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Synthesis Review of Digital Frameworks and DEPSWALIC Digital Competency Framework for Teachers from Basic to University Level

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Abstract: *Digital pedagogical skills are essential for teachers dedicated to the ethical and effective use of digital resources in blended learning, artificial learning, teaching, communication, collaboration, evaluation, and problem-solving in the era of digitalization. A variety of competency frameworks have been developed for teachers and learners by incorporating several components to accomplish the academic demand for learning and professional development. However, many of them do not address a wide range of resources, tools, and skills. The main objective of this research was to develop an inter-level digital competency framework for mathematics teachers from the school to the university level. DEPSWALIC Digital Competency Framework for Teachers has developed based on the literature and the necessary digital skills of teachers to complete their all activities digitally. The framework suggests that the teachers should have twenty-seven sub-skills under six keys skills (1) writing and presentation tools, (2) internet surfing and communication tools, (3) course management and evaluation tools, (4) learning and sharing tools, (5) related applications and (6) audio and visual documents development tools. Also, framework suggested that the teachers should be sensitive and careful on policy and ethical values in the use of such resources in professional activities. Additionally, skills of LMS, audio and video development tools, subject related online resources, software, and mobile applications skills for making digital games, creation of personal blocks, digital library, and result analysis related skills and resources are new attractions of this framework.*

Keywords: Digital, pedagogy, ICT, competency, teacher, framework, DEPSWALIC

Introduction

Digital skills are necessary for lifelong learning, information management (Prifti et al., 2017), modeling, and authentic learning (Rokenes & Krumsvik, 2014). Digital pedagogical skills,

digital competency, ICT competency, and digital literacy have similarly defined in different literature (Gallardo-Echenique et al., 2015; Spante et al., 2018) which supports the professional activities of the teachers (Mirete et al., 2020). Competency represents holistic excellences and abilities that include knowledge, skills, and attitudes (Kimura et al., 2017) however, only knowledge and skills have considered under this research. Digital pedagogy or technology literacy (Joynes et al., 2019) and its adoption or utilization (United Nations, 2019), which have been integrating several disciplines of our life activities (Maderick et al., 2015). Digital pedagogy characterizes the use of technology in instructional practices (Prakash, 2014), use of digital resources in processes, experience, evaluation, communication (Beetham & Sharpe, 2013), and transfer the knowledge through the teaching-learning process. It is the skill of the learner for the utilization and integration of suitable technology in the right ways and correct time (Dangwal & Srivastava, 2016) and also for supporting the learners for adjusting the technology-based culture and context (UNICEF, 2019). Digital literacy and institutional performance are key indicators of digital competency (Hatlevik et al., 2015; Metiri Group & METIRI, 2003), ICT stipulates new institutional chances and force tutors towards the use of novelties in instructional tendencies (Pons, 2010), so teachers have to update with novel technologies (Levano-Francia et al., 2019).

The competency of emerging technology in the education field demand digital competent professionals or teachers (Ally, 2019), who have a solid knowledge of digital resources (Ottestad et al., 2014), confident and critical use of electronic media, high-level information management skills, and well-developed information and communication technology (ICT) skills (Caena & Redecker, 2019; Ferrari, 2012). Digital competency contributes to determining self-efficacy among pre-service teachers (Elstad & Christophersen, 2017), increase the professional standard of tutors (Avdeeva et al., 2016; Kuzminska et al., 2018), create instructional management (Wei et al., 2016) and ideas (Benali et al., 2018) and support to professionals towards research activities (Yazon et al., 2019). Tutors should care about how, what, where, (ITU, 2018) when and which resources should be used in their teaching, whereas for the learners home environment and institutional performances act as major determinant factors in digital competency.

The education system of several countries has been transmitted into the blended mode and the role of tutors is also transmitted as a facilitator, content expert, managerial, pedagogical, and social personality, assessors, researcher, and evaluator (Ni She et al., 2019). Self-directed learning consisting skills for safe use of technology, e-learning, and open educational resources (OECED, 2019) is the popular concept of this age. Teachers should understand the diversity of the social aspects by which they should address and respect different cultural consequences (Engen, 2019). Calvani et al., (2010) emphasized the ethical, cognitive technological skills of teachers. Teachers should have knowledge of the synchronous and asynchronous systems of learning, scheduling, and effective delivery of content to the audience or learner (Ni She et al., 2019). Hence the different frameworks have been developed based on blended mode, connectivism, and constructivist theories of learning. Different countries, institutions or organizations have their own requirement

(Caena & Redecker, 2019), status (Taddeo et al., 2016), and models (UN, 2016) to measure the digital competencies of teachers and learners (Hatlevik et al., 2015).

Effective pedagogy is supportive to achieve the educational goals of the learners (Entz, 2006) and insists on effective learning environments (Hirschman & Wood, 2018). Martin & Grudziecki, (2006) have categorized digital pedagogy in three levels; (i) digital competence including concepts, approaches, attitudes related digital skills, (ii) digital usage which includes content and discipline-related tools and (iii) digital transformation which represents innovation and creativity of the teachers. Teacher training and communication strategy are the components of the theory of change (Westbrook et al., 2013) indicating that the teachers should update with new inventions, knowledge, and skills. Technology should be integrated into teacher training and instructional practices (Kovshikova et al., 2019). Learners of this age are self-driven and digitally smart (Hirschman & Wood, 2018). The concept of self-regulated learning (LLLP, 2019) is also taking place and the application of digital resources may support those concepts. In the present communication, we establish a DEPSWALIC Digital Competency Framework for Teachers of basic through university level by setting 6 keys dimensions of learning and personal developments based on ethical values and developed policies. The dimensions include digital resources for writing and presentation purpose, internet surfing and communication, course management and evaluation, learning and sharing, use of subject-related applications, and skills of developing audio-visual documents. Furthermore, the paper also highlights recently developed digital competency frameworks, their outcomes and achievements, and also compares the existing frameworks with this framework. The previous frameworks mentioned in the literature were developed and addressing the issues for all teachers however this model tried to focus on the digital pedagogical skills of mathematics teachers. Additionally, other researchers can also use this framework by changing subject related applications in terms of mathematics related resources of this model.

