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ICT Competency of Mathematics Teachers at Secondary Schools of Nepal

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ABSTRACT

This study aimed to investigate ICT competency of mathematics teachers at secondary schools of Nepal. A cross-sectional survey design was deployed among 336 secondary school teachers of Nepal. The data was analyzed by Mann Whitney U, Kruskal Wallis H, and multiple linear regression. Result showed that teachers' ICT competency level was found to be proficient in the fundamental concept of computers and the use of Internet. In contrast, it was found to be developing-level in software and hardware. Statistically significant results were found in competencies with respect to age, type of school, culture, and district. Additionally, own laptop, Internet use, work experience, knowledge of software and hardware were significant predictors for ICT competency of teachers. The overall findings clarify that ICT enhancement programs are needed for mathematics teachers at secondary schools in Nepal.

Keywords: ICT competency, mathematics teaching, SAMR models, TPCK, software, Nepal

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INTRODUCTION

New methods and techniques in education have emerged in virtual learning, blended learning, project-based learning, and student-centered learnings powered by Information and Communication Technology (ICT). UNESCO (2018) has re-iterated the novel role of ICT as a representation of digital technologies in the forms of computers, laptops, TV, software, hardware, and the Internet. The application of these tools has been evident in quality education (Caluza et al., 2013; Vitanova et al., 2015). Nowadays, teachers, apart from those traditional pedagogical skills, should have the necessary ICT skills. ICT competency of teachers exhibits their capabilities to use computer software, hardware, and the Internet for academic purposes. Moreover, ICT competency of mathematics teachers plays a significant role in education at all grades in the schools in Nepal. Schools should integrate the ICT tools into the classrooms in all subjects, including mathematics (Joshi, 2017; Valencia-Molina et al., 2016), for which every teacher should have appropriate technological skills. Not only in mathematics, but technological skills are integral components of STEM education (Kanematsu & Barry, 2016; National Research Council, 2003). Mathematics teachers should develop practice-based ICT skills as a part of 21st-century skill enhancement program (Akarawang et al., 2015). Such skills should be paramount for school teachers to plan and implement modern constructivist and progressive instructional practices. For such reformed practices, ICT application in instructions is a new need in this century (Dagiene, 2011).

After the development of Web 2 tools, ICT has been repeatedly integrated and implemented in education (Darwish & Lakhtaria, 2011). However, teachers need specific competencies to implement such tools in the classroom. There are a few models of ICT competencies of teachers. Some examples are the UNESCO ICT competency framework for teachers (Marcial & Rama, 2015), substitution, augmentation, modification, and redefinition (SAMR) and model (Hamilton et al., 2016). Other models are technological, pedagogical and content knowledge (TPACK) (Angeli & Valanides, 2009; Mishra & Kehler, 2006) model; ISTE standards for teachers emphasizes digital age learning, student learning, professional growth, digital citizenship and digital age work (ISTE, 2008); and country-specific models (Wang, 2013). Therefore, the study of teachers' ICT competency has diverse models, methods, and terminologies. For example, digital literacy (Krumsvik, 2008), ICT competency (Akarawang et al., 2015; Briones, 2018; Dagiene, 2011; Hewagamage & Hewagamage, 2015; Marcial & Rama, 2015; Tasir et al., 2012; UNESCO, 2018; Wang, 2013), digital skills (Kelentrić et al., 2017), digital competency (Dagiene, 2011; Hatlevik & Christophersen, 2013; Tomte, 2013) and Internet skills (Mrkauskaite, 2007) that are some studies related to the ICT competency of teachers.

Many factors are contributing to enhancing teachers' ICT competencies. For example, teacher professional development training (Akarawang et al., 2015; Morris, 2010); classroom use of technology (Uerz et al., 2018); ICT integration in the curriculum framework (MoEST, 2019) and curriculum making (Prestridge, 2012); institutional support to gain ICT skills, personal experiences on computer usage, dedicated entrepreneurship and digital didactic (Krumsvik, 2008); and the working environment and ICT attitude of teachers (Drent & Meelissen, 2008) are the major contributing factors in enhancing ICT competency and its practical implication in pedagogical practices. Today's teachers have to update themselves and resourcefully adapt teaching-learning content, use digital instruments, and analyze ICT implications (Dagiene, 2011). Therefore, ICT capability is an essential element of teachers' general cognitive and pedagogical skills (Mrkauskaite, 2007), which helps organize content to reduce their loads (Daling, 2017).

To mention a few works on ICT competency, Hewagamage and Hewagamage (2015) appropriated computing and network services, while Stuart et al. (2009) took ICT knowledge and experiences, and Akarawang et al. (2015) took cognitive ability, skills, and attitude under ICT competency. In this context, UNESCO (2008) categorized ICT competencies under three layers-- technology literacy, knowledge deepening, and knowledge creation. Various research works proposed different tools to evaluate different subject teaching, employing fundamental applications, computer hardware, Internet surfing, and computer software to assess metrics under their study. The majority of researchers, including Keong, Horani, and Daniel (2005), Sim and Theng (2007), Varughese (2011), and Alharbi (2014) dealt with the teachers' knowledge, skills, and confidence in using ICT and compared their competency with the demographic variables, such as sex and age.

The Government of Nepal introduced the Information Technology Policy (IT Policy) in 2000 "as a tool for development and growth" (MoCI, 2015, p. 6). This initiative was the first IT-related policy of Nepal that focused on integrating computer education in the school curriculum (Government of Nepal, 2000). The National Curriculum Framework of Nepal 2007 has mandated information and communication technology as an integral part of the school curriculum. It has recognized the importance of ICT to bring educational transformation in the country (CDC, 2007). Next, School Sector Reform Plan 2009-2015 focused on ICT assisted teaching/learning activities (MoE, 2009) and financial support to the schools for ICT infrastructure development. A master plan on Information & Communication Technology (ICT) in Education 2013-2017 focused on four indicators as ICT infrastructures, development of human resources, digital contents, and system enhancement (MoE, 2013). The Government of Nepal, Ministry of Information and Communication formulated and promulgated the National Information and Communication Technology Policy 2015 to enhance the country and its people's competitiveness through better governance, improvement in the health and education system, and economic growth (MoIC, 2015). It also focused on ICT literacy, e-learning, ICT integration in classroom practices, and ICT-based teacher training (MoIC, 2015).

Another policy provision is ICT education master plan 2013-2017 (MoE, 2013). The plan highlighted some ongoing efforts to promote ICT in education, for example, teacher training ICT through different means (radio and FM) and inclusion of computer science in grades 9-12 as an optional subject, offering computer science or engineering at bachelor's and master's degree courses in higher education institutions, and computer and ICT training in technical and vocational training courses (MoE, 2013). There are several other government efforts to promote ICT in education through 'one laptop per child (OLPC) in 26 districts, lab model projects, Internet connectivity, and development of digital learning materials (MoE, 2013). Considering all these efforts and other provisions, the ICT in education master plan outlined its mission "to narrow down the digital divide" (MoE, 2013, p. 13). However, achieving this mission needs several efforts, including the ICT competency of teachers. The stakeholders have realized that there is a shortage of ICT competent human resources in schools and educational institutions. Therefore, the plan outlined for developing ICT teaches for schools by providing computer and IT training. These efforts to boost ICT competency of teachers and students has been reflected in recent policy documents as well.

