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Effect of Mathematics Teachers' Problems in Teaching Equation, Figure, Drawing Symbols and Use of Software on Mathematical Content Instruction

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Abstract

The aim of the research was to measure the effect of mathematics teachers' problems in teaching equation and figure, drawing symbols, and use of software on the problems of mathematical content instruction online with respect to educational background and ICT training status. The cross-sectional online survey design was used among 258 secondary level mathematics teachers of Nepal. The path analysis technique was used to analysis the data. The finding of the research shows that the problems in using software and drawing figures are main predictors to the problems in instructing mathematical content with respect to non-educational background and untrained in ICT teachers. Whereas the problems in drawing symbols and teaching equations are main predictors in mathematical content instruction with respect to educational background and trained in ICT teachers.

Keywords: Software, mathematical content, problems, mathematics, ICT, Nepal

Introduction

Education has evolved over time to become a more robust and efficient system for generating a competent and competitive generation in order to keep up with the development of the modern world. However, to create an interesting and appropriate mathematics class for students, math teachers must be ingenious in their choice of a teaching strategy and in diversifying the learning activities (Ling & Mahmud, 2023). The instructor's ability influence his expertise in preparing, reflecting, and delivering instruction in setting and meeting his instructional goals (Wagner et al., 2007). The way that students are taught in the classroom has been drastically altered during COVID-19 Pandemic and it creates new opportunity in our traditional teaching with the use of internet access. Teachers instruct their pupils while they seated in their own homes. To achieve the goal of teaching and learning, teacher faces numerous obstacles. For teachers who have been doing classroom instruction for a long time, teaching online is a massive challenge in and of itself, as per a study by Poudel (2021). Additionally,

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various studies conclude that most developing countries of the world like Nepal, their educational institutions and teacher faces challenging for teaching math online.

In the context of Nepal, the degree of problems varied at the university level depending on the age and experience of the teachers whereas in secondary level, the institution types, ICT training status, and experience using the electronic devices by teachers are the main factors determining the problem of teaching mathematical content during online instruction (Khanal, Joshi, Adhikari, & Khanal, 2022). The outcome revealed by Khanal et al. (2022) showed that Algebra, Statistics, Vectors, Geometry, and Analysis are challenging disciplines for instructors who are teaching math online. A representation is any symbol, or set of signs, characters, diagram, item, figure, or graph that can be used to teach or learn mathematics. It is a crucial component of teaching and learning mathematics. Diverse modalities of representation can improve teaching and learning mathematics (Mainali, 2021). Middle school students problem faced to presented in variables more so than problems presented in numbers (Chan et al., 2022). Due to the requirement that students comprehend the meaning of variables, work with unknowns, and establish explicit relationships between the words, students frequently struggle to answer variable problems (Malisani & Spagnolo, 2009).The use of multiple representations has drawn a lot of attention as a pedagogical strategy to promote learning in the mathematics classroom due to developments in technology and the modeling of mathematical concepts. Moreover, the use of numerous representations for numerical, graphical and symbolic in mathematics was made possible by the expanding use of technology in calculus which was increasingly common in algebra and arithmetic (NCTM, 2000). However, it has also been stated that not all teachers had the required skills to teach in a digital space (Nair et al., 2020). Hence, teachers need digital skills and abilities to efficiently their effective implementation in the mathematics classroom (Joshi, Neupane, et al., 2021; Joshi & Singh, 2020; Khanal et al., 2021).

