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Teaching Mathematics at Upper Secondary School in the Digital Age: A Case Study in Cambodia

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សង្ខិត្តន័យ

ការសិក្សាស្រាវជ្រាវនេះបានរកឃើញពី (1)តម្រូវការចាំបាច់ (2)បញ្ហាប្រឈម និង(3)ដំណោះស្រាយ ក្នុងការបង្រៀនគណិតវិទ្យា ទន្ទឹមនឹងនេះ គ្រូបង្រៀន អ្នកសិក្សា និងអ្នកពាក់ព័ន្ធត្រូវបានលើកកម្ពស់ការអភិវឌ្ឍបំណិនទន់ និងបំណិនរឹងដែលធ្វើអន្តរាគមន៍ជាវិជ្ជមានដើម្បីធានានូវការពង្រឹងគុណភាពអប់រំឱ្យស្របតាមនិន្នាការអប់រំក្នុងតំបន់ និងពិភពលោកដើម្បីសម្រេចបាននូវគោលដៅនៃការអប់រំសម្រាប់ទាំងអស់គ្នាក្នុងសហស្សវត្សរ៍ថ្មី។ ទោះយ៉ាងណាក៏ដោយ ការស្ទង់មតិបានបង្ហាញយ៉ាងប្រត្យក្សថា បច្ចេកវិជ្ជាឌីជីថលនៅមានកម្រិត និងសម្ភារៈឌីជីថលមិនគ្រប់គ្រាន់ គឺជាឬសគល់នៃបញ្ហា។ ការអង្កេតជាក់ស្តែងបានផ្តល់បរិមាណលទ្ធផលសមស្រប និងចំណុចខ្លះបានបង្ហាញពីទំនាក់ទំនងរវាងគុណភាពនៃការបង្រៀន និងការរៀនក្នុងការស្វែងរកយុទ្ធវិធីទ្រទ្រង់។ សំណួរស្រាវជ្រាវបានទាញចេញពី គោលបំណងស្រាវជ្រាវដែលមានបីប្រភេទគឺ (1)តើការបង្រៀនគណិតវិទ្យានៅសាលាមធ្យមសិក្សាទុតិយភូមិ ក្នុងយុគសម័យឌីជីថល មានតម្រូវការចាំបាច់អ្វីខ្លះ? (2)តើការអនុវត្តការបង្រៀនគណិតវិទ្យា នៅសាលាមធ្យមសិក្សាទុតិយភូមិ ក្នុងយុគសម័យឌីជីថលមានបញ្ហាប្រឈមអ្វីខ្លះ? (3)តើការបង្រៀនគណិតវិទ្យា នៅមធ្យមសិក្សាទុតិយភូមិមានដំណោះស្រាយយ៉ាងដូចម្តេចខ្លះ?។ ការសិក្សាស្រាវជ្រាវនេះ បានប្រព្រឹត្តទៅតាមរយៈការប្រមូលទិន្នន័យបរិមាណវិស័យពីនាយក នាយិកា នាយករង នាយិការង ប្រធានក្រុមបច្ចេកទេសគ្រូបង្រៀនគណិតវិទ្យា និងសានុសិស្ស នៅវិទ្យាល័យតាមរយៈកម្រងសំណួរជាភាសាខ្មែរ ដើម្បីស៊ើបអង្កេតលើការផ្សារភ្ជាប់គ្នារវាងការគ្រប់គ្រង ការបង្រៀន និងការរៀនគណិតវិទ្យាដែល N(គណៈគ្រប់គ្រង, គ្រូបង្រៀនគណិតវិទ្យា, សានុសិស្ស) = N(90, 158, 933)។ លទ្ធផលនៃការវិភាគ

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ទិន្នន័យលើ និង $(\bar{x}_1 = 2.96 , \bar{x}_2 = (2, 36) = 8.534, p < 0.05$ បានបង្ហាញថា កន្សោមក្របខ័ណ្ឌ ទស្សនាទានចំពោះអថេរមិនអាស្រ័យទាំងបីពិតជាមានកម្រិតខុសៗគ្នា និងការបង្រៀនគណិតវិទ្យាមានបញ្ហាប្រឈម ច្រើនជាងដំណោះស្រាយ និងតម្រូវការចាំបាច់មានកម្រិតទាបជាងការស្វែងរកដំណោះស្រាយ ក្នុងន័យនេះ សម្ភារៈបង្រៀន និងទេព្យកោសល្យបង្រៀន គឺជាចំណុចចម្បងក្នុងការលើកកម្ពស់គុណភាពអប់រំពីព្រោះស្ថានភាពមិនល្អ វាមិនទទួលបានជោគជ័យទេដោយសារការគាំទ្រ ឬការអនុវត្តបច្ចេកវិទ្យាព័ត៌មានវិទ្យា សារគមនាគមន៍ និងបច្ចេកវិទ្យានៅមានកម្រិត និងការប្រើយុទ្ធវិធីបង្រៀនបានបង្ហាញពីផលប៉ះពាល់វិជ្ជមាន និងអវិជ្ជមានដែលជាទម្លឹករណ៍សម្រាប់សិក្សាបន្ថែមលើការអនុវត្តវិធីសាស្ត្របង្រៀន។

Abstract

The research showed (1) Necessity, (2) Challenges, and (3) Solutions in teaching mathematics. At the same time, teachers, learners, and stakeholders were encouraged to develop soft skills and hard skills that intervened positively to ensure the quality of education in line with regional and global educational trends to achieve the goal of education for all in the new millennium. However, surveys clearly show that limited digital technology and inadequate digital materials were at the root of the problems. Practical observations provided a fair number of results and some points showed the relationship between the quality of teaching and learning in supportive strategies. The research questions were: (1) What are the requirements for teaching mathematics at the high school in the digital age? (2) What are the challenges of implementation of mathematics teaching at the high school in the digital age? (3) What are the solutions for teaching mathematics at the high school? The research methods through quantitative data were collected from principals, deputy principals, deputy directors, technical team leaders, mathematics teachers, and high school students through questionnaires in Khmer language to investigate the link between teaching management and mathematics learning where N (principals, teachers, students) = N (90,158,933). The results of the analysis on $(\bar{x}_1 = 2.96 , \bar{x}_2 = 3.26 , \bar{x}_3 = 3.32)$ and F(2 , 36) = 8.534, p < 0.05 showed that the conceptual framework expressions for the three independent variables were quite different and teaching mathematics was challenging more than solutions and needs which were lower than finding solutions. In this sense, teaching materials and teaching talent were the main keys to improving the quality of education while the situation was not good; it was unsuccessful because the support or implementation of information and communication technology and technology was still limited and the use of teaching strategies showed positive and negative effects as arguments for further study on the application of teaching methods.

1. Introduction

Mathematics plays an important role in daily life as a base for both science and society (Cahyono and Ludwig, 2019). Mathematical teaching skills combined with 21st century technology and skills were developed in the educational field in Cambodia and Human resources in mathematics is an important force for the successful development of the society in line with the main goals of socio-economic development (IST, 2019). This means that training young people to become full citizens with knowledge, skills, behavior and fitness was the duty of the Ministry of Education, Youth and Sport (MoEYS) and citizens' duty to improve the education sector in line with the reform policy and strategies to achieve the goal of developing a country and to ensure the improvement of the quality of education which is a common trend of countries in the world (MoEYS, 2014). The MoEYS has developed two medium-term education policies: (1) To ensure quality education with equity and environment to promote lifelong learning opportunities for all, and; (2) To ensure quality. The right to be a leader and manager of education officials at all levels (Hangchuon, 2023).