School Sector Development Plan 2016-2023 focused on the implication of ICT based teaching-learning practice (MoE, 2016). These acts/policies/guidelines have contributed to the development of ICT in educational institutions and other governmental units. Motives of all these policies are to implement and integrate modern technology in classroom practice. It will be possible only when teachers have good command in technological tools/devices/resources deployed in real teaching practices. Recently, the Government of Nepal, Ministry of Education, Science, and Technology has revised the framework and extended the provision of ICT in education as a means of communication and as a medium of learning. It has listed four major areas to utilize ICT in education— means of communication in school administration, facilitating teaching and learning, the capacity build of stakeholders including teachers, and a separate discipline included in the curriculum to enhance students' life skills (CDC, 2019).

There are academic programs of 3 to 4-years B. Ed. in Mathematics Education and 2-years M. Ed. in Mathematics Education offered by different universities of Nepal. Also, there is a 1-year program of B. Ed. in Mathematics Education for those having B. Sc. and B. A. in Mathematics. A teaching license is compulsory for all school teachers to teach in a school. All the programs have some ICT-related content, including teacher training courses, the syllabus of teaching license, and permanent teacher selection criteria. Such provisions are undoubtedly a good practice of Nepal's educational system and also signifies the importance of ICT for Mathematics teachers. This paper recommends the most influential factors of these good practices, in which the schools should emphasize the best practices.

The effectiveness of these policies and plans have not been fully assessed and realized through research actions in different parameters or variables. Hence, a research gap was identified in the Nepalese context. Some parameters of ICT competency of mathematics teachers can be - school types, culture and teaching experience, teaching level, school's ICT facilities, and so on. More dependent variables, namely the fundamental concept of computers, computer software, the Internet, and hardware, can also be considered for carrying out research work. In this paper, both dependent and independent variables were used to assess and analyze the ICT competency of Mathematics teachers at secondary schools in Nepal. Therefore, this research attempted to measure ICT competency level of mathematics teachers at secondary schools in Nepal to contribute to the literature gap in this novel area of study. The broader objective of this study was to examine the ICT competency of mathematics teachers at secondary schools of Nepal.

Specific objectives included analyses of four parameters of ICT competency, namely (1) Fundamentals of Computer, (2) Computer Hardware, (3) Software and Applications, and (4) Use of the Internet, in relation to age, academic background, qualification, experience, type of school, culture, teaching level, and district.

In the rest of this paper, first, we reviewed some literature related to teachers' ICT competencies. Second, we outlined the research method. Third, we presented the findings and results of the study. Fourth, we discussed the results in relation to the literature. Finally, we concluded the paper with a recommendation for further study.

LITERATURE REVIEW

We reviewed some literature related to teachers' ICT competencies that focus on varieties of issues, such as the effect of ICT use in developing competence, ICT competency for inquiry-based teaching, and effect of ICT competencies on classroom practice.

Vitanova, Atanasova-Pachemska, Iliev, and Pachemska (2015) studied ICT competencies of 220 primary school teachers from ten schools in four regions of Macedonia. The items included teacher knowledge of ICT, use of ICT in classroom teaching, ICT training, the confidence of using ICT in the classrooms, and their attitudes toward the use of ICT for teaching. The findings showed that the sample teachers used ICT for a variety of uses, for example, Navigation in Operating System (90%), Email (89%), Internet (94%), Text editor (94%), Multimedia presentations (81%), and Excel and other spreadsheets (79%). They also reported that the majority (58%) of teachers had high proficiency in ICT skills. They reported demographic factors, such as gender, age, work experience, and subjects the teachers teach as the determining factors of ICT competences. Also, they found that male teachers had a higher level of ICT competency than female teachers.

Kubricky and Castkova (2015) studied teachers' ICT competency in their practice of inquiry-based instruction within a constructivist approach to teaching-learning. They reported that modern technologies support in teaching in a variety of ways, for example, representation of students' ideas, concepts, and opinions; source of information for new knowledge, creation of a new context for engaging students, interaction among students and teaches, and means of the intellectual development of students. They highlighted the use of the Internet for accessing databases and communicating with the community of learners. For all these productive uses of ICT tools, teachers should have ICT competences "as a part of professional competence" (Kubricky & Castkova, 2015, p. 883). They outlined some ICT related professional competences of teachers, such as subject matter related ICT competence, pedagogical and didactical ICT competence, and diagnostic and intervention ICT competence. All these competencies should be well integrated into the teaching practice in the classroom holistically.

Tondeur, Aesaert, Prestridge, and Consuegra (2018) analyzed 931 preservice teachers' ICT competencies in Flanders, Belgium, by using a survey. They used preservice teachers' ICT competencies as the dependent variable and their background and attitudes related characteristics as independent variables. In the dependent variable, they observed two kinds of variables - competencies to educate students to use ICT tools and competency to integrate ICT in their lessons. They used SQD-scale to assess the independent variables. This scale used six categories of items that included teacher educators as role models, reflection on the role of technology, ability to design the use of technology, ability to collaborate with others, stepwise development of technological skills, and feedback to their pupils. They analyzed the survey data by using multivariate hierarchical regression models. They found that preservice teachers' ICT competencies to use the variety of tools for learning varied within-institution significantly, but it was not significant between-institution variance. On the other hand, preservice teachers' ICT competency to use in instruction also was similar to varying student-level significantly, but not at the institution level. They also found that the frequency of using ICT did not affect their ICT competencies because it did not distinguish between the level of ICT use for personal purpose and educational or institutional purpose.

Suarez-Rodriguez, Almerich, and Orellana (2018) studied a basic model to integrate teachers' ICT competencies with technological tools at the personal and institutional level. They discussed how ICT tools' use at an individual and institutional level affects teachers' ICT competencies. They constructed a structural model to integrate technological competencies, pedagogical competencies, personal and professional use, and classroom use of tools concerning gender, frequency of use, level of education and, computer classroom. One of the purposes was to validate this model of ICT competencies by establishing the relationship between the teachers' competencies across tools and pedagogical practices. They used a survey tool on a sample of 1095 primary and secondary school teachers (both male and female) using stratified random sampling in the Valencian Community in Spain. The survey tool consisted of questionnaires with teacher characteristics and other variables such as access, ICT knowledge and skills, different uses of ICT, ICT in teaching, ICT training, attitude towards ICT, and challenges of using ICT in the classroom. The questionnaire was designed for an online survey and print mode. The survey responses were collected in four months when the links or print copies were sent to the potential respondents. They analyzed the data by using both descriptive statistics and structural linear modeling. The researchers found that the technological competencies of teachers were higher than their pedagogical competencies. Interestingly, the teachers' ICT competency level was at the general user level, not an ICT advanced user. That means the teachers had normal ICT competencies, such as general use of computers and other ICT tools in the classroom, but specialized uses for specific tasks, such as modeling, creating, and presenting, were in shortage.