Literatures and Gaps

Technological, Pedagogical and Content Knowledge (TPACK) is another model developed by Mishra & Koehler, (2006). The model highlights the teacher's knowledge on their subject matter, way of teaching and learning, and the use of technology in their instructional practices. However, the model has not stated the varieties of teaching-learning related digital tools. Puentedura, (2006) developed SAMR (substitution, argumentation, modification and redefinition) model. The model consists of four layers substitution, argumentation, modification and redefinition categorized based on the level of using digital resources by the teachers. The model seems to be applicable in evaluating m-learning, e-learning (Romrell et al., 2014), and digital resources users' status of the teachers. However, the model did not consist of the different activities related tools for instructional practices. UNESCO developed ICT Competency Framework for

teachers in three-level competency parameters: technology literacy, knowledge depending, and knowledge creation by taking six indicators as understanding ICT in education, curriculum, assessment, pedagogy, ICT organization, and administration, and teacher professional learning (UNESCO, 2008, 2013).

Information processing, learning environments, interpersonal, communication and collaboration skills, digital citizenship, and digital identity are core digital competencies (Catalunya, 2015) of academicians. (UNESCO, 2016) indorse that teacher should have skills in using digital resources for research, development, design instructional planning, cooperation, and communication-related activities. Similarly, contextual skills (Microsoft, 2017), communication, collaboration, use of digital tools and technology (Dore et al., 2015), digital literacy (Joynes et al., 2019) critical thinking, creativity, and digital citizenship (Ontario, 2016) are basic requirements of 21st century skills of the educators (DoEL, 2015). A variety of competency frameworks or models have been developed for teachers and learners incorporating numbers of necessary components in this age. DQ Institute (2017) developed a Digital Intelligence (DQ) framework containing eight indicators: digital safety, security, emotional intelligence, communication, literacy, right, identity, and use along with 24 components. The institute has also developed the Future Learning 2030 Framework for learners by incorporating today's most appropriate problems like privacy management, digital citizen identity, screen time management, cyberbullying management, and cybersecurity management in this modern internet driven world. The framework is more applicable for the ethical use of digital resources and tools for teaching however not focused on teacher's professional development, planning, and research-related skills.

Redecker (2017) developed a Digital Competency Framework for educators. The competencies are categories under educators' professional, and pedagogies competencies and learners' competencies including 22 indicators under six areas. Professional engagement, digital resources, teaching and learning, assessment, empowering learners and functioning learners' digital competencies are the four areas of the model. The model consists of research, collaboration, professional development, content development and modification, teaching, evaluation and feedback and learners support in digital skills related information. Ethical and policy awareness of teachers, data analysis skills, professional development, research, course-related resources, and audio-visual document development skills with related tools. Kelentric et al., (2017) develop a model named Professional Digital Competence Framework for teachers. The framework consists of seven indicators: subject, basic skills, school and society, ethic, pedagogy and subject didactics, leadership of learning process, interaction and communication and change, and development. All indicators were well defined in three techniques: required knowledge, skills, and competencies of the teachers. The model focused on the utility of subject-related digital resources, materials and learning resources, respect to intellectual property, privacy, security and ethical value. Also, the framework conveys digital awareness of teachers, guardians and learners, evaluate and utilize digital resources, self-learning, develop digital environment, feedback to the learners,

communication with peers, and other related bodies, develop curriculum and other learning resources. The framework has not explained professional development, result analysis, research, planning, and policy awareness related skills with tools. NIoET, (2017) develop a model named Digital Competence Framework for teachers by including five indicators as information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. The framework preferred competency about internet surfing, browsing, data evaluation, interaction, collaboration, communication and sharing the content, creating digital content, solving content-related problems, and digital safety. However, it does not explain the ethical and policy awareness, planning, research, content development, and professional development related activities.

ITU, (2018) categories digital skills in three fragments: basic, intermediate, and advanced skills which include use of MS Word, email to artificial intelligence and cybersecurity and others. ETF (2018) developed a Digital Teaching Professional Framework for teachers including eight indicators in three stages of exploring, adapting and leading. The framework contains the competencies of teachers to use digital resources for instructional planning, comprehending novel consequences, encouraging learners to enhance digital capabilities, content extraction in teaching and learning, use of resources for assessment and feedback, accessibility. and self-development are major beauties of the framework. However, the framework has a gap in result analysis, subject related and research-related skills of teachers and ethical and policy-related awareness of teachers. The Digital Competence Framework for Austria – Dig Comp project was developed in 2013 and has been updated in 2017 and 2019. The framework clearly defines the digital competencies of all citizens under six digital domains as digital safety, problem-solving and continuing learning, content creation, communication and collaboration, information and data literacy, and foundation and access with twenty-four sub-domains (FMDEA, 2018) but the framework was not particularly focused on teachers skills, and instructional practices. Digital foundation, participation, citizenship and productions are four pillars of digital competency with major components cognitive, critical, collaborative, communicative, creative, cultural, and civic (Sinay & Graikinis, 2018).

Ally (2019) developed a Competency Profile for the Digital Teacher (CPDT) framework highlighting the open educational resources, access and development of digital resources, and pedagogical strategies. Barajas & Frossard, (2019) categories digital pedagogies into three fragments as (1) professional environment under educators' professional competencies, (2) digital creative resources, digital creative pedagogies, creative assessment, learner's empowerment under educators' pedagogical competences, and (3) learner's digital creativity under learners' competencies. Government of Quebec GoQ, (2019) develop a Digital Competency Framework for students and teachers containing 12 indicators: digital resources for learning, information literacy, innovation and creativity, critical thinking, problem-solving, personal and professional development, inclusion and diversity needs, content production, communication and collaboration incorporating ethical citizenship. However, the framework does not explain the tools for planning,

research, evaluation, and necessary tools to apply preferred skills. European Union, (2019) develop a Digital Competency Framework for teachers by including four parameters; digital resources, professional development, and collaboration, educational activities, and facilitating learners' digital competencies. Classter (2020) also categorized several tools for classroom teaching. The framework exhibits different activities like searching, selecting, training and lifelong learning, research activities, developing their own pedagogical practices, collaborating, and communicating under professional development to support learners and teachers. Although the framework seems to be more valuable than another existing framework. However, the information about digital literacy, referencing and data analysis tools are poorly explained and also has not recommended particular applications and guidelines to the learners.