The teaching methods in Cambodia had been changed and used in an approved manner according to the goals, tasks, and content of teaching following science's social, political, and developmental conditions such as between 1863 and 1963, teaching methods adopted biblical and abstract study habits (Chan, 1997). After 1979, the use of teaching methods based on science and technology, but in recent years, many teaching methods had jumped into the Cambodian education system, which curriculum regulations had shifted the perspective of pedagogical concepts and methods from teaching to learning taking learning activities from the transfer of wisdom to self-development and skill development students' ability to love lifelong learning and ensure quality education for all and the above progress towards the quality of education and make life better by increasing the integration of the curriculum into daily life, so the Ministry of Education, Youth and Sports has improved the curriculum to meet the needs of the labor market, the interests of academics, scientists and investors. The new curriculum is based on the 2015 general education and technical education curriculum framework, which requires the improvement of content and curriculum, as well as providing students with the option to choose a subject that they are capable of and enjoy. Students can choose from a science or social science course or a technical education from 10th to 12th grade (MoEYS, 2018).

The Industrial Revolution 4.0 changed educational patterns focused on knowledge production and innovation programs. One of the key elements that must be considered in boosting the country's economic growth and competitiveness in the Industrial Revolution 4.0 period was the design of innovative education systems and the enhancement of teaching and learning skills and innovation and the global competition of the

21st century, the quality of education must continue to improve (Wahyuddin et al., 2022). To improve students' ability to graduate upper secondary school in the digital age, the form of teaching mathematics was necessary to (1) Study the needs; (2) Understand the challenges, and; (3) Have problem-solving skills. To achieve these three factors, the learners must be interactive. Inspiration, fun, competition, encouraging students to participate actively and providing opportunities for initiative, creativity, and independence in line with students' talents, interests, and physical and mental development, and a learning model applied to achieving student achievement was collaborative learning. Moreover, active learning was any teaching method that engaged the student in the learning process (Gokce, 2020). Efforts to understand what teachers do and improve their teaching and expertise had increased interest in exploring and examining different activities, processes, and the nature of differing collaborations through which mathematics teachers work and learn (Robutti et al., 2016).

Collaborative learning refers to a teaching method in which students at various levels of ability work together in small groups toward common goals (Wahyuddin et al., 2022). This process included how teachers interacted with students regarding the information to be taught and the assessment criteria and how students interact with teachers and with other students in which classroom communication takes the form of writing and presentation. Mathematical programs such as GeoGebra helped teachers and students understand formulas, apply logical thinking, and innovate in the context of developing or applying science and technology that are applied systematically and lead to goals. One was to make inferences and make the right decisions to solve problems by the content. Recently, the prevalent nature of dynamic content on the web has inspired mathematics educators to experiment with GeoGebra (Pocsova et al., 2021). GeoGebra was created to help students gain a better understanding of mathematics. Students can manipulate variables easily by simply by dragging "free" objects around the plane of the drawing, or by using sliders. Students can generate changes by manipulating techniques of the free objects, and then they can learn how the dependent objects will be affected. In this way, students have the opportunity to solve problems by investigating mathematical relations dynamically (Dikovic, 2009).The important argument in mathematics education and active learning was the process of providing experiences, coupled with ideas and motivations when teaching mathematics and concepts, exploring in detail the teaching methods to increase understanding of the process of mathematics, thus teachers need to acquire knowledge, skills, attitudes and habits in order to adapt to technology, to understand technology, and to take advantage of opportunities offered by technology. All that was involved at the high school level was pedagogical and technological training. Students have 12 years or more of mathematics problem-solving experience and active learning in math combined with theory brings math problem-solving skills (Horzum & Unlu, 2017).

The main purpose of this study was to look at learning the essentials of teaching mathematics in upper secondary school (grades 10–12) in the digital age, analyze the challenges of implementing mathematics teaching in high schools in Cambodia, and explore appropriate solutions to improve the quality of mathematics teaching in high school in Cambodia for answering the three research questions: (1) What are the requirements for teaching mathematics in high school in the digital age? (2) What are the challenges with the implementation of mathematics teaching in high school in the digital age? and (3) What are the solutions for teaching mathematics in high school?

1.1 Re-visiting Mathematics Education in Cambodia

The history of contemporary mathematical education is the history of a struggle against computers and information technologies. As a result, specially selected simplified math problems are used while teaching. Just as it was a hundred years ago, contemporary students are forced to memorize a lot of rules and theorems in order to solve math problems. But we know that today they can get the same results using simple computer calculations (Ochkov & Bogomolova, 2015).

This study was built within a theoretical framework informed by constructivist theory in education of the math trail program and the use of digital technology to support the program (Cahyono and Ludwig, 2019). Following the increased proliferation of technologies in schools, research shows a mismatch between technology availability, access, frequency of technology uses and the quality of instruction using information and communications technologies (ICT). Successful integration of ICT in schools will depend on the deeply held beliefs and cultures of practice within schools that may lead to systematic ICT integration in instruction (Kiru, 2018). For the use of computer technology at school, it was important to have the necessary equipment. The use of ICT should not reveal the power of the computer, but the power of the student. Therefore, the atmosphere created by the teacher in the classroom contributes to the development of students' creativity along the curriculum of the subject of mathematics for high school social sciences for high-frequency understanding that teachers used information technology and (ICT) in teaching mathematics was information that was important to help teachers using ICT in teaching mathematics and students' learning experiences with ICT. In addition, efforts to understand how teachers used ICT were needed to investigate the various factors that

may influence the use of ICT in mathematical content to examine the solution factors contributing to improving the use of ICT by mathematics teachers. A clearer and deeper understanding of how to teach mathematics to students that combined with effective practice in teaching mathematics electronically had improved the study of mathematics and secondary mathematics teachers' previous training in digital teaching tool and their level of digital teaching competence (Muniz et al., 2021). Constructive theory stated that learners develop their knowledge in the learning process by associating new information with previous knowledge rather than merely perceiving it or accepting the information gained transfer from others (Kurbonov and Istamova, 2021).

Although the process of an individual based on individual perceptions and reflections to learners need other people to create interactive topics to strengthen their experiences because of the different cultures and environments around them. This perspective underscores the importance of collaboration between teachers and students. Therefore, it was necessary to organize the learning environment (students' learning and teachers teaching activities were active or inactive that focus on four indicators: (1) Equipment in line with the curriculum, (2) Organize the development of physical equipment according to plan; (3) Plan the budget for repairing school infrastructure and (4) Inspect equipment to ensure Student safety) properly between students and teachers in the classroom to increase the development of students' awareness. In this sense, teachers played an important role in providing support to students for building knowledge by organizing learning activities and providing basic knowledge that could facilitate the cognitive process because this means of support was a steppingstone to help learners reach specific areas of fitness skills between the level of actual development and the level of potential development (Cahyono and Ludwig, 2019). Support for this mathematical learning process was provided by the teacher by providing predictive math assignments and guidance for students to recreate problems in such interactions. The teacher's mathematics teaching strategy was developed in the activities of interpretation and analysis to expand the students' ideas on mathematical calculations in two stages: (1) The transformation of matter from the reality of the problem into matter mathematics and (2) Operational processes in mathematical systems (Gabriele, 2016).