Further, ICT competency was significantly affected by the participants' gender, education level, frequency of computer uses at home, and in the classroom. They concluded that the basic model of ICT competency closed associated with technological competencies with their pedagogical competencies. It also demonstrated a strong link between ICT competencies with the use of tools for both personal and pedagogical purposes.

Anshiono, Murungi, and Mwoma (2018) studied the influence of teachers' ICT competencies in the classroom use of ICT while teaching mathematics. They applied an exploratory sequential mixed method approach to gathering data from forty purposively selected lower primary schools in Mombasa County of Kenya. They used three tools to gather quantitative and qualitative data: survey, interview, and class observation. The researchers first administered a survey to collect quantitative data from 109 primary teachers. Then they employed semi-structured interviews and observations to gather qualitative data. They

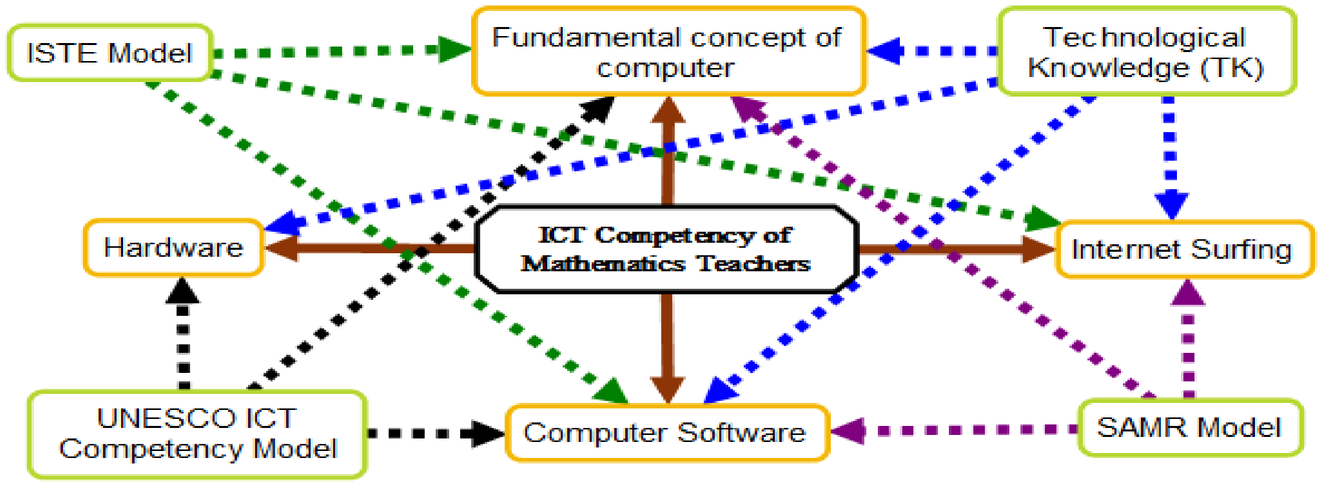

Figure 1. Theoretical Framework for ICT Competency of Mathematics Teachers

used descriptive statistics (percent values of frequencies) to analyze the quantitative data. They analyzed the qualitative data by finding meaningful themes to describe the major constructs. They found that 38.5 % of teachers received ICT training through seminars and workshops, and 25.7% of teachers received ICT training at commercial college to enhance their ICT competencies. Some others received ICT training from either teacher training centers (TTCs) or universities. These results from the study indicated that the participants enhanced their ICT competencies through different means. However, most of the teachers reported that they had a low level of competency in using ICT facilities to upgrade instructional materials, determine the mathematical needs of students, and develop appropriate mathematics activities. Only 27.5% of the participants reported that they used ICT facilities to prepare lesson plans, suggesting that the majority of teachers could not use ICT skills to improve their teaching.

The literature review showed that ICT competency is an essential aspect of teacher knowledge, skill, and pedagogical development within different frameworks. However, there is a severe scarcity of research on mathematics teachers' ICT competency in general, and it is more evident in the Nepalese context. From the discussion in the above sections, we integrated some theoretical concepts to construct a theoretical frame to guide this study.

THEORETICAL FRAMEWORK

We integrated ICT competencies from different four sources to construct our framework to explore high school mathematics teachers' ICT competency - UNESCO ICT Competency for Teachers (2008 and 2018), Hamilton et al.'s (2008) SAMR model, TPACK model of Mishra and Koehler (2006) and ISTE's (2008) technology standards (**Figure 1**).

The UNESCO formulated an ICT competency framework for school teachers in 2008. UNESCO ICT competency framework of teachers has categorized the competencies on six parameters--understanding ICT in education, curriculum and assessment, pedagogy, ICT, organization and administration, and teachers' professional learning in three-level technology literacy, knowledge deepening and knowledge creation (UNESCO, 2008). These six skills areas with three levels constitute at least 18 fundamental skills or competencies. The UNESCO ICT Competency Framework provides a comprehensive guideline for school teachers' knowledge, skills, and attitudes toward applying the variety of tools in teaching-learning. The framework provides a template to integrate teacher understanding of ICT about six skill profiles-- curriculum, assessment, ICT tools, organization, and professional learning at three levels —literacy (being aware), proficiency (deepening), and expertise (creating). This framework has been updated further in response to the UN General Assembly's "The 2030 agenda for sustainable development" (UNESCO, 2018, p. 7).

Another framework for ICT competency is the Substitution, Augmentation, Modification, and Redefinition of the content of teaching through the use of an ICT tool (Hamilton et al., 2016). This theoretical framework emphasizes on how teachers should use ICT tools in their classrooms. The first level assesses if the teacher can substitute a lesson activity with a tool without modification. In the second level, the teacher can make some modifications to the task with the help of an ICT tool to suit the lesson and context. At the third level, the teacher can fully modify a task or content activity with the ICT tool to use it flexibly. At the fourth level, the teacher can re-create a task or activity by creatively using the ICT tool. These four levels of proficiency or expertise of the teachers to apply ICT in this model are modified design of technological pedagogical content knowledge (TPACK) of Mishra and Koehler (2006) and UNESCO's ICT competency framework with three levels of six areas (UNESCO, 2008).

Another model for ICT framework is technological pedagogical content knowledge (TPACK) by Mishra and Koehler (2006). It integrates the three domains of knowledge—technological knowledge, pedagogical knowledge, and content knowledge to guide the integrated approach to use ICT tools in teaching-learning in a meaningful way. Therefore, ICT competency of school teachers can be observed with this model to see how they connect technology with teaching and designing teaching of specific contents. This model can be further extended to analyze the overlapping domains of knowledge ---technological-pedagogical knowledge, technological-content knowledge, and pedagogical-content knowledge. Then the overlapping of these three domains leads to form a common zone, which is TPACK (Mishra & Koehler, 2006).