Procedure of Framework Development

The framework has been developed based on two foundations: available literature and necessary skills of teachers for entirely adopting digital technology in instructional practices. The literature was searched based on the keywords as digital pedagogy, digital competency of teachers, digital literacy of teachers, ICT competency, ICT competency framework for teachers, 21st-century skills of teachers, and ICT literacy of teachers, and available resources have been included in the literature section. Additionally, some necessary skills not covered by the literature are also included in the framework and categories they are based on the nature of the items. Teachers are change agents of society and they should adopt updated knowledge and skills in their career; hence the ethical and policy awareness have considered as the root of the framework for using digital resources. All digital resources used to run in digital assistant hence, digital assistance is kept as the mainstream of the tree diagram. Additionally, all digital technology skills are separated under six categories based on the nature of items and suggestions of experts. The framework named "DEPSWALIC Digital Competency Framework for Teachers (DDCFT)" where DEPSWALIC is created by the first letter of six key skills, ethical awareness, and digital assistants. The framework has developed for targeting school to university teachers.

Description of the Framework

DDCFT has six key skills with twenty-seven sub-skills to the use of digital resources for different purposes and two-key awareness with six-sub awareness. The key skills are (1) writing and presentation tools, (2) internet surfing and communication tools, (3) course management and evaluation tools, (4) learning and sharing tools, (5) related applications, and (6) audio and visual documents development tools. Furthermore, the paper also highlights recently developed digital competency frameworks, their outcomes, and achievements, and also compares the existing frameworks with this framework. These skills are related to blended, online, distance and mobile,

planning, course material development, research-related activities, digital library management, scientific ways of result analysis, communication, collaboration, evaluation and feedback, professional update and development, engagement with professional courses, etc. The detail of each component is explained below:

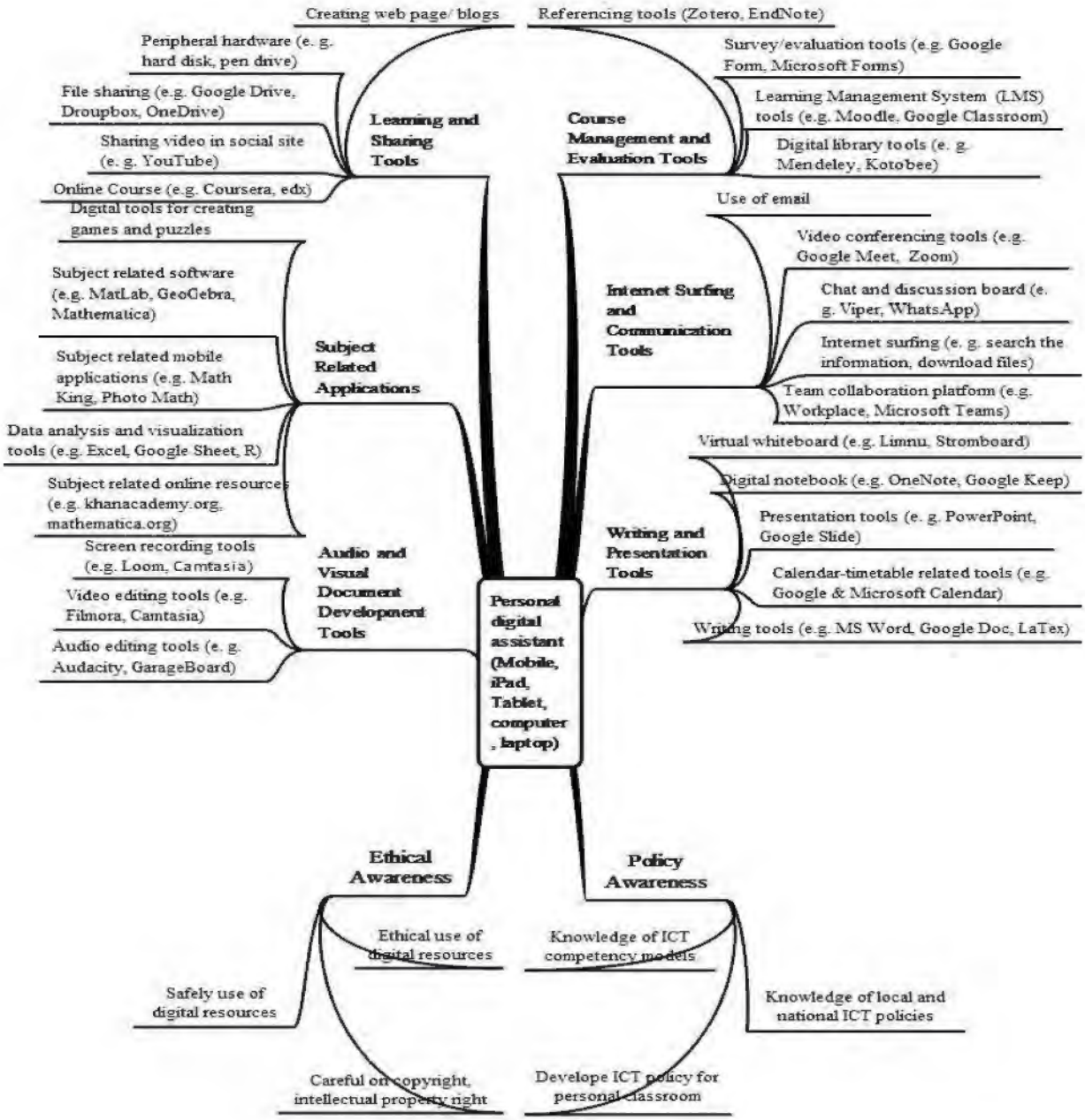

Figure 1 DEPSWALIC Digital Competency Framework for Teachers

Personal digital assistant (Mobile, iPad, Tablet, computer, laptop)

Personal digital assistant represents the digital devices which are commonly used in teaching-learning activities. Turn on, shutdown, and use of the general features of the devices which are necessary and basic skills for teachers because all the digital applications and resources used to run on these devices. For the application of all resources, the digital assistant is mandatory, hence it is taken as a trunk in the tree diagram.

Ethical awareness

Ethical use of digital resources is the basic foundation of professionals. It is related to the moral values of teachers and the concept of cybercrime, cybersecurity, intellectual property right, copyright with some legal provisions towards misuse of digital resources is taking place. Teachers are mirrors of changing society hence they should be careful about such issues and should guide learners on these conceptions. Hence it is taken as the root of the framework. Three components (i) safe use of digital resources (ii) ethical use of digital resources and (iii) carefulness on copyright, intellectual property right (Khanal et al., 2021) has been included under ethical awareness. Unnecessary installation of application disturbs the devices and storage capacity, processors, available programs, and basic feature of the devices related knowledge necessary for safely use of digital resources. Ethical use awareness represents the moral value during the use of digital resources whereas carefulness on copyright, intellectual property rights are also necessary skills for the teachers when developing original resources and sharing personal experiences.