The excellence of mathematical education is defined in eight aspects: (1) Prepared lesson plans correctly according to clear principles and activities according to the lesson. In preparing the lesson plan the teacher must follow five steps including administration, reminders, old lessons, teaching new lessons, strengthening knowledge, and assigning tasks to students or guiding students to self-study lessons, (2) Providing various experiences so that students can explore and learn on their own. The teacher was just a guide for the students to learn math and a facilitator when the students faced complex problems, avoiding the transfer of knowledge to the students (3) Organized lessons to communicate, and remind up and down. Assess and fill students' true shortcomings. The teacher uses inspirational questions to ask the students and then selects the answers from the students (4) Linking theoretical knowledge to practice (5) Paid attention to integrate moral progress in teaching and learning activities (6) Acted in accordance with the living conditions of students around the context of Khmer cultural life and the realities of daily life (7) Choose simple local materials that are practical or innovative in teaching mathematics and (8) Trained students to solve practical problems so that students can remember all the important content of the lesson for a long time. Therefore the potential of studying mathematics well through educational activities was the activity of preparing lesson plans in accordance with the detailed curriculum of mathematics and the context of each region in Cambodia (MoEYS, 2018).

The process of calculating mathematical exercise could gain experience from the students around them and not only in the textbook but also mathematics outside in order for students to be able to build their mathematics talents, the mathematics teacher was required to develop the students' creativity in the learning that is done because it is necessary to develop a learning model to develop students' creativity in an open problem-solving (Ketut, 2017). The mathematical teacher solved some of the mathematics assignments related to those issues, and then the students learned about mathematics through various media. Strengthening teaching methods in schools took advantage of the sources of information included in the mathematical curriculum that mapped out teaching and learning, although mathematics teaching methods were familiar. Technology-supported non-formal education programs seem to be new due to the advances in technology and the use of mobile phones in recent years, which have significantly improved as they take advantage of new developments in mobile technology (Rohid et al., 2019). A review of the use of the Internet in math instruction conducted in recent years to determine how it evolved and the three identities that new methods are being developed by educators Mathematics is (1) The principles of design and Innovation (2) Social interaction and knowledge and (3) Tools and resources (Engelbrecht et al., 2020).

These notions reflected the differences in perspectives developed over the last decade within these three limits, providing evidence of advances in theoretical frameworks and support in the development of new approaches to construction. Older tools such as teaching and learning resources have leveraged digital technology to create new ways to solve math problems with math teachers w new initiatives to train and develop problem-solving skills.

New ideas and innovations are needed in a globalized world to develop a society that requires teachers to guide students in innovating and developing new ideas in the evolution of education to achieve permanent learning and ensure that learning interactions change where innovation is sensitive to issues that provide opportunities for teachers and students to develop problem-solving skills and have sufficient time to build high-quality products (Gabriele, 2016). In a constructivist setting in mathematics and science are viewed as systems with models that describe how it was. Although this process is individualistic (based on individual perceptions and reflections), but learner needs other people to create intersubjectivity so that his/her experiential world becomes stronger (Bimbola and Daniel, 2010). Students' abilities in mathematics include: (1) Can interpret and recognize situations in various contexts that require nothing more than direct conclusions (2) Can download information from a single source and use any formula or theory to illustrate it (3) Can practice operations, formulas, procedures, or theories to solve problems involving positive integers and (4) Have the ability to interpret simple results (MoEYS, 2022).

Programming is the process related to the development and implementation of instructions for computer programs so the computer can perform specific tasks, solve problems and support human interactions because these processes have been linked to mathematical thinking, several European countries have claimed that since programming is related to the development of algorithmic thinking, it is an important skill for the digital society and the 21st-century skills of problem-solving, creativity and logical thinking (Forsstrom and Kaufmann, 2018). Students and teachers need to cooperate in using this learning model. For example, a teacher explains several steps to solve the problem, teacher also provides the best strategy to complete the assignment and create a flexible atmosphere where students can study at ease (Cahyani and Irwan, 2020).

However, mathematics lessons need to be enriched with teaching aids like concrete materials, pictures, demonstrations etc. to help students' comprehension. Regrettably, such are usually not available due to teacher's convenience or lack of interest to provide such environment. Higher order thinking skills basically means thinking that occurred at the higher-level in a cognitive process. According to taxonomy Bloom which has revised thinking ability in the cognitive domain was divided into six levels, they are knowledge, understanding, application, analysis, synthesis and evaluation (Hikmah and Amin, 2018). In addition, time is not often available for the use of teaching and learning materials in the mathematics classroom (Gabina et al., 2021). Digital learning environments enable learners to gain numerous cognitive competencies and capacities, and digital literacy helps students develop critical skills for engaging with, consuming, and producing digital media. Facilitating students to work with digital tools in technology-rich environments prepares them to live in a world of digital transformation, one that is continuously changing how people work, communicate, play, and experience their daily lives. In the digital storytelling setting, students are bowth the users and consumers of digital media (Niemi et al., 2018).

2. Study Areas and Methodology

This is qualitative research collected primary data for analysis to respond to research questions that require the provision of information about the scope of use of mathematical teaching methods by mathematics teachers at public secondary schools to gain a clear understanding of how they have used teaching methods in the digital age. The research contributed to the improvement and implementation in the classroom, and the research process was described in terms of planning, implementation, observation, and reflection cycles. Classroom implementation and improvement is a repetitive process in the cycle of teaching and learning, forming a circle and each cycle for observing what has happened, evaluating, and reflecting on it, how to conclude from observation and review of their plans and teaching and learning cycles that allowed researchers to evaluate classroom performance for educational improvement. The research includes collecting and analyzing data for surveys with accurate response scales and driving data analysis to be smoother in formulation. Understand detailed teaching and learning or curriculum and create timely benefits to drive the implementation of revised action plans in the next teaching and learning cycle. This study used two variables: (1) Variable dependent was given by y = teaching mathematics at high school in the digital age, and; (2) Variables independent was given by x_1 = needs, x_2 = challenges and x_3 = solutions.

The problem of teaching and learning mathematics at upper secondary schools in the digital age was a need for teaching mathematics in high school, challenges with the implementation of mathematics teaching in high school and solutions in teaching mathematics in high school. Analysis and interpretation strategies to reflect the application of quantitative research methods. In the first phase of the study, upper secondary high schools were surveyed in five provinces with one pilot upper secondary high school surveying participants' perceptions and the importance of executive research in their teaching careers. The survey was conducted in the early stages of the study which there were five scale elements in the form of a questionnaire in which respondents were asked to select the number of each level of questionnaire designed to understand. The respondents looked at the role and process of performance in the context of

Table 1: Class of categories.

Items	*Categories*
Items 1	Designing the necessary knowledge and skills of information technology, communication and technology to use in the teaching profession essential for teaching mathematics in the digital age had six elements for teaching and eight elements for managers.
Items 2	Designing the challenges of using mathematics teaching materials and using mathematics teaching skills in the digital age had 10 elements and the challenges for teaching mathematics in the digital age had 13 elements and 10 other elements for the managers.
Items 3	Designing solutions to be able to use mathematics teaching materials and teaching skills in the digital age as a priority with 10 elements and problem-solving related to teaching mathematics in the digital age with 9 elements and 10 other elements for the managers.
Items 4	Designing the attitudes, knowledge, classroom management and professional consciousness of mathematics teachers in the digital age as a priority were 5 elements and a mathematical instructional content with 10 elements.

Table 2: Sample size of principals, teachers and students.

Study areas	*Principals*		*Teachers*		*Students*		*Total*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Takeo	23	2	35	8	140	155	198	165
Banteay Meanchey	23	2	36	12	135	113	194	127
Kampong Cham	18	3	37	8	99	97	154	108
Kampot	17	2	16	6	69	125	102	133
Total	81	9	124	34	443	490	648	533

educational development in Cambodia and some of the factors that may contribute to improving or hindering three priority activities: (1) The support from school managers; (2) Mathematics teachers used the teaching methods, and; (3) Students' mathematics study (Table 1).