International Society for Technology in Education (ISTE) formulated five technology standards for school teachers. The first standard states that teachers should use technology to "facilitate and inspire student learning and creativity" (ISTE, 2008, p. 1). This standard

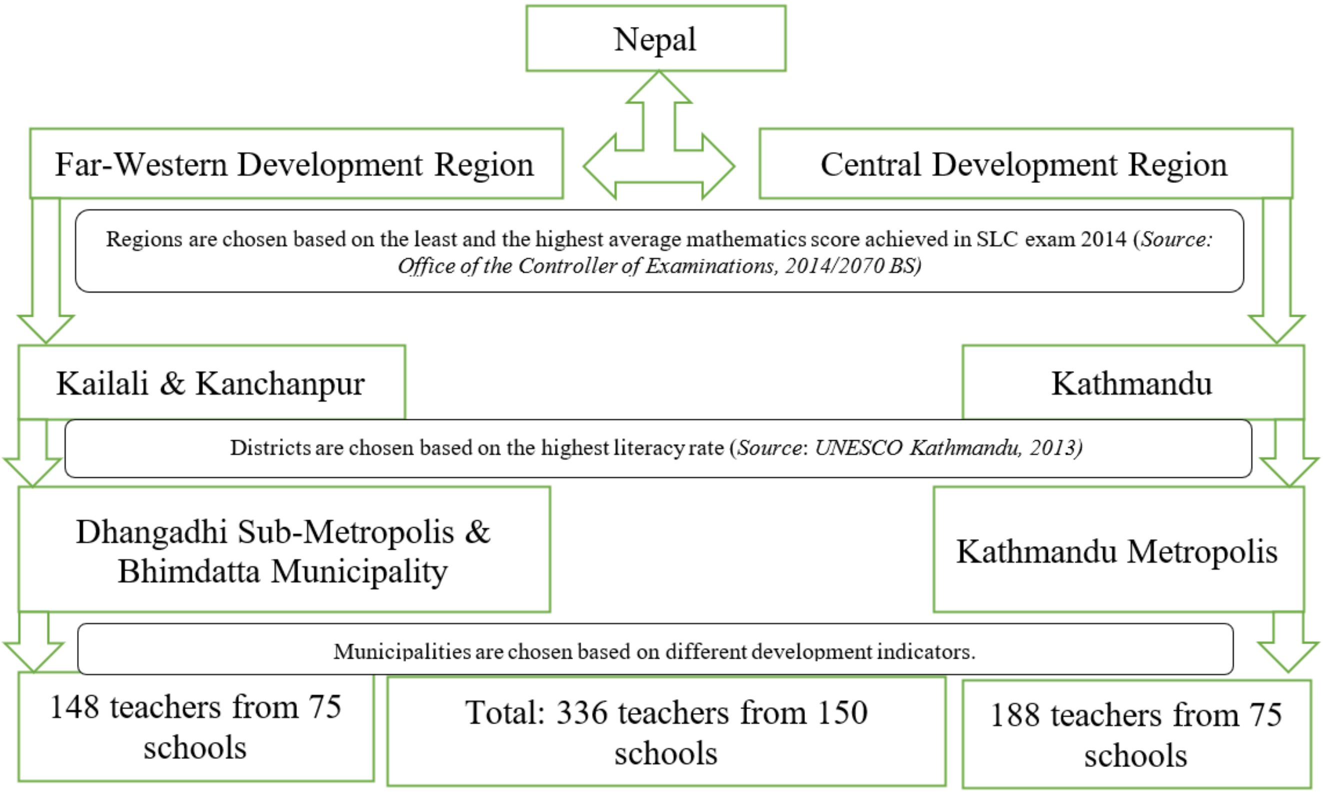

Figure 2. Multistage Sampling Frame for the Selection of Regions, Districts, Schools, and Teachers

focuses on the creativity of students through a variety of activities. The second standard focuses on advanced learning experiences through new design and development of activities and assessments through technological tools. The third standard emphasizes the modeling activities by using technological tools for demonstration, collaboration, communication, and modeling by using new technological tools and applications. The fourth standard is about promoting digital citizenship with the responsible use of technological tools for ethical, equitable, and culturally friendly pedagogy. The fifth standard highlights teachers' professional and leadership development through their participation, collaboration, evaluation, and contribution in the teaching-learning. This way, ISTE's (2008) standard focuses on teacher knowledge and skills for contextual and meaningful use of technological tools for students' holistic development.

METHODOLOGY

Study Setting

This study was carried out at secondary schools of Kathmandu, Kailali and Kanchanpur districts of Nepal. Mathematics teachers teaching at the lower secondary and secondary level (grades 6-10) having computer facilities were the participants in the study. These districts were selected as three strata for the study.

Research Design and Sampling

A cross-sectional survey design (Creswell, 2014) was implemented in the survey. The sample schools were chosen from the selected three districts. As the Department of Education and the District Education Office of the districts do not have an up-to-date record of mathematics teachers of schools having computer facilities, the selection of those schools has been a kind of "*site seeing*" strategy. Not all schools were likely included in the study. The sampling frame was not calculated because of the undefined population. Nepal was decentralized into five development regions and seventy-five districts at the time of data collection, and the new political division has seven provinces and seventy-seven districts. Based on different developmental indicators such as population, infrastructure, income, literacy, and other resources, each district has different local governance units called metropolis, sub-metropolis, and village development committees (VDC). As ICT is a relatively new concept in Nepal, only developmental regions have been selected based on developmental indicators viz. literacy rate, School Leaving Certificate (SLC) results, and average mathematics achievement rates of SLC result. A multistage cluster purposive sampling technique was used in this study. Detail sampling frame of the study is given in **Figure 2**.

Variables Used in the Study

Age, academic background, qualification, experience, type of school, culture, teaching level, and district were taken as independent variables. Further, age was categorized into two groups - (i) less than 30 years (49.7%) and (ii) greater than or equal to 30 years (50.3%); gender into two groups - (i) male (81.5%) and (ii) female (18.5%); academic background into three groups based on their academic background in higher education - (i) science (28.9%), (ii) humanities and management (20.8%), and (iii) education (50.3%). The minimum qualification of the teachers for teaching at the lower secondary level (class 6-8) was intermediate, and for secondary level (class 9-10) was a bachelor. So, the qualification of the teachers was categorized into three groups as (i) intermediate (2.4%), (iii) bachelor (55.6%), and (iii) master (42%). Another variable, experience, was further divided into two groups - (i) less than 10 years (58.6%) and (ii) greater than or equal to 10 years (41.4%). Similarly, the type of school was categorized into (i)