The incorporation of technology into mathematics education has an impact. In a time of swift technological and societal change, teaching children is a passionate job and a creative challenge. Research conducted by Afzal and Gondal (2010) showed that teacher-facilitated software instruction is superior to both traditional classroom teaching methods and computer-assisted instruction (mathematics software). Students should be encouraged to employ speaking, listening, reading, and writing in the mathematics classroom in order to convey their comprehension of mathematical terms, symbols, and concepts. They should also be encouraged to switch effortlessly between verbal, symbolic, graphical, and numerical versions of mathematical concepts by using a variety of representations like a diagrams (Thompson & Chappell, 2007). Diezmann and English (2001) explained a diagram as a ‘‘visual representation that displays information in a spatial layout’’ (p. 77). Goldin and Steingold (2001) argued that a mathematical representation cannot be comprehended independently; rather, it can only be understood as part of a larger system of accepted definitions and practices. Depending on the nature of the subject matter, teachers can select any software or application. To enhance teaching and learning processes, math teachers can use digital resources in a variety of ways, therefore they need to be high level of computer competency (Joshi, 2016b). Hence, teachers' teaching skill is useful to systematically using tables, charts, or lists; developing digital simulations; using analogies; working back over the work; involving reasoning activities and logic; and using various new applications such as GeoGebra and Kahoot (Ling & Mahmud, 2023).

ICT infrastructure equipment in the form of hardware, software, and internet services has developed into a factor that will affect the efficacy of virtual teaching throughout the

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implementation of teaching and its facilitation (Adarkwah, 2021). The results revealed by Adhikari et al. (2022) indicate that the level of challenges in teaching mathematics online was found to be significantly high 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. The results of (Khanal, Joshi, Adhikari, Khadka, et al., 2022) showed that one of the biggest difficulties for math teachers using the online form of instruction was integrating their technical knowledge and digital resources with the students and teaching figures and curves. The research conducted by Joshi et al. (2020) indicates that many teachers were faces the problem to integrate their subject with technology and they were not aware about how to write equations and symbols in the online files in the case of India.

Various studies such as (Adarkwah, 2021; Adhikari et al., 2022; Khanal, Joshi, Adhikari, & Khanal, 2022; Khanal, Joshi, Adhikari, Khadka, et al., 2022; Ling & Mahmud, 2023; Nair et al., 2020) explained about numerous problems that faces by mathematics teachers by teaching in the content of mathematics like teaching figures, equations, tables, curve drawing, drawing symbols and using software online however there are lack of research about their impact with mathematical content. Hence this research was conducted to find the answer of the question "What is the effect of mathematics teachers' problems in teaching equation and figure, drawing symbols, and use of software on the problems of mathematical content instruction?"

Methodology

The cross-sectional online design was employed in the research. In total 258 mathematics teachers were participated in the survey. The list-based sampling (Fricker, 2017; Khanal, Joshi, Adhikari, & Khanal, 2022; Schonlau et al., 2002) technique was employed in the research for data collection. Self-constructed tool was used in the research for data collection through Google Form. The reliability of the instrument found to be 0.83 which was calculated by Cronbach Alpha method. The validity was ensured by content validity method. The result was analyzed by path analysis technique in AMOSE software. The assumptions of path analysis were tested before analysis.

Variable information

ICT related training and educational background are considered as categorical variables. The ICT training have two categories as yes (72.5%) and no (27.5%) where yes represents trained and no represents untrained teachers in ICT. Similarly, education background has two categories as education (69%) and other (31%) whereas the education represents the teachers from education stream related background whereas other represents the teachers form humanity, science and other background. The detail of these variables is presented in Table 1. The results were analyzed based on categories of these variables. Problems of teaching equations, figures, drawing symbols, and use of software were considered as independent variables which were measured in five-point rating scale as strongly disagree to strongly agree. Mathematical contents of secondary level as Sets, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, Probability, Transformation, and Vector were considered as dependent variables. The problems of teaching mathematical contents were also measured in five-point rating scale as very difficult to very easy. The detail of dependent and independent variables is presented in Figure 1.

