwah (2021) studied the challenges of teaching mathematics in the pandemic period and the study revealed a

similar situation in the context of Ghana. Additionally, teaching figures and curves were major problems indicating that the mathematics teachers had less idea on the use of developing digital tools because several tools had the good feature of drawing, animation, and visualization as GeoGebra, Mathematica, Microsoft Mathematics, and others. Moreover, mathematics teachers had lack of collaboration among themselves to enhance proficiency in digital tools (Copriady et al., 2021). Despite these problems, teachers faced fewer challenges in content surfing, course management, and content development indicating that teachers were competent in internet surfing and course management.

Skill and training related problems were found to be comparatively high among the teachers having one and four devices. As a result, the problem was high having mobile-only and the availability of more devices was not sufficient for digital skills and training. These findings corroborate with other challenges in e-learning such as accessibility, affordability, flexibility, learning pedagogy, life-long learning, and educational policy (Siswono et al., 2017). Basically, the problem is high with respect to the basic level which means those teachers need additional skills and training as compared to others. The problems regarding infrastructure and use of resources are high among females, which reveals that the social structure of Nepal is still based on a patriarchal system. Meanwhile, teachers having only one device were mobile users, who lacked varieties of resources. As a result, the achievement remained unsatisfactory as Joshi et al. (2020) concluded that the instructional achievement of online learning was debatable because it caused the absence of face-to-face relationships among learners, and instructors. Teachers in teaching public institutions and university level indicated that public school and university levels had less practice of online teaching.

Mathematics related resources are rich for basic to secondary level because the content of mathematics is equivalent to others and such resources are poorly available for university mathematics. Additionally, university teachers teach separate content hence, they may have more problems in support and collaboration. In this regard, Boczkowska, Bakalarski, Sviatoslav, and Leszczyński (2018) also recommended that e-learning programs are necessary systems of continual education, and to advance the value of education. Additional work needs to be directed to the enhancement of online learning programs. Course management and evaluation related problems are comparatively high among female teachers which shows that all females have the responsibility for home and parental care in the Nepalese context.

The constitution of Nepal advocates the rights of women. Many organizations have women empowerment programs but they are not effectively carried out, so female mathematics teachers suffer from several problems. The female teachers with only one device (mobile) face learning-related problems indicating that they have fewer options of using digital resources in online teaching. This finding is similar to the results of the study carried out by Omotayo and Haliru (2020), who concluded that the learners must be motivated to get digital competency to remain relevant in modern times. The level of problems was found to be comparatively low among private institution's teachers, which may be due to the reason that the private schools were trying to run their teaching and learning activities online since all formal classes were physically closed during the pandemic and they should run these activities for their business.

The variables like gender, type of institution, ICT training status, and teaching level had a significant contribution to determining teaching-related problems, indicating that ICT related training, gender equality, similar practices in online teaching are needed in all types and levels of the institution for minimizing these problems. In addition to this, effective online education consists of online teaching and learning, boosting of several research works, principles, prototypes, theories, ethics, and appraisal of benchmark concentrations on quality online course design, teaching, and learning (Bozkurt & Sharma, 2020; Hodges, Moore, Lockee, Trust, & Bond, 2020). The variables of institution type and ICT training status are significant contributing factors to determine resources and infrastructure-related problems, hence equality and equity programs in all levels and all types of institutions should

be in priorities. ICT training and institution type have a significant contribution to determine the support and collaboration, course management and evaluation, and learners related problems.

The fact has been accepted even by United Nations as of July 2020, that 98.6% of learners worldwide were affected by the pandemic, representing 1.725 billion children and youth from pre-primary to higher education in 200 countries (United Nations, 2020). Variables like skills and training, resources using skill and infrastructure, teaching, support and collaboration, course management and evaluation, and learner related problems have significantly predicted each other during this period. However, support and collaboration and course management and evaluation related problems showed a negative role to determine the skills and training related problem whereas resource using skill and infrastructure and training related problem presented a negative role to determine learner related problems. These problems are different from hindrances to the digital transformation of higher education institutions which are change, pace, technology, competencies, and financing (Kopp, Gröblinger, & Adams, 2019).

The teachers teaching at university levels with reference to teachers of other levels is a significant predictor in support and collaboration and learners related problems. Experience significantly predicts the teaching-related problems and experience and age significantly predict the support and collaboration related problems. The gender, number of available devices, institute types, teaching levels, ICT training, teaching levels, and types of job are explanatory factors to determine the problems of mathematics teachers in online teaching in Nepal during the pandemic.

5. CONCLUSION

Mathematics teachers faced many problems while teaching through online mode during the pandemic. Technical skills of students, availability of resources to students, teaching figures, and curves are major problems of mathematics teachers in online mode. Gender, number of available devices, institutions type, teaching level, ICT training, and types of job are the factors of mathematics teachers causing problems in teaching mathematics. The findings indicate that challenges are subjected to overcome for effective online teaching, however, only the individual efforts of teachers are not sufficient. Access to ICT devices and training to use them properly for the pedagogical purpose seems essential.

This research has made innovative contributions to identify mathematics teachers' problems during online teaching. The results in this work provided a new perspective of the problems of teachers in online teaching; so, it gives new insights to the policymakers for making new policies to enhance the mathematics teachers' skills in digital resource development, management, and execution. The result may prove more useful for experts and teachers to manage their problems for effective mathematics teaching through online methods. Almost all the countries have started their classes virtually because of pandemic and developed countries also have practice of flipped and blended mode of instruction. Hence the results of this research may be useful for developing countries as well as developed countries for identifying their challenges during online mode of instruction.

The study had a few limitations such as it was limited to mathematics teachers. Other subject teachers of diverse levels may also face same problems hence this study tends to be helpful for identifying their problems and manage new strategies for implementing effective online classes. However, the most obvious shortcoming of the work was the online survey used in this study for data collection. The survey could identify only a limited number of digitally literate mathematics teachers from different levels hence, the result may not be generalized in a different setting. Despite this limitation, the findings of this study are important because all educational activities are running online mode in this pandemic and the study tried to identify the instructional practice related issues in a developing country like Nepal. Further studies can be conducted by taking a large number of teachers from diverse subjects and geographical locations.

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