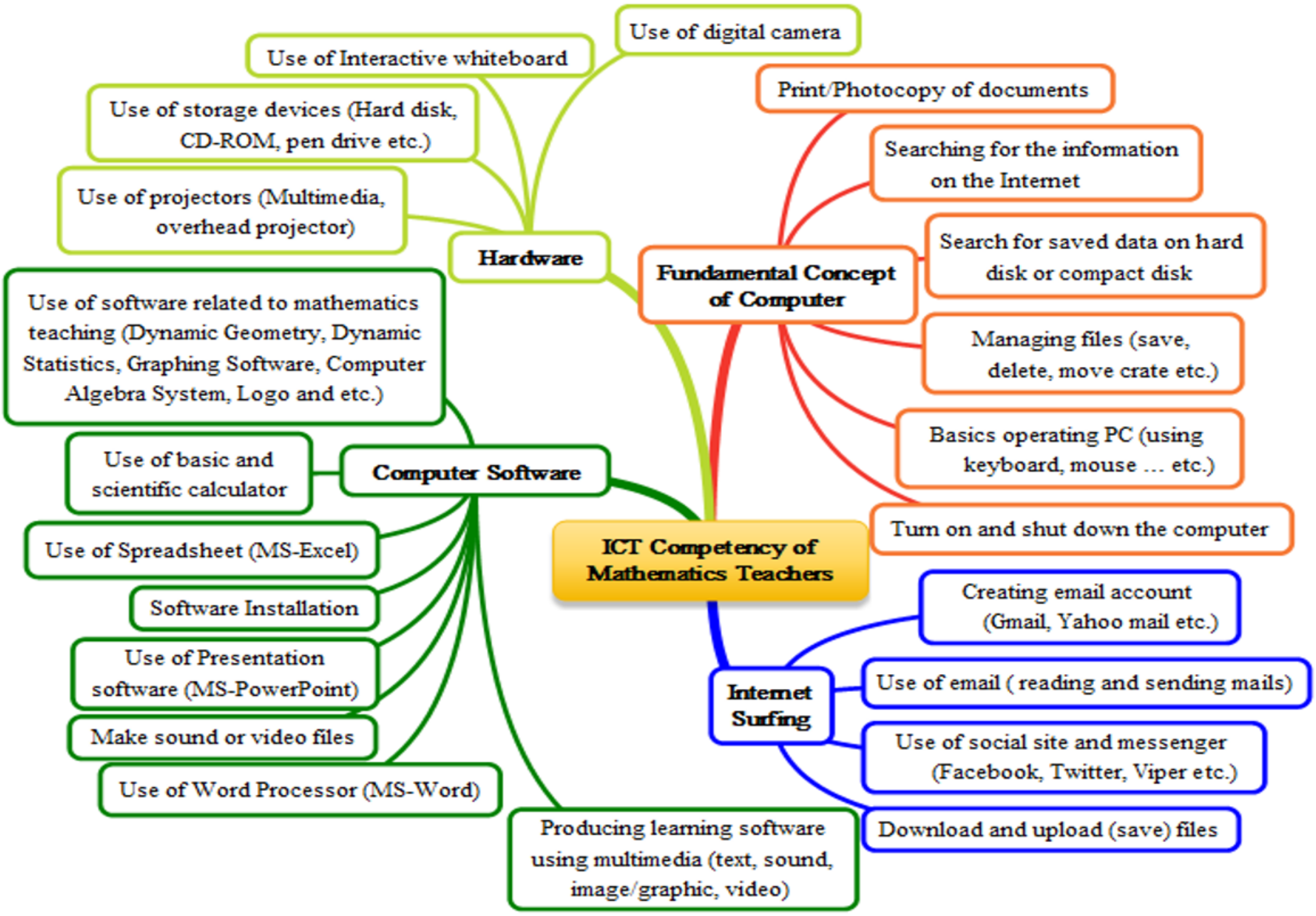

Figure 3. Conceptual framework

private (72.3%) and (ii) public (27.7%). Teachers were also categorized based on the location of the sample schools, (i) urban (56%) and (ii) rural (44%), and two sub-categories under 'culture' where Kathmandu was chosen as an urban district and Kailali and Kanchanpur districts as rural. In the same way, teaching level had two categories - (i) lower secondary (39%) and (ii) secondary (61%). Teachers who taught at both levels were included under the secondary level. The school samples were included from three districts - (i) Kathmandu (56%), (ii) Kailali (19.9%), and (iii) Kanchanpur (24.1%).

All elements of ICT competency were categorized into four dimensions - (i) fundamental concepts of computer, (ii) computer software, (iii) hardware, and (iv) the Internet. These four dimensions were taken as dependent variables. The variable elements were developed based on two models - (i) technological knowledge (TK) under TPACK, which is also called 21st century learning for teachers (Koh et al., 2017), and (ii) SAMR model. All items were organized in the form of a Likert scale as (i) excellent, (ii) good, (iii) fair, (iv) low capability, and (v) no capability at all, scoring being 5 to 1 respectively. The detail of the variable items has been demonstrated in **Figure 3**.

Instrument and Data Collection

In this study used a researcher-constructed instrument with 23 items under the four dimensions. The validity and reliability of the tool were calculated for the standardization of the tool. Contents validity was observed by providing the tool to the related subject experts to get feedback and comments on consistency, relevancy, sufficiency, and easiness to read and understand. The reliability coefficient (Cronbach's alpha) was found to be 0.954, which is above the general acceptance level of 0.6 (Cohen et al., 2007a). Data are collected from the selected districts and schools during the study period from January to June 2016.

Statistical Analysis (Item Rest Correlation)

The survey data was analyzed using methods of descriptive analysis of mean and standard deviation (SD) for determining five different competency levels (Daling, 2017) viz. (4.20-5.0) excellent, (3.40-4.19) proficient, (2.60-3.39) developing, (1.80-2.59) emerging and (1.00-1.79) learning. There was no randomness in sampling, and data was not found to be normally distributed (normality is tested on the 5% level of significance by Shapiro-Wilk and Kolmogorov-Smirnov tests and found the p-value ≤ 0.05 in all cases). Thus, inferential analysis of the Independent Samples Mann Whitney U test was applied for binary variables that had two sub-categories. Kruskal-Wallis H tests (Cohen et al., 2007b) was applied for independent variables with more than two sub-categories. These inferential statistics were computed based on means of rating scores of all related items under the four dimensions and their associated variables. The p-value ≤ 0.05 was considered statistically significant, and data were analyzed using Statistical Package for Social Science (SPSS version 23 for Windows). A multiple linear regression (MLR) analysis was run between the dependent variable (one of the ICT competences) and the independent variables such as gender, age, academic background, grades taught, work experience, type of school, culture, district, and the rest of other competence variables. Additional dummy variables were created for the items with more than two sub-categories, one dummy variable for each sub-

Table 1. Competency of Mathematics Teachers on Fundamental Concept of Computer, software, internet surfing and hardware (N=336)