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Table 1 Sample characteristics (n=258)

Variable	Categories	Frequency	Percentage
Training status			
	No	71	27.5
	Yes	187	72.5
Educational Background			
	Education	178	69.0
	Others	80	31.0

Results

Figure 2-6 and Table 2 showing the detail results based on total, categories of educational background and ICT training related variables. The model explaining 6%, 5%, 7%, 2%, 4%, 3%, 2%, 6%, and 8% variance in Sets, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, Probability, Transformation, and Vector respectively with respect to total sample (Figure 2). The model explaining 8%, 4%, 8%, 6%, 4%, 4%, 1%, 5%, and 8% variance in Sets, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, Probability, Transformation, and Vector respectively with respect to the participants of education background (Figure 3). The model explaining 10%, 11%, 13%, 8%, 8%, 4%, 7%, 19%, and 20% variance in Sets, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, Probability, Transformation, and Vector respectively with respect to the participants from other than education background (Figure 4). The model explaining 7%, 5%, 4%, 3%, 3%, 2%, 1%, 5%, and 7% variance in Sets, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, Probability, Transformation, and Vector respectively with respect to the participants which were trained in ICT (Figure 5). Similarly, the model explaining 10%, 8%, 21%, 6%, 6%, 5%, 7%, 10%, and 12% variance in Sets, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, Probability, Transformation, and Vector respectively with respect to the participants which were untrained in ICT (Figure 6).

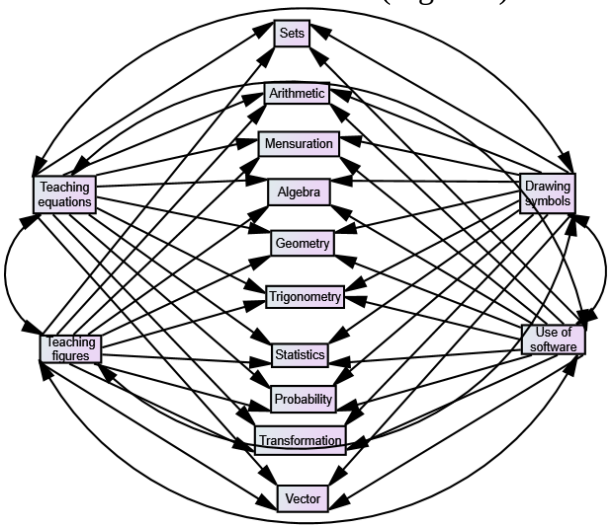

Figure 1 Conceptual framework

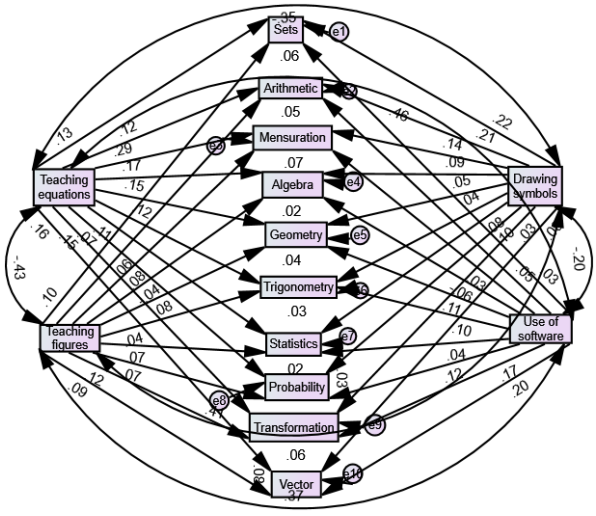

Figure 2 Results based on total samples

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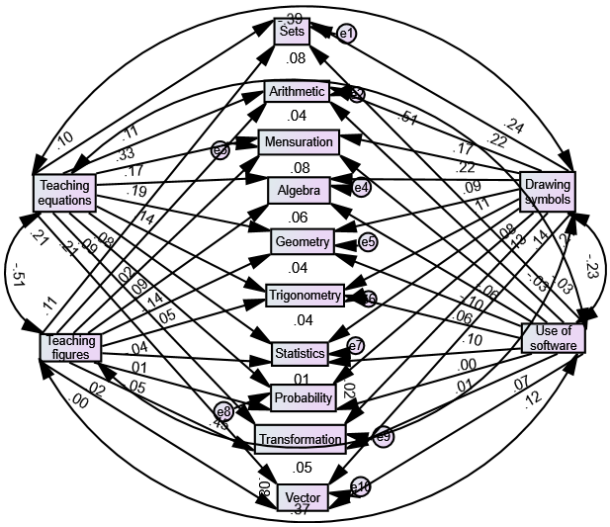