Issues related to the ethical use of resources, copyrights, intellectual property rights, cybersecurity are popular and serious problems. Local, national, and international policies and practices and self-constructed policies for effective use of digital resources are necessary to all teachers hence ethical policy awareness has been taken as the basic foundation of the framework.

Policy awareness

Policy awareness includes (i) knowledge of ICT competency models, (ii) knowledge of local and national ICT awareness, and (iii) develop ICT policy for the personal classroom (Khanal et al., 2021). Knowledge of developed ICT competency model or framework provides the guideline to the teachers for the use of innovative technologies also it suggests that teachers should be updated. Knowledge of local and national ICT policy guides teachers to the use of technology-based on the objective, target, and aim of the nation. Additionally, every teacher should be aware of making their own policy for effective use of technology in their classroom teaching.

Writing and presentation tools

Writing and presentation tools are basic and necessary tools for writing, presentation, and information management. Skills to use such tools are mandatory to all teachers for typing/writing using software or virtual board for teaching and documentation. Detail of the tools are given in Table 1.

Table 1 Writing and presentation tools

Categories	Supportive tools	Features and Implication
Writing tools	MS Word, Google Doc, LaTex, Math Type	Writing tools are very important for all teachers for developing notes, questions, and others. Nowadays MS Word also has many features like writing, designing, formatting, editing, linking the text with other documents and Google Docs have also similar features like word however voice typing and sharing and collaboration are additional and important features. LaTex is scientific tool, which is more applicable in mathematics, science and engineering related discipline for writing symbols, equations and other contents. Similarly, there are verities of writing tools however Word, Google Doc LaTex, and Math Type are commonly used tools. So, every teacher has a good command of such tools.
Calendar-Timetable	Google Calendar, Microsoft Calendar	Digital timetable or scheduling management is another important skill for teachers. For the management of digital timetable and schedule, several colanders can be found even two examples of such tool are mentioned here. With the help of such tools, we can schedule our class, meeting, and other relevant activities.
Presentation tools	PowerPoint, Mahtematica, Google Slide	Presentation tools are applicable for sharing an attractive presentation content. Designing, animation, slide recordings, etc. are major features of the presentation tools. It makes it attractive for the classroom and teachers can reuse their slides by editing, modifying, and updating. The feature of slide generation is also available in Mathematica tool, which is directly related to mathematics and easier and more comfortable for writing mathematical notations and symbols.
Digital Notebook	Evernote, OneNote, Google Keep	For making short and immediate writing, teachers can use these tools as a personal digital diary. It is helpful for making short and immediate notes for long-term memories.
Virtual whiteboard	Limnu, Stromboard, Mural, Explain Everything, Miro	For teaching in online and face-to-face mode, teachers can use a digital whiteboard. There are several features as writing with different color and size, inserting image and text, drawing objects, omitting unnecessary contents are

	major functions of the tools. These tools are the replacement of white/blackboard.

Internet surfing and communication tools

In blended mode, Internet surfing represents the use of digital resources for information sharing, downloading, participation, and use of video conferencing tools for taking classes, communication, and collaboration tools. These tools are applicable for sharing, communication, and collaboration.

Table 2 Internet surfing and communication tools

Categories	Supportive tools	Features and Implication
Use of email	Massage and file transfer, receive and read the message	The use of emails is applicable for communication and collaboration in the teaching-learning process. Many of the digital tools and applications are demanded personal email for its applications hence teachers should have the skills to use emails for different purposes. Additionally, it can be used to transfer and share the files with their administrators, peers, guardians, and students. Mostly, teachers can use email for sharing different resources like notes, books, and other reading materials as well as other necessary documents with the students and other stakeholders.
Internet surfing	Search the information, download files	Internet surfing represents the searching strategy of necessary documents through the internet. There are several public domains like official and personal sites for searching digital content, software, apps, books, slides, and other documents. If teachers have knowledge of searching such documents, it saves time, easy to find official and authentic resources, and also protects the devices. Hence teachers should update their searching capability by which they can also suggest to the learners.
Video Conferencing Tool	Google Meet, WebEx, Zoom	Video conferencing tools are applicable for taking online classes, participate in virtual meetings, conferencing, training, and workshops. There are several tools for video conferencing by which we can easily organize our class and meeting in a virtual platform. These tools have several features like screen sharing, recording, writing, file sharing, attendance of the participants, and others. Hence the teachers should have those skills for a virtual class, meetings, training, workshops, and conferences.
Team Collaboration Platform	Workplace, Microsoft Teams	Team collaboration tools are very useful to teachers and students for individual and group calling, course management, and sharing documents. Almost of the functions are similar to video conferencing tools however these tools have separate usernames passwords to be used in

		separate groups by which the persons not enrolled in the group cannot participate in the activities. Group and individual calling, screen sharing, messaging, virtual whiteboard, assigning task or assignment, scheduling, recording, etc. are major features of these tools.
Chat and discussion board	Viper, WhatsApp, Facebook	These are common tools for communication. Individual and group chatting, calling and sharing files, screen sharing are major features of these tools for teachers. However, these tools have not provisioned screen recording, controlling participation and most of them developed for android mobiles. These tools are also user-friendly, applicable for sharing notices, sharing feelings, problems, and opinions.

Course management and evaluation tools

Officially sharing the content, enroll the learners, and recording keeping of students and teachers' activities are complicated tasks and it is related to reliability, validity, and authenticity of the institutional activities. The tools are applicable for managing the digital library, course management, evaluation of learners' activities, sharing feedback, and respect to the intellectual properties.

Table 3 Course management and evaluation tools

Categories	Supportive tools	Features and Implication
Evaluation and Survey tools	Google Form, Microsoft Forms	Survey tools are mainly applicable for collecting feedbacks, assignments, attendance, and evaluation of the students. It can be used based on daily teaching-learning activities. Set up different types of questions like short answers, paragraph writing, multiple-choice and multiple-choice grid, communicate with learners, and collaborate with peers are major features of the tools. The tools also have features of the collection of email, time of submission, limit to one response can be set and results are automatically collected in the form by which it can easily download in the excel sheet. Additionally, the questions can be asked by the attachment of image, audio, and videos with the tool. Hence these tools are applied in the evaluation process.
Learning Management System (LMS)	Moodle, Google Classroom, Edmodo	Learning management represents the arrangement of instructional activities in the virtual platform. These tools are applicable for course management like management of content related books, notes, audio, video, the link of digital

		resources, set up different questions for evaluation, peer evaluation like by rubric, teachers and students' progress bar, sharing notices, personal and group comment and feedback. All records can be stored for a long time and also the provision of reuse of classes hence the skills of using this application is necessary for the teachers.
Digital library tool	Mendeley, Kotobee	In this digital age, students and teachers can find several documents in digital form and can store their devices. The digital library tool has the feature of sharing the documents in-group, making notes, store the files, and making folders. Such a library can be used and manage for a lifetime and it is cloud-based storage hence not necessary to carry personal devices. Most people are used to studying digital documents hence teacher should use themselves and suggest the use of such resources to their students.
Referencing tools	Zotero, EndNote	These tools are helpful for the academic writing and research activities of the professionals. Research is the major part of teachers' professional developing and referencing tools are applicable for auto citation and referencing during academic writing by single-clicking.