The survey listed the competencies and skills of using five teaching methods that were emphasized in the sequence of the study which respondents were asked to demonstrate proficient abilities in applying each skill in their practice. The response scale consists of five optional answers that range from minimal to very large and were defined by the numbers [1 = very little, 2 = little, 3 = average, 4 = many and 5 = so many] which in the primary section gathers information about gender, place of work, place of study, diploma, pedagogy training and work experience (Bhattacherjee, 2012). As a pilot study, this study was conducted in Kampong Speu province. The argument of credibility for the content scale was validated by pilot questionnaires with the school managers and mathematics teachers in Kampong Speu High School.

Based on the education potential of each province, We randomly selected the sample size in four provinces in the 2021-2022 school year to complete the survey questionnaires that divided into three groups are (1) There were 90 school managers; (2) There were 158 Mathematics teachers, and; (3) There were 933 students as shown in Table 2. The sample size of four provinces with 30 upper secondary schools in Takeo, Banteay Meanchey, Kampong Cham, and Kampot as shown in Table 2.

Data was a scale for evaluating the quality of research and a mirror for reflecting on interviews and observations without the natural structure of the participants in terms of investigating how they performed teaching in their classrooms at this stage the study was more than four months starting on May 16, 2022, until October 4, 2022. It was an important part of intentional classroom observation that was useful for this study, especially for trying to incorporate specific interactions of events and samples into a digital age and the observations accompanied by a sample of the three participants and focus on the group interviews of the participants. In this phase of the study, the structure of formal and informal interviews was opened on participants that were conducted during the data collection process.

All data obtained from the questionnaires were quantitatively analyzed by coding each variable and entering them into the IBM SPSS 25 for Windows 2016 program to analyze the relationship between each factor. This analysis was performed using various programs such as factor analysis and one-way ANOVA to find the value descriptive data between each variable, significant difference level and the frequency of response of the sample. The analyzed data are displayed through various graphs using MS Excel. The design to compare responses to individual items and the mean and standard deviation values of the respondents appropriated to be considered details of the scope of the research work to increase confidence in the quality of research that was spent with class participants and consistently observed to learn more about classroom culture and accelerates complex

Table 3: Students' perception on classroom management and professional consciousness.

Item	*Questionnaires*	*Mean*	*Standard deviation*
1	He gives a fair score	4.51	0.694
2	He is a firm teacher and thorough in teaching	4.48	0.667
3	I believe in his ability	4.46	0668
4	He was a good teacher, friendly and had a good communication	4.15	0.746
5	Teacher gives students enough opportunity to think a lot	4.13	0.766

Table 4: Students' perception on teaching mathematics lesson.

Item	*Questionnaires*	*Mean*	*Standard deviation*
1	Students understand many new lesson content through the teacher	4.07	0.785
2	Teacher always gives homework and extra research for students every day	3.99	0.927
3	Teacher's teaching is easy to understand	3.97	0.768
4	Classrooms are well disciplined, not messy, easy to learn	3.86	0.814
5	Teacher links lesson content to daily life	3.42	1.015
6	Teacher always has teaching materials as an aid	3.40	1.019
7	Teacher divides the students into partners or groups for discussion	2.87	1.144
8	Teacher teaches math by online (Telegram, Zoom, google meet) is attractive	2.73	1.079
9	Teacher uses ICT to teach math	2.56	1.078
10	Teacher shows how to use software (Geogebra) to solve math problems	2.53	1.194

Table 5: Perception of principal on needs of knowledge level and skills about ICT.

Item	*Questionnaires*	*Mean*	*Standard deviation*
1	Encourage to research math through new websites	3.73	0.946
2	Help solve problems related to teaching math	3.56	0.863
3	Identify websites with online materials for teaching math	3.53	0.810
4	Introduce new technologies to teach math	3.38	0.758
5	Define new technologies for teaching math	3.34	0.781
6	Introduce ICT that can be used to better understand mathematical content	3.32	0.872
7	Identify technologies that can be used to show difficult content in math	3.26	0.758
8	Select ICT which use in math	3.23	0.912

operations in the use of data sets in the primary data analysis process.

3. Result and Findings

The study identified specific procedures for challenges, solutions and requirements for teaching methods and learning for developing competencies and thinking skills toward students' principals and teachers in the activities of teaching and learning mathematics. The findings and results of this research are illustrated as the perception of students, principals and teachers.

Table 3 showed that high school teachers not only teach rigorously but they always give a fair and unbiased score (M = 4.51, SD = 0.694) in any short test or exam. Monthly as well as semester exams which was a testament to the fact that high school teachers really had a professional ethics as teachers. In addition, the strengthening of classroom discipline, the provision of research or homework assignments and the provision of sufficient time for students to think about solving or exploring the new rules of the lesson during the study period as shown in the Table 2 reflected on optimism and students' preferences and beliefs in the abilities with talents of their teachers.

Table 4 showed that despite the high school teachers had clear the pedagogy and professional ethics, the teaching of mathematics in his digital age was still limited. In fact, students' data showed that the use of technology for solving mathematics sproblems as well as how to engage students in online learning was still low. This proved that teachers at upper secondary school really need more development their skills in using these technologies.

From Table 5, the high school managers identified some issues and requirements for learning and teaching mathematics in the digital age in each high school. Given the need for knowledge and skills in information technology and communication, management has indicated that a large number of mathematics teachers need to be encouraged to research on mathematics websites, guidance in the use of new technologies and Selection of ICT programs to be used in teaching mathematics.

From Table 6, the teaching and learning of mathematics in each high school, especially, in rural high schools faced the problem of skills of using technology and methods of teaching mathematics in this digital age. As a testimony, the managers showed that his school was facing challenges in attracting students to participate in learning activities, lack of electronic devices that serve learning and teaching. Especially problems with the Internet (for schools in Rural) which is a factor that causes the training gap to be large and limited.

From Table 7, in order to solve the challenges and make the process of teaching and learning mathematics positive in the era of industry 4.0, each high school board expressed the concept that (1) Teachers should have electronic devices that serve adequate teaching at least one good smartphone as well as good internet service on campus (2) Appropriate teaching methods and use of various technologies to attract students to participate in learning activities.

Fig. 1 stood for a mean and standard deviation of the response to the need for knowledge and skills in information technology, communication, and technology for use in the teaching profession.

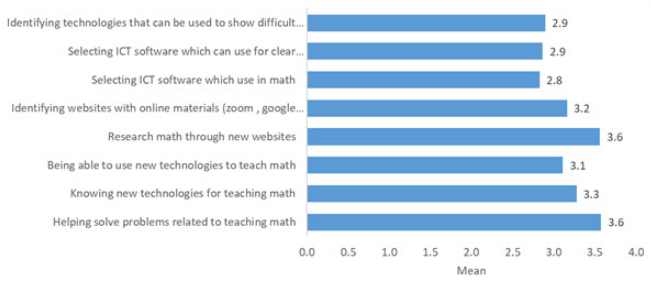

Fig. 1: Teacher perception on the need for the teaching profession.

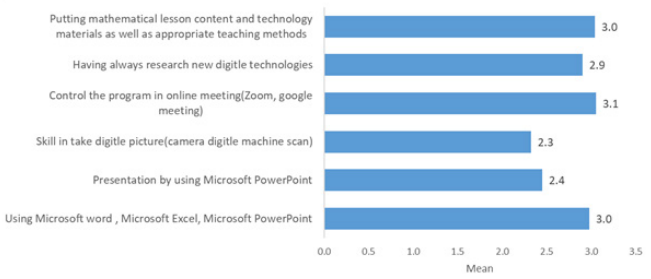

Fig. 2: Teacher perception on the need for teaching mathematics in the digital age.