Figure 3 Results based on participants from Education background

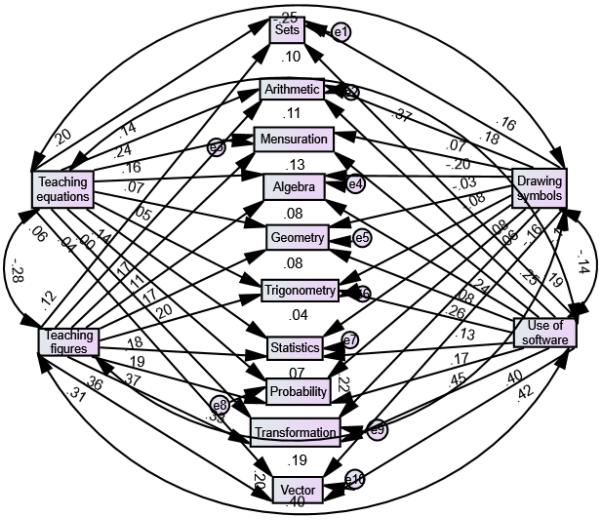

Figure 4 Results based on participants from other than education background

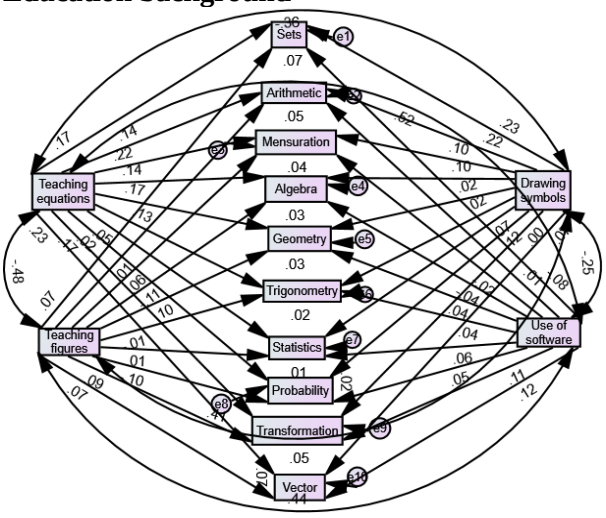

Figure 5 Results based on trained teacher on ICT

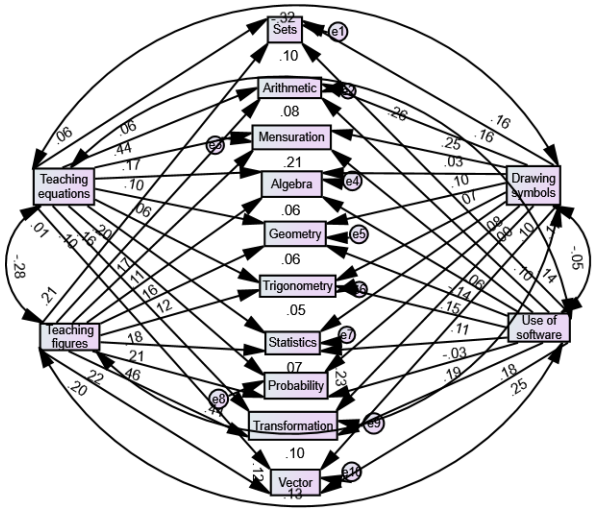

Figure 6 Results based on untrained teacher on ICT

Figure 2-6 and Table 2 showing that the drawing symbols have positive significant results in set with respect to total sample (Beta=0.22), education background (Beta=0.24), and trained in ICT teachers (Beta=0.23) whereas same results were measured in teaching equation with respect to total sample (Beta=0.13) and trained in ICT (Beta=0.17) teachers. In Arithmetic, use of software (Beta=0.25) with respect to other educational background teachers, drawing symbols with respect to total sample (Beta=0.21), education background (Beta=0.22), and trained in ICT (Beta=0.22) have significant positive effect. Similarly, in Mensuration, the results found to be positively significant in use of software (Beta=0.24) with respect to other educational background, teaching equation with respect to all categories (Beta=0.29. 0.33,0.24, 0.22, and 0.44 in total, education, other, trained and untrained in ICT respectively), and drawing symbols with respect to total sample (Beta=0.14), education background (Beta=0.17), and untrained in ICT (Beta=0.25) teachers.

Teaching equation with respect to total sample (Beta=0.17) and education background (Beta=0.17) and drawing symbols with respect to education background (Beta=0.22) are

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significant predictors to the Algebra. The use of software in other educational background (Beta=0.26) and teaching equation with respect to total sample (Beta=0.15), education background (Beta=0.19), and trained in ICT (Beta=0.17) are significant positive predictors to the Geometry. In Vector, teaching figure with respect to others (Beta=0.36), use of software with respect to total sample (Beta=0.20), others (Beta=0.42), and untrained in ICT (Beta=0.25), drawing symbols with respect to education background (Beta=0.21), and teaching equation with respect to total sample (Beta=0.16), education background (Beta=0.21), and trained teachers in ICT (Beta=0.23) are significant predictors.