Variables	Number of Respondents	Fundamental concept of computer		Computer software		Internet surfing		Hardware	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	p-value		0.00*		0.00*		0.00*		0.01*
<30 years	167(49.7)	4.23	0.92	3.31	0.90	4.19	0.99	3.49	0.99
≥30 years	169(50.3)	3.92	1.06	2.95	0.95	3.77	1.07	3.19	1.06
Sex	p-value		0.48		0.87		0.63		0.76
Male	274(81.5)	4.07	1.03	3.13	0.93	3.96	1.06	3.34	1.06
Female	62(18.5)	4.09	0.88	3.13	0.98	4.06	0.94	3.33	0.94
Academic background	p-value		0.83		0.87		0.68		0.46
Science	97(28.9)	4.03	1.06	3.16	0.99	4.05	1.04	3.41	1.08
Humanity/management	70(20.8)	4.15	0.99	3.10	0.99	3.86	1.21	3.38	1.04
Education	169(50.3)	4.07	0.99	3.13	0.90	3.98	0.99	3.38	1.03
Qualification	p-value		0.22		0.47		0.92		0.94
Intermediate	8(2.4)	3.85	1.33	2.67	1.12	4.16	0.91	3.16	1.28
Bachelor	187(55.6)	4.04	0.97	3.14	0.96	3.98	1.03	3.34	1.01
Master	141(42.0)	4.14	1.03	3.15	0.91	3.96	1.09	3.36	1.06
Experience	p-value		0.19		0.05*		0.00*		0.39
<10 years	197(58.6)	4.13	0.99	3.22	0.92	4.12	1.05	3.39	1.01
≥10 years	139(41.4)	4.00	1.03	3.01	0.97	3.78	1.03	3.28	1.08
Type of school	p-value		0.00*		0.00*		0.00*		0.00*
Private	243(72.3)	4.28	0.85	3.29	0.88	4.20	0.90	3.53	0.95
Public	93(27.7)	3.55	1.19	2.70	0.97	3.41	1.21	2.86	1.09
Culture	p-value		0.00*		0.00*		0.00*		0.05*
Urban	188(56.0)	4.39	0.68	3.27	0.90	4.24	0.84	3.46	1.01
Rural	148(44.0)	3.68	1.20	2.95	0.96	3.65	1.20	3.2	1.05
Teaching level	p-value		0.06		0.54		0.91		0.98
Lower secondary	131(39.0)	3.97	1.03	3.09	0.96	3.98	1.04	3.34	0.99
Secondary	205(61.0)	4.14	0.99	3.16	0.93	3.98	1.06	3.34	1.06
District	p-value		0.00*		0.01*		0.00*		0.03*
Kathmandu	188(56.0)	4.39	0.68	3.27	0.90	4.24	0.84	3.46	1.01
Kailali	67(19.9)	3.83	1.06	2.90	1.09	3.72	1.15	3.33	1.09
Kanchanpur	81(24.1)	3.56	1.30	2.99	0.85	3.59	1.24	3.08	1.02
Total	336(100)	4.08	1.01	3.13	0.94	3.98	1.05	3.34	1.03

**p-value* ≤ 0.05 (i.e., Significant)

category. The variable coefficients and p-values were used to interpret which independent variables were significant predictors of the dependent variable in each model.

RESULTS

The results of this stud have been discussed in terms of teachers' competency in the computer, software, Internet, and hardware with respect to age, sex, academic background, qualification, experience, type of school, culture, teaching grade level, and the location (district).

ICT Competence in Concept of Computer and Software, Internet Surfing and Hardware

Table 1 shows that the ICT competency level of teachers of age <30 years is Mean=4.23 and SD=0.92, and age ≥ 30 years is Mean=3.92 and SD=1.06. The difference in their average competency by the age group, school type, culture and location are significant at 0.05 level of significance suggesting younger teachers are more competent than the older ones, private school teachers have a higher competency than public school teachers, urban culture has a greater competency level than rural culture, and urban district has a higher competency the rural district teachers in the area of the basic concept of computers. However, there is no significant difference in their basic knowledge of computers by sex (p>0.05), although they were proficient. Similarly, there was no statistically significant difference among the teacher's competency in basic computer concepts by their major areas in academic degree, qualification, experience, and grade levels they teach (p>0.05) (**Table 1**).

The ICT competency level of mathematics teachers in the use of the software is found to be in the developing phase having the mean score in the interval 2.60-3.39. The age group of 30 years or below had a better use of the computer software than the older group, less experienced have more use of the software than more with teaching experience. Likewise, teachers of private schools, urban culture and located in Kathmandu had a better utilization of computer software than their respective counterparts at 0.05 level of significance. However, the use of software by the teachers were not significantly different by sex, academic background, qualification, and the grade levels they taught (p>0.05) (**Table 1**).

ICT competency level of Mathematics teachers in the use of the Internet are Excellent among private (Mean=4.20 & SD=0.90) and urban (Mean=4.24 & SD=0.84) school teachers. However, the level is Proficient in the remaining measured parameters. Mann Whitney U and Kruskal-Wallis H test statistics have produced significant results with age, experience, type of school, culture, and district at 0.05 level of significance. The competency level of younger, less experienced, private schools urban, and Kathmandu district teachers are higher than their respective counterparts. Whereas the teacher competencies related to