Learning and sharing tools

Teachers can develop and share their content in the form of notes, slides, articles, audio, and video by which any person can study or watch or listen to such resources. Additionally, teachers can also participate in different platforms for professional development. Different types of resources in different languages and different forms can be available in digital computing hence teachers should have skills for their effective application.

Table 4 learning and sharing tools

Categories	Supportive tools	Features and Implication
Sharing video in social site	YouTube	YouTube is the most popular site to upload and share the video developed by different professionals. It's an easy process to create accounts and upload videos. Through this skill, tutors can develop content and experience sharing tutorials and share with a public or private domain. The information shared in the public domain can be visible to all global communities and is the best experience sharing platform.

Online Course	Coursera, edx	There are several organizations providing short-term and long-term professional training, seminars, conferences, and workshops through online platforms. The teacher is the change agent of society hence they should have to update and upgrade their professional career by participating such platform.
File Sharing	Google Drive, Dropbox, OneDrive	File and folders can be store in different drives by which it can be shared with others through their links. These are cloud-based storage having fixed storage capacity as Gmail has 15 GB, OneDrive has 5 GB similarly other different drives have their separate stored capacity. These are applicable to teachers for storage and share the database with other.
Peripheral hardware	hard disk, pen drive	These are external storage devices. Mostly hard disk is useful for storing big data and pen drives are applicable to storage and transfer the documents to other devices. Similarly, another drive is also available for big data storage.
Creating web page/ blogs	Google Site	Webpages are important to share profiles and other contributions like books, articles, videos, audios, and others with the global community. Especially for students to follow and find related information in required time through such blogs.

Subject related applications

Different types of resources have been developed on dissimilar subjects. The resources are mainly three types as online resources, software, and mobile application. Mobile application and software are around similar however mobile applications can be used in mobile and software can be used in laptops and computers even some applications can be used in both types of devices. Some subject related games and puzzle creating tools are available in the online platform which makes learners creative, active, and careful in learning.

Table 5 subject related application

Categories	Supportive tools	Features and Implication
Digital tools for creating games and puzzles	puzzlemaker.discoveryeducation.com	There are several applications by which teachers can develop different games, puzzles, and other subject specific creativities for the learners. Also, teachers can refer to their students to

		practice such activities. Such activities make active and creative to the learners.
Software	MatLab, GeoGebra, Mathematica	Different software like GeoGebra, Wolfram Alfa, MatLab are available in digital market which are important for writing, visualize, animation and other mathematical activities and problem-solving in mathematics.
Mobile applications	Photo Math, Math King, GeoGebra	Mobile and mobile applications are highly applicable and supportive for teachers and learners to learn and share content related information (Reinhart & Robinson, 2014). Several applications have been developed by various people and organizations for mobile users. So, teachers have skills to use such applications by which they can suggest to learners for their importance and use. For mathematics, several apps can be found for drawing, animation, list of formula, mathematical problem solving and calculation, and calculation of area, perimeter and volume.
Online resources	www.khanacademy.org, mathematica.org	There are several online portals related to different subjects including mathematics. Some of them are useful for multiple subjects and classes. Hence teachers should have knowledge of such resources and using the process of these resources hence teachers should be able to support and suggest their students for their utilization and application process in mathematical learning.
Data analysis and visualization tools	Excel, Google Sheet, R, SPSS	Data analysis tools are applicable to find the effectiveness of instructional practices in scientific and logical ways. Basic skills like calculation of frequency, range, mean, standard deviation, and correlations are mandatory to all teachers by which they can easily find the effectiveness of their teaching-learning activities and make

	plans for further improvement. Based on result analysis teachers or administrators can scientifically and logically evaluate the performance of teachers and the achievement of learners. Hence mathematics teachers should have skills of using such resources like Excel, R, SPSS, and Google Sheet.

Audio and visual document development tools

Audio and video development tools are very important to develop audio and visual documents. Teachers of this age can develop and share audio-visual documents with their learners by some modification. Screen recording tools can capture all activities of a computer screen and other tools will help to modify and delete unnecessary information from the captured and other videos.

Table 6 Audio and visual document development tools

Categories	Supportive tools	Features and Implication
Screen Recording	Loom, Camtasia	Knowledge of screen recording tools are important for every teacher by which they can capture their screen activities like video, audio, and image form and make educational documents by editing screen recording software have features of recording, selection of the particular portion of the desktop, sound recording and also capture all activities of the computer screen.
Video Editing	Filmora, Camtasia	Skills of video editing tools are necessary for all teachers because it makes our activities short and attractive. Several options like text highlighting, animation of image and video, integration of different video, audio and text, and separation of audio and video from the visual documents are basic features of these tools.
Audio editing tools	Audacity, GarageBoard	Audio editing tools are essential to make, edit, and corrupt the audios. It has features of remove some parts of unnecessary parts and background Eco sound of the audio documents. Speed and sound effects can be controlled.

Effectiveness of the Model in Pandemic Situation

Educational activities are entirely disturbed by the COVID-19 pandemic all over the world (Schleicher, 2020). There were no more digital competency-related issues before the pandemic because all most classes were running in face-to-face modality. Preparedness of teachers, learners,

guardians, institutions, and the government was the main issue during that transition period. Learners have high expectations towards the use of digital resources after the pandemic (Sharma & Alvi, 2021) because of having risks to run the face-to-face class (UNESCO, 2020) in this pandemic and they have positive attitude towards online learning (Mergany et al., 2021). We were facing several challenges in classroom practices like assign assignments, classwork and homework checking, sharing learning materials, self-learning about digital tools, identification of subjective tools, taking regular class, ethical use of digital resources, surfing and developing digital content and resources, and managing learning resources during that period (Hall et al., 2020). After the COVID-19 pandemic, all institutions were closed physically and they demand and implement their learning online (Espino-Díaz et al., 2020). It is an opportunity for teachers and other concerned stakeholders to shift educational activities online (Rajhans et al., 2020) which also support increasing the learning performance of learners (Hong et al., 2020). Every teacher should be digitally competent for effective teaching (Seufert et al., 2021) and adoption of technology in teaching learning activities promote inclusive education (United Nation, 2021). The framework gives the conceptual ideas to the teachers in using appropriate digital resources for their classroom practices and adjusting professional career hence it is more relevant in this situation.