Similarly, teaching figure with respect to others (Beta=0.37) and untrained in ICT (Beta=0.46), use of software with respect to others (Beta=0.45) are significant predictors to the Probability. Moreover, teaching equation with respect to total sample (Beta=0.15), education background (Beta=0.21), and trained in ICT (Beta=0.17), teaching figure with respect to others (Beta=0.36), and use of software with respect to total sample (Beta=0.17) and others (Beta=0.40) are significant predictors to the transformation. In remaining cases the results found to be insignificant and only the results having at least one significant value in the variable are reported in Table 2.

Table 2 Detail of regression width corresponding significant value (n=258)

Content	Problems	Total	Educational background		Trained in ICT	
			Education	Others	Yes	No
Set	Drawing symbols	0.18*	0.19*	0.13	0.18*	0.14
Set	Teaching equations	0.11*	0.09	0.17	0.14*	0.05
Arithmetic	Use of software	0.04	-0.02	0.17*	0.01	0.07
Arithmetic	Drawing symbols	0.16*	0.16*	0.13	0.16*	0.13
Mensuration	Use of software	0.03	-0.06	0.21*	-0.02	0.06
Mensuration	Teaching equations	0.28*	0.35*	0.21*	0.22*	0.43*
Mensuration	Drawing symbols	0.13*	0.16*	0.06	0.09	0.24*
Algebra	Teaching equations	0.16*	0.17*	0.14	0.14	0.17
Algebra	Drawing symbols	0.08	0.20*	-0.17	0.09	0.03
Geometry	Use of software	0.11	0.06	0.25*	0.04	0.14
Geometry	Teaching equations	0.16*	0.21*	0.07	0.18*	0.1
Vector	Teaching figures	0.09	0.00	0.28*	0.07	0.19

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Vector	Use of software	0.20*	0.12	0.41*	0.11	0.24*
Vector	Drawing symbols	0.09	0.21*	-0.16	0.07	0.12
Vector	Teaching equations	0.17*	0.23*	0.06	0.24*	0.01
Probability	Teaching figures	0.06	-0.05	0.32*	-0.09	0.41*
Probability	Use of software	0.11	0.01	0.40*	0.05	0.16
Transformation	Teaching equations	0.16*	0.21*	0.04	0.17*	0.1
Transformation	Teaching figures	0.12	0.02	0.34*	0.08	0.22
Transformation	Use of software	0.16*	0.07	0.39*	0.11	0.17