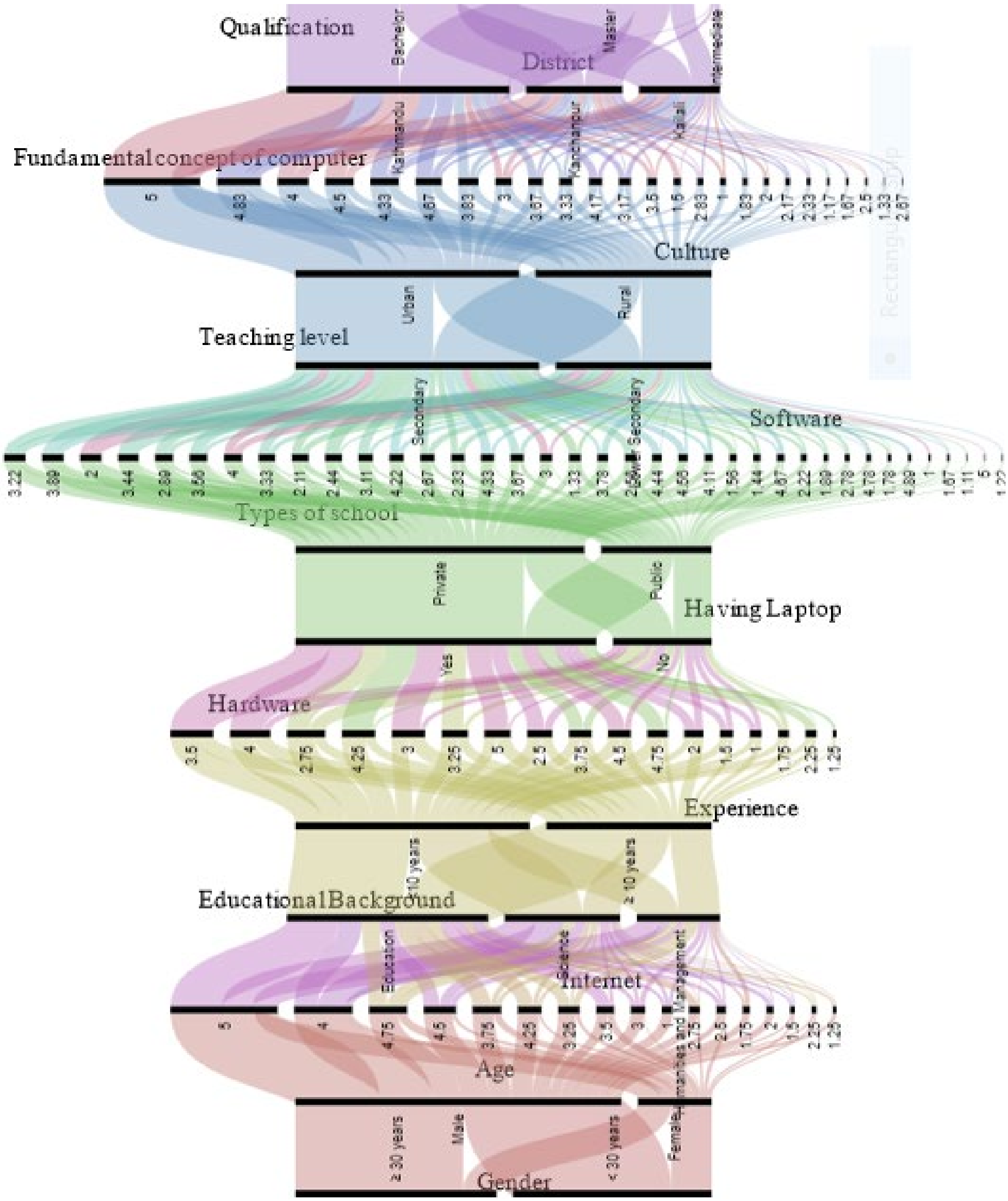

Figure 4. Graphic representation of detail of the competencies with all socio-demographic characteristics

use of Internet with sex, academic background, qualification, and teaching level of the teachers were not significant at 0.05 level of significance (**Table 1**).

ICT competency level in computer hardware is found to be Proficient among the teachers of age >30 years (Mean=3.49 & SD=0.99), teachers having science background (Mean=3.41 & 1.08), private school teachers (Mean=3.53 & SD=0.95) and teachers from urban areas (Mean=3.46 & SD=1.01). However, the level is in the developing stage for the remaining parameters. ICT competency level of computer hardware has been found to be significant in relation to age, type of school, culture, and district at a 95% level of confidence, whereas insignificant results have been observed among the remaining parameters (**Table 1**). However, detail of the four competencies with socio-demographic characteristics are given in **Figure 4**.

Regression Analysis

A multiple linear regression (MLR) analysis for Model-1 was carried out between the dependent variable competency in the concept of computer and independent variables (Gender, Age Group, Degree major, Degree level, Work Experience, Own Laptop, School Type, UR Culture, Grade levels, District, Software, Internet, and Hardware) (**Table 2**). The results showed that Own Laptop and Internet Use were

Table 2. Multiple Linear Regression Model of Dependent Variable (Competency on the Concept of Computer, Use of Computer Software, Use of Internet and Use of Computer Hardware) against the Independent Variables

	Concept of Computer			Software			Internet Use			Hardware		
	B	Sig.	VIF	B	Sig.	VIF	B	Sig.	VIF	B	Sig.	VIF
(Constant)	1.822	.003		.777	.266		-.489	.429		-.231	.747	
Gender (male)	.044	.621	1.227	.038	.703	1.228	-.057	.518	1.227	.032	.754	1.228
Age Group (≥30 years)	-.180	.064	2.398	-.125	.251	2.414	.107	.267	2.414	-.094	.400	2.418
Science	-.074	.334	1.230	-.012	.910	1.523	-.213	.023	1.499	.058	.593	1.522
Humanities	.109	.194	1.186	.041	.634	1.501	-.013	.863	1.502	-.063	.470	1.500
Intermediate	.004	.986	1.114	-.280	.271	1.223	.351	.118	1.218	-.134	.589	1.113
Master	-.025	.744	1.426	-.003	.973	1.445	-.016	.834	1.445	.035	.687	1.426
Work Exp. (< 10 years)	.189	.055	2.398	-.024	.830	2.425	-.221	.023	2.387	.226	.045	2.395
Own Laptop	-.192	.021	1.305	-.158	.090	1.315	.123	.136	1.318	-.067	.482	1.325
School Type	.067	.412	1.368	.059	.518	1.369	.119	.141	1.362	.081	.386	1.368
UR Culture (Rural)	-.665	.261	87.840	-.121	.855	88.180	.917	.117	87.510	.173	.798	88.171
Teaching level (secondary)	.135	.079	1.420	.024	.783	1.433	-.058	.443	1.431	-.118	.180	1.425
Kailali	-.810	.171	57.366	-.264	.691	57.676	.744	.203	57.413	.500	.459	57.606
Kanchanpur	-.963	.109	67.148	-.013	.985	67.692	.849	.153	67.260	.290	.673	67.654
Concept	[Model Variable]			.124	.050	3.569	.264	.000	2.375	.080	.211	3.221
Software	.083	.095	2.250	[Model Variable]			.605	.000	2.026	.492	.000	1.744
Internet	.618	.000	2.261	.471	.000	2.013	[Model Variable]			.353	.000	3.274
Hardware	.061	.211	2.607	.104	.095	3.209	.097	.050	2.242	[Model Variable]		
Models ANOVA	Model 1 F (16, 319) = 44.604 p<0.05, R^2 = 0.691 Excluded: Education, Bachelor, Kathmandu			Model 2 F (16, 319) = 25.311 P<0.05, R^2 = 0.559 Excluded: Education, Bachelor, Kathmandu			Model 3 F (16, 319) = 52.071 P<0.05, R^2 = 0.723 Excluded: Education, Bachelor, Kathmandu			Model 4 F (16, 319) = 32.29 P<0.05, R^2 = 618 Excluded: Education, Bachelor, Kathmandu		

the significant predictors of participants' competency in the concept of a computer with R^2 of regression = 0.691 and variance being significant at p<0.05. None of the other independent variables were significant predictors of the participants' competency in the basic computer (p > 0.05).

An MLR analysis for Model-2 was run between the dependent variable competency in the use of computer software and independent variables (Gender, Age Group, Degree major, Degree level, Work Experience, Own Laptop, School Type, UR Culture, Grade levels, District, Computer Concept, Internet, and Hardware) (Error! Reference source not found.2). The results showed that the Computer Concept and Use of the Internet were the significant predictors of participants' competency in using computer software with R^2 of regression = 0.559 and variance being significant at p<0.05. None of the other independent variables were significant predictors of the participants' competency in computer software (p > 0.05).

The MLR analysis for Model-3 was fit between the dependent variable competency in the use of Internet and independent variables (Gender, Age Group, Degree major, Degree level, Work Experience, Own Laptop, School Type, UR Culture, Grade levels, District, Computer Concept, Software, and Hardware Competency) (**Table 2**). The results showed that Work Experience, knowledge of Computer Concepts, Software, and Hardware were the significant predictors of participants' competency in the use of the Internet with R^2 = 0.723 and variance being significant at p<0.05). None of the other independent variables were significant predictors of the participants' competency in the use of the Internet (p > 0.05).