Authors Reflection as a Tutor towards the Framework

Teaching mathematical content by showing PowerPoints and text is not more relevant hence mathematical tools are important for mathematical modeling. Writing mathematical contents in MS Word seems to be difficult tasks hence LaTex, GeoGebra, and Mathematica were used for writing as well as visualized the mathematical contents by which attraction of students can be increased in mathematics learning. We are teaching Geometry, Statistics, Fundamentals of Mathematics to bachelor-level students. LaTex, Mathematica, and GeoGebra are integrated into the curriculum of ICT in Mathematics Education at Bachelor and Master in Mathematics Education course so, these applications are under the teaching contents of authors. These tools are highly applicable to teach several mathematical contents like Algebra (Linear, Vector, and Abstract), Geometry (Analytic, Differential, Projective, Euclidean, and Non-Euclidean) at the university level. Transformation, Set, Trigonometry, Sequence and Series, Mensuration, Linear Programming, Derivative and Integration, Limit and Continuity, and Statistics at school level. Hence all of these contents are under our teaching contents. Some examples of graphic representation of the contents are presented in Figure 2 to Figure 7. LaTeX is a writing tool that is most effective for writing the mathematical equation, visualize the figure in text and draw different figures in the text. It can also be used online by the link overleaf.com. Teachers and students can type with smart formatting any mathematical content in this tool. Additionally, the GeoGebra also has features of typing mathematical content like LaTex however teachers and learners should have some additional skills of using some special commands for their implication which can be easily found in different user guides. It is easier because of having text for symbolic notations for example *\beta* for β and others, *\int* for integration symbol, *\iint* for double integration, *\sum* for sigma, \\

for changing paragraphs, *\;* for spacing (GeoGebra), *\sqrt* for squire root, *\begin{pmatrix}\\1 & 2\\4 & 5\\\end{pmatrix}* for 2×2 matrix with components 1, 2, 3 and 4 (Heck, 2001; Parker & Schwein, 2016). Additionally, the LeTex have special packages to run the commands in mathematics like *\usepackage{amsmath}* for mathematics typing, *\usepackage{amssymb}* for typing mathematics symbols (Berry, 2021).

The Google Classroom, Moodle for learning management system have good impacts to learn mathematics for assigning the tasks to the learners and sharing digital materials. Google docs, Google Meet, Zoom, and Microsoft Teams seem to be good tools for collaboration, communication, and coordination with teachers and students. Hence students' attractions seem too good by getting their class at their living rooms and well collaboration with teachers and friends. Initially, we found some drawbacks of the tools like unnecessary noise of the home environment because they were not habited to take the virtual class. Shortage of digital devices as laptop/computer and internet connectivity are also the issues in virtual learning cause that the mobile screen is not sufficiently large to see the content. Some learners have problems with frequent internet connections however they enjoyed (Said, 2021) watching the recorded videos in Teams after class time. Learners have problems in preparing their assignments in Microsoft Word documents hence they were habited to solve their problems in a notebook and upload by capturing images. Initially, the students have problems in surfing digital content but after instructions, they were motivated towards self-learning. Students of postgraduate and graduate-level found to be highly enjoyed to analyzed their project-related data by using SPSS and referencing using Mendeley/Zotero with a single click. Hence the tools mentioned in the frameworks are good for self-learning, problem-solving, mathematical modeling, collaboration, and communication. By giving the idea of mathematics-related online resources, online courses related links, learners can self-motivated towards learning. Students of primary level also enjoyed by using different funny mathematical games and videos in online. Besides this, the framework is important for the practice of STEM education flipped classroom and blended mode of learning.