Discussion

The aim of the research was to measure the effect of mathematics teachers' problems in teaching equation and figure, drawing symbols, and use of software on the problems of mathematical content instruction with respect to total sample, educational background, and ICT training status of the participants. Level of problems of mathematics teachers in using digital resources in their instructional practices is high (Adhikari et al., 2022; Joshi, 2016a; Joshi et al., 2023; Joshi, Chitrakar, et al., 2021; Joshi & Rawal, 2021; Khanal, Joshi, Adhikari, & Khanal, 2022; Khanal, Joshi, Adhikari, Khadka, et al., 2022) hence the status of the problems of mathematics teachers in teaching mathematics were not reported in this study. Finding of this research indicates that the problems in drawing symbols have positive significant results in Set with respect to total sample, education background, and trained in ICT teachers which may cause that the different symbols like for union, intersection, and complement are really difficult to write like as general words and symbols. Similarly, problems in teaching equation have significant effect in the problems in teaching Set hence problems of teaching symbols and equations should be reduced to minimizing the problems in teaching Set. Joshi et al. (2020) found that many teachers were faces the problem to integrate their subject with technology and they were not aware about how to write equations and symbols in the online files in the case of India.

For teaching Arithmetic, the problems of using software have significant predictor to the teachers having other educational background which may cause that subject related software like GeoGebra, Mathematica, LaTex are integrated in education steam related course (Belbase et al., 2022; Joshi et al., 2022; Joshi, Neupane, et al., 2021; Joshi & Singh, 2020) in bachelor and master level however not in other course. Similarly, problems in drawing symbols have effect on instructing Arithmetic hence such skills should be enhanced by training programs to the teachers. Problems in using software with respect to other educational background, teaching equations, and drawing symbols are main predictors in problems in Mensuration instruction hence mathematics teacher should promote their such skills for effective instruction of Mensuration

online. The problem in teaching equation is main predictors in problems in instructing Algebra with respect to the teachers of educational background hence additional content related to teaching equation should be added in B. Ed. and M. Ed. related courses and training packages for effective instruction of Algebra.

Problems in using software with respect to other educational background teacher, and teaching equation with respect education background and trained teachers are main predictors to problems in instructing Geometry. Numerous representations for numerical, graphical and symbolic in mathematics was made possible by the expanding use of technology (NCTM, 2000) hence concerned mathematics teachers should promote such skills for effective Geometry instruction online. Similarly, problems in teaching figure and use of software are main predictors to the problems in instructing Vectors, Probability, and Transformation with respect to other educational background and untrained in ICT teachers hence government and other stakeholders must have some additional plans like training and workshops to enhance such skills of concerned mathematics teachers (Joshi, 2019). However, the problems in teaching equation and drawing symbols are significant predictors to the problems in teaching Vector and transformation with respect to education stream related and trained in ICT teachers hence such skills should be enhanced by concerned teachers.

Above overall results showing that problems in using software and drawing figure are main issues in mathematical content instruction online to the teachers having non-educational background and untrained in ICT whereas problems in teaching equation and symbols are main issues in teaching mathematical contents to the teachers of educational background and trained in ICT. Hence policymakers, course designers, teacher training developers and other stakeholders should develop their further activities based on the finding of this research.

Conclusion

The finding of the research shows that the problems in using software and drawing figures are main predictors to the problems in instructing mathematical content with respect to non-educational background and untrained in ICT teachers. The study further shows that the problems in drawing symbols and teaching equations are main predictors in mathematical content instruction with respect to educational background and trained in ICT teachers. Finding of this research are implacable to the policy makers, trainers, and other concern stakeholders for developing further policies and programs related to teachers' professional development however the finding of the research is limited to mathematics teaching online hence the result of the research may not generalize in physical or face-to-fact instruction. Moreover, the study is limited to online survey among mathematics teachers of Nepal hence further study can be conducted by adopting other research design in other country context. The content of almost country is similar and developed country have better practices in online instruction hence the result may more useful for developed countries. Furthermore, the study is limited to secondary level mathematics teachers hence further study can conducted in other level like basic and university.

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