Table 6: Perception of principal on challenges in the use of teaching materials and teaching skills on Mathematics.

Item	*Questionnaires*	*Mean*	*Standard deviation*
1	collaborative method	3.29	0.824
2	smartphone	3.29	1.008
3	bloom method	3.27	0.859
4	problem-solving method	3.20	0.864
5	wifi	3.19	1.111
6	concept map method	3.09	0.856
7	computer	3.08	0.963
8	IBL method	3.07	0.790
9	LCD projector	2.96	1.226
10	e-library	2.88	1.160

Table 7: Perception of principal on solutions for teaching materials and teaching skills in Mathematics.

Item	*Questionnaires*	*Mean*	*Standard deviation*
1	Smartphone	3.92	0.810
2	Wifi	3.73	1.068
3	Collaborative method	3.71	0.877
4	Computer	3.70	1.054
5	Bloom method	3.69	0.843
6	Problem-solving method	3.67	0.807
7	IBL method	3.58	0.834
8	Concept map method	3.47	0.837
9	E-library	3.29	1.019
10	LCD projector	3.27	1.089

In accordance with the results asserted in Fig. 1, all most teachers highlighted the need for knowledge levels for use in the mathematics teaching profession, which is important in the digital age, focused on helping to solve problems related to teaching mathematics and the average focused on setting up websites with online material (zoom, google meet) for teaching math. The average demand for ICT skills focused on the availability of new technologies in teaching mathematics and the low demand focused on the selection of ICT programs to be used in mathematics. However, there were still barriers to the use of new technologies to teach mathematics and select ICT software to be used in mathematics.

Fig. 2 stands for the mean and standard deviations of teacher's requirements needed to teach mathematics in the digital age

In accordance with the results asserted in Fig. 2, a considerable number of teachers highlight the practical needs of teachers in relation to teaching mathematics in the digital age, focusing on program management for online meetings (Zoom, google meeting) and less

Table 8: Teacher perception on factor loadings for need.

Questionnaires	*Factor 1*	*Factor 2*
A1.1 Help solve problems related to teaching mathematics	0.567	
A1.2 Get acquainted new techniques in teaching mathematics	0.761	
A1.3 Can use new technologies to teach mathematics	0.811	
A1.4 Research mathematics on the new websites	0.674	
A1.5 Define websites with online materials (zoom, Google Meet) for teaching math	0.724	
A1.6 Select ICT software to be used in mathematics	0.794	
A1.7 Select ICT software that can be used to better understand mathematical content	0.724	
A1.8 Identifies technologies that can be used to present difficult content in mathematics	0.699	
A 2.1 Using Microsoft word, Microsoft Excel, Microsoft PowerPoint		0.699
A 2.2 Presentation using Microsoft PowerPoint		0.777
A 2.3 Digital Photography Skills (Digital Cameras and Scanners)		0.829
A 2.4 Program management for online meetings (Zoom, google meeting)		0.727
A 2.5 Always learn about the new digital technologies		0.722
A 2.6 Incorporating mathematical lesson content and technology materials as well as appropriate teaching methods		0.617

on digital imaging skills such as digital cameras and scanners. The high average need for ICT skills focused on the integration of mathematical lesson content and technology materials, as well as appropriate teaching methods and minimal presentation using Microsoft PowerPoint. In particular, the study also showed that despite the high school teachers trying to learn about the new digital technologies and digital photography skills (Digital Cameras and Scanners) were not yet complete enough to teach mathematics.

In order to verify the validity of a factor analysis on our data, a Kaiser–Meyer–Olkin (KMO) test and Bartlett's test were conducted to verify the suitable dataset for the factor analysis. Both tests are used to measure the sampling adequacy and to determine the factorability of the correlation matrix. Bartlett test results was 1447.501, p <0.001 and KMO test was 0.903 showed that factor analysis was applicable for these data. Based on the Eigenvalue > 1 in Scree Plot hence we got the two factors as shown in the Table 8, where only loading greater than 0.4 were shown.

Factor 1 (F1) is correlated almost all strong with participation can use new technologies to teach mathematics (0.811, A1.3), participation select ICT software to be used in mathematics (0.794, A1.6), participation get acquainted new techniques in teaching mathematics (0.761, A1.2), participation define websites with online materials (zoom, google meet) for teaching math (0.724, A1.5), participation define websites with online materials (zoom, google meet) for teaching math (0.724, A1.5), participation select ICT software that can be used to better understand mathematical content (0.724, A1.7), participation select ICT software that can be used to better understand mathematical content (0.724, A1.7), participation identifies technologies that can be used to present difficult content in mathematics (0.699, A1.8), participation research mathematics on the new websites (0.674, A1.4) and participation help solve problems related to teaching mathematics (0.567, A1.1). Factor 2 (F2) was correlated almost all strongly with participation in digital photography skills (Digital Cameras and Scanners) (0.829, A 2.3), participation in presentation using Microsoft PowerPoint (0.777, A 2.2), participation in program management for online meetings (Zoom, google meeting) (0.727, A 2.4), participation always learn about the new digital technologies (0.722, A 2.5), participation using Microsoft word , Microsoft Excel, Microsoft PowerPoint (0.699, A 2.1) and participation incorporating mathematical lesson content and technology materials as well as appropriate teaching methods (0.617, A 2.6).

The exploratory factor analysis confirmed that all questionnaires in Table 3 followed the two key concepts for standing to the need for knowledge and skills in information technology, communication, and technology for teaching mathematics in the digital age.

F(1): Knowledge and skills about information technology communication and technology(KSCT).

F(2): Needs related to teaching mathematics in the digital age(NRTA).

The results of the study on the need of teaching mathematics in high school in the digital age had two factors include: (KSCT) and (NRTA) were consistent with the results of a study by Muniz, L.J.R et al. (2021) showing that Technological pedagogical content knowledge (TPCK) requires an understanding of the representation of subject-matter concepts that use ICT, pedagogical techniques that use ICT to constructively teach disciplinary contents, knowledge of what makes specific subject-matter concepts are difficult or easy to

learn and how ICT can help to address these problems, knowledge of students' prior subject-matter knowledge and theories of epistemology, and knowledge of how technologies build on existing subject matter knowledge to develop new learning or strengthen the old one. In summary, the TPCK adds the dimension of literacy across disciplines of digital literacy to the Technological pedagogical knowledge (TPK). In this research study, TPCK refers to the specific applications of technology for the teaching and learning of mathematics. As well as Technological knowledge and TPK, this knowledge domain requires teachers to keep up to date with technology advances. A study by Muniz, L.J.R et al. (2021) showed that mathematics teachers recognized the need to be trained within the specific curriculum for teaching mathematics and mathematics teachers had received prior training in specific software for teaching mathematics (GeoGebra, Wiris, etc.) and they needed more training in these tools, as in the following case:

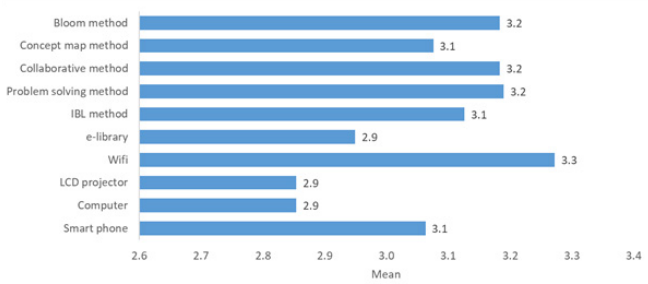

Fig. 3: Teacher perception of challenge in teaching skills in the digital age.