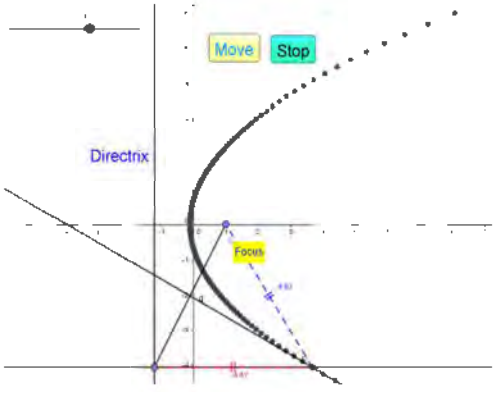

Figure 2 Visual representation of parabola in GeoGebra

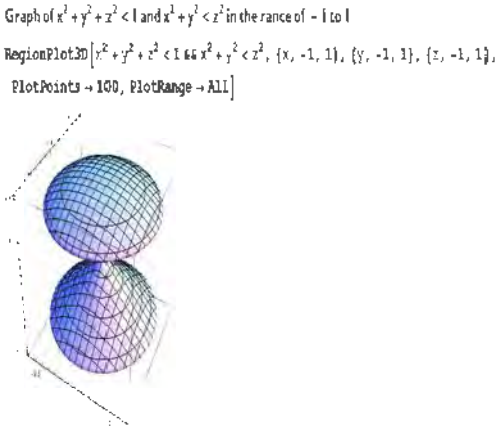

Figure 4 Visual representation of inequalities in Mathematica

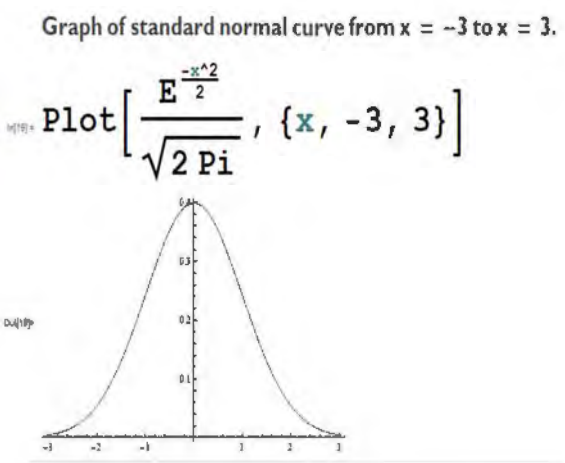

Figure 3 Visual representation of normal curve in Mathematica

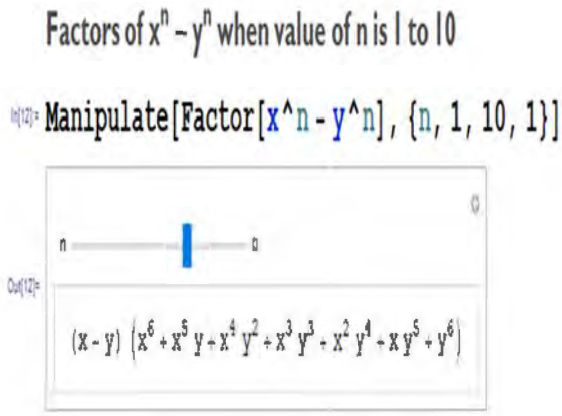

Figure 5 Visual representation of factorization in Mathematic

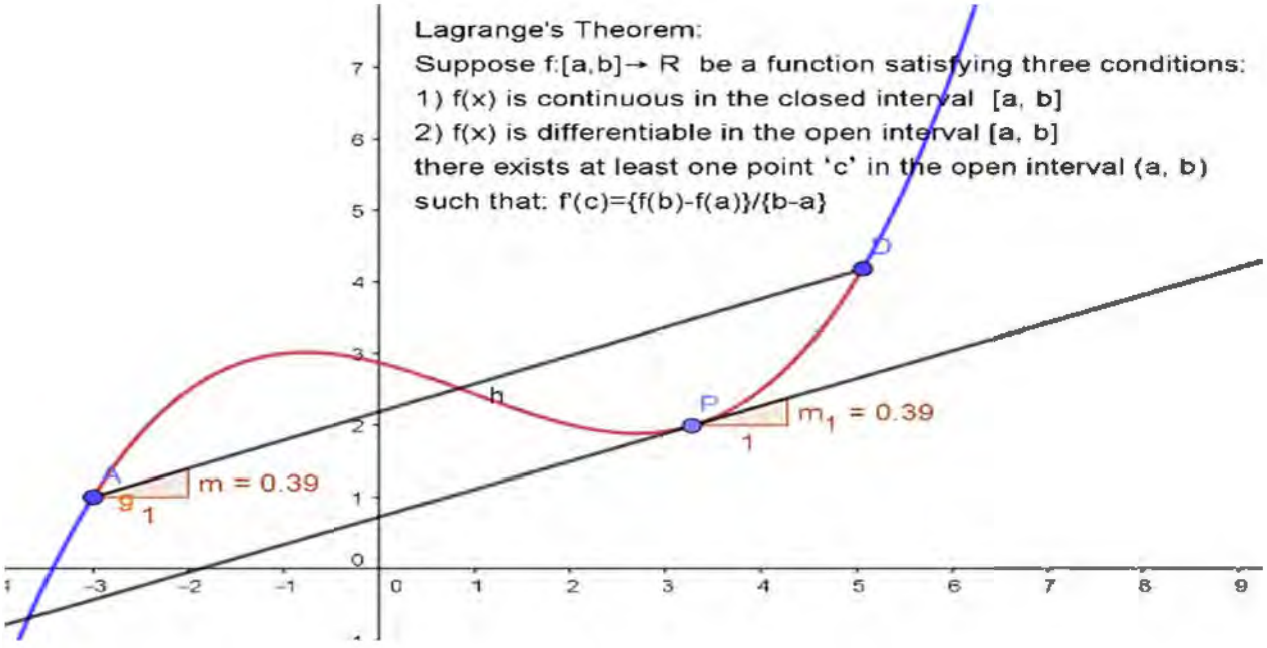

Figure 6 Visual representation of Lagrange's theorem in GeoGebra

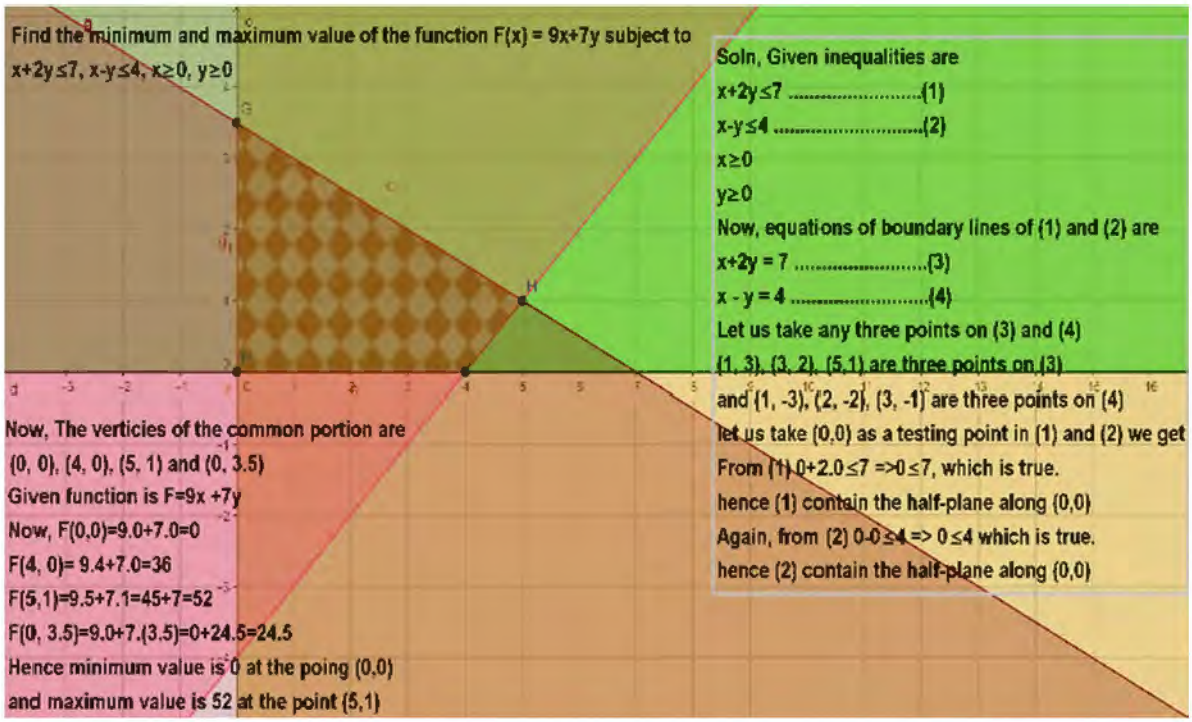

Figure 7 Visual representation of linear programming in graph

Authors Reflections as a Resource Person on the Framework

Mathematics is a separate discipline having symbolic language, graphs, and figures. Hence the mathematics subject-related tools/resources are important for meaningful learning by drawing, visualization and animation. Typing of mathematical problems is not simple like others hence mathematical tools are presented in the framework. Teachers should be the role model for effective teaching hence they should be digitally competent and smart. Additionally, as resource persons, we got a chance to participate and share our ideas in different online training series conducted by different mathematics education-related organizations and found that mathematics teachers had deprived skills on using digital tools. Some teachers were unaware of the use of digital resources for different purposes like assignment, document sharing, learning management, surfing documents through the internet, communication, and collaboration with their students and teachers. In this context, this framework gives a clear concept to those teachers to the use of appropriate tools for their different teaching and learning activities. Additionally, the framework will support their professional development and adjustment with this digital global community.

Discussion

The purposed framework consists of necessary and useful skills for mathematics teachers for teaching learning activities, communicate, collaborate, document development, and sharing based on ethical and policy awareness. The skills of writing and presentation are basic tools for writing and presenting the composed documents to students. However, some documents have features of communication and collaboration like Google Slide and ITU (2018) mentioned these under basic skills for teachers. Digital planning-related tools are also categorized one of the basic requirement and ETF (2018) also exposed that the use of digital resources should be manipulated in instructional planning. Internet surfing and communication tools are applicable for sharing information, communication, collaboration. With these skills, teachers can share course materials, take their virtual class, and collaborative work with students by chatting, calling, and messaging. These skills are more applicable to blended, online, and distance learning in the synchronous and asynchronous modes of learning. These skills are under the substitution and argumentation phase of SAMR (Puentedura, 2006) model and belonging to technological skills of TPACK (Mishra & Koehler, 2006) model additionally Microsoft (2017), Dore et al. (2015) and Joynes et al. (2019) also suggested that this communication, collaboration, and digital literacy-related skills are necessary digital skills of teachers..

Course management and evaluation tools are applicable for learning management system (LMS) which is best for course management, record keeping of the students and teachers' activities of virtual activities, personal digital library, referencing and survey tools where survey tools can be applied for several test or evaluation where Redecker (2017), ETF (2018) and Barajas & Frossard, (2019) mentioned digital assessment under their framework. However, some tools as among digital libraries and referencing tools have common tools also like Mendeley and Zotero. Referencing tools are applicable for academic writing of the teachers which is a part of the professional development of teachers also prioritized by UNESCO (2016), Barajas & Frossard (2019), and European Union, (2019) Learning and sharing tools consists to publish the personal experience through the personal sites, sharing developed text and visual document towards the global community or with students, use of drives and take professional skills through different professional courses and training.