The last MLR model (Model-4) was run between the dependent variable competency in the use of computer hardware and independent variables (Gender, Age Group, Degree major, Degree level, Work Experience, Own Laptop, School Type, UR Culture, Grade levels, District, Computer Concept, Software, and Internet Use) (**Table 2**). The results indicated that Work Experience, Software, and Internet Use were the significant predictors of participants' competency in the use of computer hardware with R^2 of regression = 0.618 and variance being significant at p<0.05. None of the other independent variables were significant predictors of the participants' competency in the use of computer hardware (p > 0.05). Three variables (Education, Bachelor, and Kathmandu district) were automatically excluded from the model by the SPSS because their tolerance values were all zeros making the variance inflation factor (VIF) infinitely large due to the existence of multiple collinearities caused by those variables.

DISCUSSION

A teacher should have several skills and knowledge, including PK, CK, PCK, TK, and TPACK, to be a successful teacher. In this context, ICT competency is fundamental for teachers to implement effective pedagogical practices (Prestridge, 2012). Therefore, every teacher should have good skills to use emerging technological tools (ISTE, 2008). ICT competency levels of mathematics teachers have been found to be proficient in the fundamental concept of computer and use of the Internet even then it is in developing level in software and hardware. This finding is similar to other studies on ICT competency, such as Daling (2017), and Joshi (2016). This indicates that mathematics teachers have good skills in basic computing and fewer skills in software and hardware use.

ICT competency level of mathematics teachers having age < 30 years, experience <10 years, teaching level, private and urban school teachers are found to be better in their counterparts, as shown in **Figure 4**. Hence, it has become evident that age, experience, type of school, and culture are contributing factors to determine the ICT competency level of mathematics teachers in Nepal. It may be different in other countries. For instance, Vitanova et al. (2015) have investigated that professional use of ICT, ICT capability of schools, professional computer, attitude, and motivation are significant factors determining teachers' ICT competency. Likewise, Santiañez et al. (2019), and (Guo et al., 2008) have shown that ICT competency is significantly related to the age and experience of teachers. Again, from the results of this study, teachers' ICT competency level from science background is higher than that of teachers with education or humanity or management background. However, this level is in favor of the latter about the fundamental concept of the computer. This result suggests that it is not mandatory in the Education / Humanity / Management stream to determine teachers' ICT competency level. Part of the result shows that teachers with higher qualifications have high competency compared to their lower counterparts. However, this is not valid concerning internet surfing. Hence, qualification also has a vital role in determining the ICT competency of mathematics teachers.

Overall, the ICT competency level is found to be better in the fundamental concept of computers and the use of the Internet than the use of software and hardware. This result supports previous studies in Sri Lanka at the university level (Hewagamage & Hewagamage, 2015) and in Malaysia among school teachers (Kong et al., 2005; Sim & Theng, 2007; Tasir et al., 2012). However, the competency level is found to be poor in New Zealand among school leaders (Stuart et al., 2009) as well as in Nigeria among school teachers (Sakiyo et al., 2013) according to a study based on classroom practice of ICT. The linear multiple regression models demonstrated that three independent variables, age, owning a laptop, and school types, were the significant predictors of the mathematics teachers' competency in the basic concept of a computer, use of software, Internet, and hardware at 0.05 levels of significance. Although the competency level of teachers in Kathmandu with bachelor's degree and science majors had high levels of proficiency, those variables could not be used as significant predictors of ICT competency due to multiple collinearities caused by these variables.

In our study, socio-demographic variables like sex, academic background, working experience, and teaching level, etc. have almost similar competency levels as in the dependent variables. A few variations are found in teachers' competency level with their counterparts in relation to age, qualification, type of school, culture, and district of school teachers in favor of < 30 years, higher academic degree, Kathmandu district, urban and private school. Age, type of school, culture, and district have significant results in all measured confidence levels, and the insignificant results are observed in relation to sex, academic background, and type of school. Competency with the variable experience, there are mixed results - significant in software and the Internet and insignificant in the fundamental concept of computer and use of hardware. Similar results have also been observed by Danner and Pessu (2013) in relation in sex among university students in Nigeria and also by Marcial and Rama (2015) in the Philippines in case of qualification and type of school. However, in our study, results are opposite in relation to sex, probably because of the group's homogeneity with regard to the subject. Another insignificant result has been found in the relation of age in the study carried out by Guo, Dobson, and Petrina (2008) in the Faculty of Education at the University of British Columbia (UBC), Canada.

The results also focus that teachers should have their own laptop/computer, and access to internet use to develop competency in the concept of the computer. The teachers need to have computer concepts and use of the Internet to have competency in computer software use. The well-experienced teachers with sound knowledge of computer concepts, software, and hardware can develop competency in the use of computer hardware.

This study corroborates that the teacher's knowledge of software and hardware is in the process of consolidation within the framework of technology literacy and ICT competency standard of teachers as envisioned by UNESCO (2008). The findings also suggest that mathematics teachers of Nepal do not yet meet the complete ICT literacy criteria. By relating the result with the reference models, we come to generalize that mathematics teachers' technological skill is in a moderate level of TK model. It is in the substitution and argumentation phase of the SAMR model. More importantly, teachers should have a concept of a blended mode of teaching-learning with more application of ICT tools for interaction, exploration, and presentation in the classroom. They should design, develop and incorporate learning, assessment, communication, and collaboration by using technological tools in their pedagogical practices (ISTE, 2008).

CONCLUSION AND RECOMMENDATION

ICT competency of mathematics teachers of secondary and lower secondary schools in Nepal has been found to be in proficiency level in relation to the fundamental concept of computers and the use of the Internet, whereas it is at developing level in case of the use of software and hardware. The findings indicate that access to the Internet and computer to the teachers helps to develop competency in the concept of a computer, which enhances the use of computer software. The work experience, internet facility, knowledge of computer concepts, software, and hardware are directly related to the development of competency in the use of computer hardware. This implies that universities and teacher training providers should emphasize and prioritize their activities in developing software and hardware skills related to content and pedagogy. Experienced and aged teachers, teachers from rural areas, and the teachers in public schools have been found to be less competent in ICT skills. Therefore, a comprehensive and inclusive ICT training programs should be developed and implemented by targeting this group of teachers. The findings suggest that mathematics teachers' ICT competency level is in the substitution and argumentation phase of the SAMR model, and it is in the basic knowledge level of the TK model. Moreover, the competency level lies in UNESCO's ICT skill indicator and falls under the deprived literacy phase of the ISTE model technologically.

Furthermore, variables such as age, type of school, culture, and the district of schools contributed positively to teachers' ICT competency level. In contrast, sex, academic background, qualification, and teaching level made no significant differences. Additionally, easy and common information has been measured in software and hardware, which indicates that specialized programs are needed in order to develop the ICT competency level of teachers in Nepal. Based on the overall result of this study, we suggest that the government, universities, colleges, and related stakeholders incorporate standard ICT competency models for teachers' professional development. We also recommend policymakers, ICT experts, and other stakeholders to further revise the existing policies, curriculum, and ICT related training and management in favor of the result found by this study to support all teachers to enhance their ICT competencies. Further study is recommended to model the effects of mathematics and other subject teachers' ICT competencies on their students' learning outcomes.

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