Case: Equation $a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0 = 0$ where $a_n, a_{n-1}, \ldots, a_1, a_0 \in R$, $n \in N$ and $a_n \neq 0$ that will need use a program such as Microsoft Excel to solve it when $n \geq 5$.

Fig. 3 stands for the mean and standard deviations of responses to challenges in the use of mathematics teaching materials and teaching skills in the digital age. In accordance with the results asserted in Fig. 3, most

Table 9: Teacher perception on factor loadings for challenge.

Questionnaires	*Factor 1*	*Factor 2*	*Factor 3*	*Factor 4*	*Factor 5*	*Factor 6*
B1.1 Smartphone					0.699	
B1.2 Computer				0626	0.517	
B1.3 LCD projector				0.636		
B1.4 wifi				0.704		
B1.5 E-library				0.592		
B1.6 IBL Method		0.718				
B1.7 Problem-solving methods		0.851				
B1.8 Collaboration method		0.839				
B1.9 Concept map method		0.788				
B1.10 Bloom method		0.616				
B2.1 Problems in using electricity						0.744
B2.2 Poor internet service or weak wifi			0.578			
B2.3 Lack of ICT devices such as smartphones, computers			0.680			
B2.4 Lack of television and radio			0.753			
B2.5 Use of zoom for a limited time			0.624			
B2.6 Lack of mathematics textbooks					0.611	
B2.7 Online mathematics teaching is not up to need			0.507			
B2.8 Online math instruction makes students lose interest in the content of the lesson.	0.831					
B2.9 Solving mathematics problems in online classes is hard to understand	0.761					
B2.10 Teachers do not yet know how to design online mathematics classes to be attractive	0.772					
B2.11 Teachers use (Telegram, Zoom, google meet) to get students involved in online math classes						
B2.12 Teachers do not like to teach math classes online when students are not interacting	0.708					
B2.13 Lacks experts in additional training on the use of technology tools	0.611					

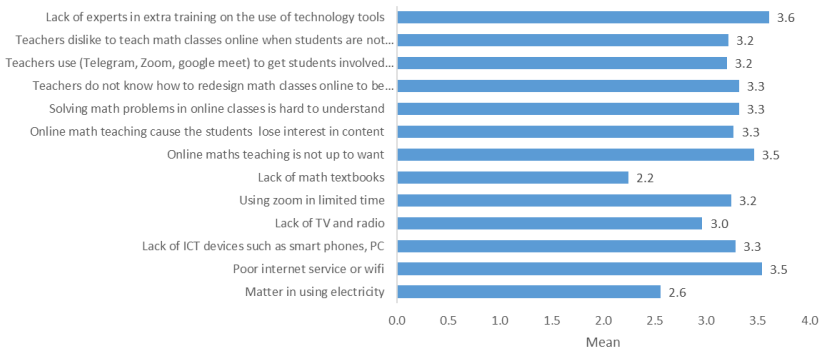

Fig. 4: Teacher perception on challenge in teaching mathematics in the digital age.

teachers pointed out the challenges of using math instructional materials in the digital age, focusing on wifi, smartphones, computers and LCD projectors. Mathematical teaching skills in the digital age focus on problem-solving teaching methods and collaborative teaching methods and bloom teaching methods and the low-level medium focuses on concept mapping teaching methods.

Fig. 4 stands for the mean and standard deviations of teacher challenges related to teaching mathematics in the digital age.

Accordance to the results asserted in Fig. 4, most of the teachers pointed out the challenges of using tools related to teaching mathematics in the digital age that focused on weak internet or wifi, lack of math textbooks, television and radio. Most of them showed the skills related to the digital age focused on the lack of additional training in the use of technology tools in teaching mathematics and A minority of them focused on level of using Telegram, Zoom and Google Meet to get students involved in online math classes.

In order to verify the validity of a factor analysis on our data, a Kaiser–Meyer–Olkin (KMO) test and Bartlett's test were conducted to verify the suitable dataset for the factor analysis. Both tests are used to measure the sampling adequacy and to determine the factorability of the correlation matrix. Bartlett test results was 1444.317, $p < 0.001$ and KMO test was 0.756 showed that factor analysis was applicable for these data. Based on the Eigenvalue >1 in Scree Plot hence we got the six factors as shown in the Table 9, where only loading greater than 0.4 were shown.

Factor 1 (F1) is correlated almost strongly with participation in (0.831, B2.8), (0.772, B2.10), (0.761, B2.9), (0.708, B2.12) and (0.611, B2.13). Factor 2 (F2) is correlated almost strongly with participation in (0.851, B1.7), (0.839, B1.8), (0.788, B1.9), (0.718, B1.6) and (0.616, B1.10). Factor 3 (F3) is correlated with almost all mediums with participation in (0.753, B2.4), (0.680, B2.3), (0.624, B2.5), (0.578, B2.2) and (0.507, B2.7). Factor 4 (F4) is correlated with almost all mediums with participation in (0.704, B1.4), (0.636, B1.3), (0.626, B1.2) and (0.592, B1.5). Factor 5 (F5) is correlated with all media with participation in (0.699, B1.1), (0.611, B2.6) and (0.517, B1.2) and Factor 6 (F6) is correlated strongly with participation in (0.744, B2.1).

The exploratory factor analysis confirmed that all questionnaires in Table 4 followed the six key concepts for standing to the challenges in the use of mathematics teaching materials and teaching skills in the digital age.

F(1): Online mathematics instruction and the use of technology tools (OMIT)

F(2): Methodology of teaching(MT)

F(3): Teaching tools and quality of online math teaching(TQMT)

F(4): wifi and E-library (WEL)

F(5): Teaching materials (TM)

F(6): Electricity consumption (EC).

The results of this study on the challenges of teaching mathematics in upper secondary high school in the digital age showed that teaching mathematics had factors including, (OMIT), (MT) and (TQMT) was consistent with the results of the study MoEYS (2022) said that improving the quality of teaching requires strengthening teachers qualifications and implementing teacher training programs through regulatory studying and focusing on the development of students' abilities and the implementation of common teaching methods to motivate students learn on your own and highly thoughtful. The quality of teachers is the important factor that motivates students to have high ability, knowledge, skills and attitudes that could respond to the national, regional and international labor market. Based on research results it was found that a small of problems were related to (WEL), (TM) and (EC). On the other hand, negative views regarding classroom teaching practices indicate that differences between teachers have emerged regarding the understanding of teaching methods hence improving teaching skills is an obstacle in developing mathematics teaching skills. The development of mathematics teaching skills were driven through several important steps involved in the teaching process such as the development and high creativity of

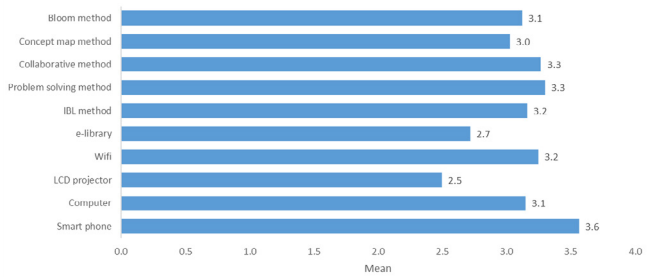

Fig. 5: Teacher perception on Solution for teaching skills that can be used in the digital age as a priority.