The subject-related application consists of five types of resources. Where digital quiz and puzzle tools are applicable for checking the creativeness of learners and make them punctual in mathematics. Software, apps, and online resources have special features for different concept learning and some of them have storage of the information where Kelentric et al., (2017) also mentioned subject-related digital skills under their model. Data analysis related tools are important for the evaluation of learners' performance, and helpfully for scientific feedback. Screen recording, audio and video tools are applicable for developing audio-visual documents and capture the

activities of computer screens. The tolls have three categories; however, some tools can be available having all of these features like Camtasia and Filmora. Ally (2019) also explained that development of digital resources is under the digital skill and NIoET (2017), ETF (2018), (FMDEA, 2018), Barajas & Frossard, (2019) and Government of Quebec GoQ, (2019) mentioned that the digital content creation is under digital competency skills of teachers. McGarr & McDonagh (2019) suggested to incorporate pedagogical, technical, ethical and attitudinal in ICT competency framework, European Commission (2018) enforced to digital literacy, creativity and safety whereas Bourgeois et al. (2019) and Carretero et al. (2017) stressed on data literacy and digital content. The model developed in this study has focused on such necessary skills of mathematics teachers. The motives of this research were to focused, highlight, and explain the necessary of mathematics teachers for adjusting virtual teaching-learning activities.

Concepts of ethical behavior, intellectual property rights, cybersecurity, and cybercrime are ethical values for using digital resources and every academician should respect, and follow such values. Hence it is considered as one main root of digital skills of teachers where the other researchers Kelentric et al. (2017), NIoET (2017), (FMDEA, 2018) and Government of Quebec GoQ, (2019) also considered ethical citizenship, ethic and digital safety as compulsory skills under their framework. On the other hand, for effective implementation of digital resources in instructional practices, the teacher should have knowledge of ICT related policies and practices at the local to international level and they have skills to develop their own digital resources using policy for classroom practices hence policy-related knowledge is second toot of the framework. These overall models/frameworks have emphasized communication, collaboration, digital citizen, content development and sharing however the skills of LMS, audio and video development tools, online resources, software, mobile application, result analysis, skills of making digital games, creation of personal blocks, digital library, survey and result analysis related skills and resources are new attractions of this framework.

Conclusion

The proposed framework consists of twenty-seven indicators under six domains and two root levels of awareness for digital resources usage. The existing models basically focused on communications, collaboration, assessment, feedbacks, digital content development, digital citizenship, development of learners' digital capacity. However, the proposed framework additionally covers the area of skills of LMS, audio and video development tools, online resources, software, mobile application, result analysis, skills of making digital games, creation of personal blocks, survey and result analysis related skills and resources were newly incorporated in this framework. This framework is highly applicable in the pedagogical practices in this digital era. The status of mathematics and other subject teachers, different level teachers among different countries in using mentioned tools under twenty-seven subskills can be measured by this

framework. For the equality and equity of a digital-friendly environment in global perspectives, the digitally smart on these indicators can share and collaborate their ideas with the poorer communities. This framework also gives the clear concept of using digital resources for different purposes for their professional development, digital teaching, and adjustment with 21st-century classrooms. On the other hand government, institutions and other stakeholders will get the ideas to emphasize the priorities of the teachers.It is also beneficial for policymakers, teacher training, and curriculum developers, teachers, students, researchers, and other concerned stakeholders. At least two examples have been taken under all the indicators which is very limited hence several tools in each category can be chosen and some indicators have common tools. Additionally, development of technology has been taking place more speedily and miraculously hence such tools can be developed newly based on the demand and development of content, creation, and context.

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