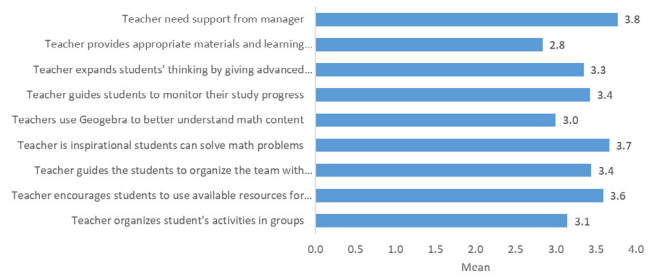

Fig. 6: Teacher perception on solution in relation to the teaching of mathematics in the digital age.

teachers through the process of thinking critically in a specific teaching situation in any lesson but teaching students to simply follow such as replacing numbers with numbers were not an adequate teaching strategy for improving the quality of teaching and learning, so the use of collaborative teaching methods was appropriate such as sign study of the following functions:

Function *f* determined by $f(x) = e^x \ln x$ then $f'(x) = e^x\left(\ln x + \frac{1}{x}\right)$. To study the signs of $f'(x)$ the teacher should introduce the way of studying the signs of $f'(x)$ by explain that $e^x > 0, \forall x \in D_f$ and letting function $g(x) = \ln x + \frac{1}{x}$ then $g'(x) = \frac{x-1}{x^2}$.

Fig. 5 stood for the mean and standard deviations of responses on mathematics teaching materials and mathematical teaching skills that can be used in the digital age as a priority.

Accordance to the results asserted in Fig. 5, most of the teachers presented solutions on mathematical teaching materials that could be used in the digital age with a focus on smartphones and wifi and a few of them showed about E -library and LCD Projector. Mathematical teaching skills that can be used in the digital age were mostly of focused on problem-solving method and collaborative methods little of them focused on inquiry-based learning methods and the bloom method and a few of them emphasize on concept map teaching method.

Fig. 6 stands for mean and standard deviations of perceptions of teachers' solutions in relation to the teaching of mathematics in the digital age.

In accordance with the results asserted in Fig. 6, most of the teachers presented good solutions related to teaching mathematics in the digital age, focused on teachers having the support of management and teachers deepening their students' thinking with advanced homework and a little of them focused on teachers providing appropriate learning materials and resources. The use of teaching-related materials in the average digital age has focused on teachers using Geogebra to better understand mathematical content.

In order to verify the validity of a factor analysis on our data, a Kaiser-Meyer-Olkin (KMO) test and Bartlett's test were conducted to verify the suitable dataset for the factor analysis. Both tests are used to measure the sampling adequacy and to determine the factorability of the correlation matrix. Bartlett's test results was 1169.865, $p < 0.001$ and KMO test was 0.828 showing that factor analysis was applicable for these data. Based on the Eigenvalue > 1 in Scree Plot hence we got the five factors as shown in the Table 10:

Factor 1 (F1) is correlated almost strongly with participation in (0.784, C1.9), (0.778, C1.8), (0.775, C1.7), (0.674, C1.6) and (0.633, C1.10). Factor 2 (F2) is correlated almost strongly with participation in (0.848, C1.3), (0.769, C1.2), (0.759, C1.5), and (0.666, C1.4). Factor 3 (F3) is correlated strongly and medium with participation in (0.858, C2.3), (0.701, C2.1), (0.604, C2.4) and (0.544, C2.2). Factor 4 (F4) is correlated strongly and medium with participation in (0.809, C2.5), (0.635, C2.8), and (0.554, C2.7), and Factor 5 (F5) is correlated both media with participation in (0.673, C1.1) and (0.602, C2.9).

The exploratory factor analysis confirmed that all questionnaires in Table 5 followed the five key concepts for standing to responses on mathematics teaching materials and mathematical teaching skills that can be used in the digital age as a priority.

F(1): Methodology of teaching (MT)
F(2): WIFI and E-library technology (WELT)
F(3): Teachers' teaching talent (TTT)
F(4): Utilize software and expand thinking (USET)
F(5): Supporting by Managers (SM)

The results of the study on the solution of teaching mathematics in upper secondary high school in the digital age showed that teaching mathematics had factors include: (MT) and (TTT) which were consistent with the results of a study by Lee, Y et al. (2018) showed that students need experience in problem-solving but did not have enough time to complete problem-solving activities in the classroom and change numbers or hypotheses in the textbook exercises should be avoided while students should be given additional support to better understand the mathematical content through the problem-solving experience provided by the activity changing the conditions of the problem given to them by the teacher. In addition, teachers should address issues related to changing conditions from complex easy to help students learn how to create problems because it is important to include both math and practice situations everyday life

Table 10: Teacher perception on factor loadings for a solution.

Questionnaires	*Factor 1*	*Factor 2*	*Factor 3*	*Factor 4*	*Factor 5*
C1.1 Smartphone					0.673
C1.2 Computer		0.769			
C1.3 LCD projector		0.848			
C1.4 wifi		0.666			
C1.5 E - library		0.759			
C1.6 IBL method	0.674				
C1.7 Problem-solving method	0.775				
C1.8 Collaboration method	0.778				
C1.9 Concept map method	0.784				
C1.10 Bloom method	0.633				
C2.1 Teacher organizes student activities in groups			0.701		
C2.2 Teachers encourage students to use available resources for their own learning			0.544		
C2.3 Teachers instruct students to organize teams with mixed abilities			0.858		
C2.4 Teachers are inspiring students can solve mathematics problems			0.604		
C2.5 Teachers use GeoGebra to better understand mathematical content				0.809	
C2.6 Teachers instruct students to monitor their study progress					
C2.7 Teacher expands the students' deep thinking by providing advanced exercises				0.554	
C2.8 Teachers provide appropriate learning equipment and resources				0.635	
C2.9 Teachers need support from managers					0.602

during the process creates problems. Because participation and practice in real world situations is difficult for students then teacher's choice of teaching method begins with the problem of the mathematics situation and extends to the real situation as the students begin to understand the concepts and related processes in mathematics such as for example model exercises and exercises in textbooks.

Applying in everyday life to math through problem-solving provided students with an educational experience to cover the content of the textbook. Most problem-solving activities in the textbook are appropriate because most students are not good at solving problems related to real-life situations. Positive perspectives on classroom practice that are relevant to the teaching process should be used as a tool for defining mathematical concepts and increasing students' understanding of those concepts. The concept of education is an innovation to expand the scope of a wide range of benefits, not just as a tool for studying mathematical concepts alone, but for solving real-world mathematical problems and giving students the opportunity to think about the mathematical problem-solving process on their own are more important than getting the right answers because the development of students' mathematics thinking skills is considered important in teaching and learning. Teachers should develop guidelines related to creating new problems before or after the end of the activity to solve problems with students because students need to know the mathematical concepts and principles that are relevant in problem-solving activities to create a preference for learning activities in the whole class. Teachers should introduce the concept of study before starting the lesson in the classroom and then introduce the concept of the math lesson to the situation transferred to the student for in-depth thinking by posing the problem to the student for solving.

In general, teachers are categorized according to their preferences and reasons for using mathematics teaching situations versus situations in their daily lives in teaching their math lessons. Another factor in teaching mathematics was (SM) consistent with the results of a study by MoEYS (2018) showed that choosing a teaching situation according to the detailed curriculum of mathematics of the Ministry of Education Youth and Sports is better than the situation outside the ministry's program when introducing the process of creating new problems in the classroom. On the other hand, most teachers like to use external situations for problem-solving in the classroom or during exams in order to develop students' thinking skills. During the interview, the teachers mentioned that their experience with incorporating multiple problems in their classrooms helped to improve problem-solving skills that are highly relevant to mathematical thinking skills. Emphasize that the relationship between problems and skills in solving mathematical problems is the participation in creating components related to problem-solving which is divided

into three levels including (1) developing mathematical thinking, (2) understanding mathematical reasoning, and (3) Mathematical knowledge and creative thinking (Hikmah and Amin, 2018). In addition, the demonstration of the effective use of definitions, formulas, theorems, and consequences in problem-solving strategies improved mathematical teaching skills. In addition, the demonstration of the effective use of definitions, formulas, theorems, and consequences in problem-solving strategies has improved mathematical teaching skills however the benefits of education related to teaching skills and problem-solving are interrelated.

This study emphasizes the importance of knowledge, then related to the skills that are integrated with math teaching skills, especially when discussing the knowledge and skills that teachers need to have to develop problem-solving skills mathematical problems such as creating new problems cannot be done without a basic knowledge of mathematics because basic knowledge can create problems that are harmoniously composed of mathematical content and mixed principles of real situations or elements of other subjects as well to modify the problem and complete the mystery. Finally, teachers evaluated and corrected problems that arise to support the development of their teaching skills. On the other hand, if the student's ability to solve the problem to get the correct answer or the wrong answer in the solution is not concerned, there is no development of the student's problem-solving ability because the purpose of creating questions is to understand the concept and practice of student experience on each question the views of some teachers said that problem-solving to understand key concepts in any given situation to grasp the concept of a question and apply the solution because understanding how to solve a problem but getting the wrong answer is a challenge that can be improved if not understood how to solve the problem is the main issue. The results of the study of solutions for teaching mathematics in high school in the digital age on motivating students to use the (WELT) and (USET) were consistent with the results of their study Niemi, H et al. (2018) Expressed the perception that encouraging students to want to learn mathematics with different contexts and teachers' feedback was very positive in terms of knowledge creation, participation and cooperation of students. However, teachers also recognize that their role has shifted to being more responsible facilitators in supporting students' work and assisting students, such as the teaching process the infinite limit in the form $+\infty - \infty$ in the application of problem-solving teaching methods through the reflection of GeoGebra as shown below:

- Understand the problem for solving the infinite limit in the form $+\infty - \infty$
- Make the plan for implementing the rule of calculating infinite limit in the form $+\infty - \infty$
- Practice the plan for the calculation of the limit
- Look back and reflect to check your answer using the GeoGebra program.

The strategy of problem-solving teaching was a method of teaching that used interlocking steps to help problem solvers find solutions to problems and obstacles in the terms or content in question. The inclusion of local culture in the teaching of mathematics also played an important role in improving the passion for solving mathematical problems which got a positive effect on the teaching of mathematics within the context of Cambodian culture which got found a mathematical teaching model and an environment of mathematical research passion and development of teaching materials had focused teaching activities to enhance the effectiveness of teaching mathematics.

4. Discussion

4.1 Necessary for teaching mathematics in the digital age

The study found that the need to teach mathematics in high school in the digital age needs to increase the knowledge and skills of information technology, communication and technology to reduce the need for teachers. To teach mathematics in the digital age at high school mathematics instruction in the digital age improved students' problem-solving skills, inseparable from the recommended instructional model to form the basis of teaching materials and instructional discoveries to help the (KSCT) and (NRTA). On the other hand, there was a discrepancy between the participants' teacher knowledge and their actual problem-posing; their posed problems did not reflect their knowledge of problem-posing (Lee et al., 2018). Facilitating teachers' thinking with problem-solving skills can be transferred to various situations to maximize the potential of the teaching process. At the same time, the experience of teachers and the use of teaching methods appropriate to the content of the lessons have improved the knowledge transfer function.

4.2 Challenges for teaching mathematics in the digital age

The study found that the challenges of teaching mathematics in high school in the digital age were due to the wifi and e-library system which greatly influenced the use of mathematics teaching materials and math teaching skills in the digital age on (OMTT), (MT) and (WEL). The teaching of mathematics in high school in the digital age showed that the teaching of mathematical concepts in the concept map method was still ambiguous which was consistent with the results stating that improving the quality of teaching requires

the strengthening of teacher qualifications and the implementation of teacher training programs through the formal education and focus on the development of students' abilities and the implementation of teaching methods. Contribute to motivating students to learn and be highly thoughtful (MoEYS, 2022). The sector of education focused on (TQMT), (TM) and (EC) toward the development of quality of teachers was an important factor that motivates students to have a high level of knowledge, skills, and attitudes that meet the needs of the national, regional and international labor market.

4.3 Solutions for teaching mathematics in the digital age

The study found that the solution to teaching mathematics in high school in the digital age was to continually develop the ability to use software and expand thinking into mathematics teaching materials and mathematics teaching skills on (MT), (WELT) and (TTT) in the digital age was priority to respond to the evolution of the education sector, focusing on: (1) The professional development of teachers; (2) The development of curricula and teaching methods, and; (3) The digital revolution for equitable learning and teaching (Hangchuon, 2023). Continuing to encourage teachers' perceptions of solutions related to mathematics teaching in the digital age and continue to explore solutions to avoid the impact of (USET) and (SM).

5. Conclusion

The effectiveness of teaching mathematics was knowledge based on experience because at all stages of teaching experience made the teaching process smooth but using digital materials was also indispensable because it was important to use teaching strategies to manage the teaching process skillfully as the following:

Need for knowledge and skills in information and communication technology, focusing on: (1) Solving problems related to teaching mathematics; (2) Researching mathematics through new websites, and; (3) Incorporating math lesson content and technology materials, as well as appropriate teaching methods.

The challenge of using mathematics teaching materials and math teaching skills in the digital age focuses on: (1) The lack of experts in additional training on the use of technology tools; (2) Teachers using (Telegram, Zoom, and Google Meet) to keep students engaged in online math classes limited, and; (3) The implementation of new teaching methods limited.

Solutions of mathematical teaching materials and skills that was used in the digital age as a priority, focusing on coding software to expand and deepen thinking.

The conceptual framework expressions for the three independent variables are quite different in the mathematical teaching process in upper secondary high school in the digital age based on the analysis on $F(2, 36) = 8.534$, $p < 0.05$ in this sense teaching mathematics has more challenges than solutions and the need for factors is lower than finding solutions. The interaction between teaching methods and digital technology in teaching and learning activities has provided tremendous improvements and increased confidence in mathematics teaching activities improving the teaching and learning situation because it obtained a positive impact on the relationship between teaching talent and achievement in teaching and learning mathematics.

In conclusion, education in Cambodia was geared towards maximum understanding of ICT skills, communication and technology for use in the teaching profession, helping to solve problems related to mathematics teaching and the integration of mathematics teaching mechanisms in the digital age. In line with education reform to improve the quality of mathematics teaching in the digital age to avoid challenges and increase solutions to contribute to the development of education in Cambodia and become a developed country.

Cambodia is a developed country the requirements for teaching mathematics in the digital age for release the challenges and increase the solutions in order to contribute to developing the educational field. Education was geared towards maximum understanding of the use of ICT and the integration of mathematical teaching mechanisms in the digital age in line with education reform. This research study examined the requirements, challenges, and solutions for teaching mathematics in high schools in the digital age to improve the teaching and learning strategy and quality of digital skills. This study, however, is still limited and lacks interpretation of research results. If there is a study on this topic, this work suggests for future study on the topic "Mechanism of teaching and learning management of mathematics respond to the standards in high school".

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Credit authorship contribution statement

PHANN Sopheap: Conceptualization, experimental design, data interpretation, visualization, drafting, reviewing and editing. PO Bunthan: Data interpretation, visualization,

reviewing and editing. LUY Ork: Data interpretation, visualization, reviewing and editing. KOUY Sokean: Data interpretation, reviewing and editing. HUOT Sokloeun: Data interpretation, reviewing and editing. All authors have read and agreed to the published version of the manuscript.

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