MAKING MATH FUN AND ENGAGING VIA THE USE OF MODERN TECHNOLOGY: CAPACITY BUILDING FOR MATHEMATICS TEACHERS

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ABSTRACT

The abrupt COVID-19 pandemic breakout shocked the world and forced educational systems to switch instantly to an online teaching-learning format (Dhawan, 2020). Many schools organized training webinars to capacitate their teachers for the online teaching-learning modality. With that, the authors planned, organized, and conducted a series of training webinars titled "Making Math Fun and Engaging via the use of Modern Technology: Capacity Building for Math Teachers," in April 2022, via Zoom platform, for the Math teachers to get updated with the knowledge and skills in using some online apps and make teaching Math online, more exciting and fun. The training was conceptualized following the ADDIE Model: Phase 1- Assessment of Teachers' Real Training Needs. A survey was conducted on the teachers' level of knowledge of apps to enhance Math teaching known as technology applications; Phase 2- Designing the Competency Framework for the training program; Phase 3- Developing the training plan; Phase 4- Implementing the teachers' training; and Phase 5- Evaluating the gains in teachers' knowledge and skills on the integration of technological apps in teaching Math. So, this study ascertained the impact of the said online training. It utilized a mixed quantitative and qualitative research methodology to assess the effect of using modern technology and used a researchers' made research instrument. Findings revealed that the training is engaging and informative, which helped the teachers absorb the topics easily and develop a positive attitude toward using the digital application in teaching. Hence, the study recommends that school heads support and motivate the teachers to use modern technology and adopt new educational trends, for better student learning, through continuous professional development and mentoring.

Keywords: Modern Technology, Digital Applications, Capacity Building, Mathematics

INTRODUCTION

The COVID-19 epidemic has caused the world's largest educational disruption in history, affecting approximately 1.6 billion students in over 190 countries across all continents. Closures of schools and other learning places have impacted 94 percent of the world's student population, with rates as high as 99 percent in low- and lower-middle-income nations (United Nations, 2020). The abrupt COVID-19 pandemic breakout shocked the world and forced educational systems to instantly switch to an online teaching-learning format (Dhawan, 2020). Schools scheduled training webinars to prepare their teachers for the online teaching-learning modality. They also regularly offer training mechanisms to address issues. Likewise, the Department of Education (DepEd) continues to ensure that the stakeholders, particularly the teachers, are equipped with the

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174

necessary educational technology skills. This is because the Department of Education recognizes how technology can improve the effectiveness of the delivery of education.

To empower and upskill Filipino teachers in educational technology, DepEd and the Global Networks Association of Teachers as a Foreign Language (GENTEFL) of Thailand hosted the Free International Multidisciplinary Webinar Series for Teachers from June 30 to July 2, 2021. (DepEd, 2021). Usec. Pascua (2021) claimed that "In the Philippines, we have been developing and implementing initiatives such as the use of television and radio, the use of various authoring tools for the development of Open Educational Resources (OER), and the use of various Learning Management Systems (LMS)." All of these educational technology tools are being scaled up at a rate in our country and around the world that has never been witnessed before." (Malipot, 2021).

Nevertheless, the interaction and successful learning of Mathematics online will not be ensured by these technological tools in online math classes that focus on higher-order thinking skills (Maclaren, 2014). For this reason, a training titled "Making Math Fun and Engaging via the use of Modern Technology" for Math teachers was conceived by the researchers to provide them with the needed capacity-building in the use of modern apps to design learning experiences that target the students' higher-order thinking skills and the teachers' creativity, covering the presentation of mathematical concepts, problems, and solution process steps, as well as the practical integration of student-teacher interaction (Costley, 2014).

In online distance learning, students and teachers use a computer to connect to the system; the computer screen is used for reading, and the keyboard is used for writing (Karal et al.,2013). By displaying Mathematical concepts and symbols in an online learning environment, it isn't easy to achieve sufficient interaction, which could also develop higher-order thinking skills that are important in mathematics education. This appears to be a limitation in the online mathematics learning environment. According to Bernhardt et al. (2004), Math educators struggle to visually explain concepts in Mathematics online classes. Mathematics is, after all, the foundation for all other

sciences, which play an essential role in everyday and professional life. It is taught at all levels of education, and it has risen to prominence as a critical area for technological advancement. On the other hand, students continue to believe that the said subject is tedious.

Studies by Glass et al. (2008), NCTM (2000), and Hattie (2009) have found related to learning mathematics that: 1) Few students enjoy recalling their mathematics lessons; 2) Many students lack motivation, pleasure, joy, and enthusiasm for learning mathematics; 3) students' attitudes have a significant impact on their mathematics achievement; 4) we lose a large portion of our students during the learning process, and 5) reducing and simplifying the content of mathematics instruction has not resulted in more profound and higher knowledge thinking and better results. Moreover, continuous discussions in the media of various countries about 1) the low results of the mathematics in TIMSS (the Trends in International Mathematics and Science Study) research; 2) the impact of the Covid19 pandemic and the background created concerning online training; 3) the amount of money that is being spent on providing schools with training about technology and the uncertainty of how to use these technologies productively in the teaching process. In the future, there is great potential for more effective technology integration in teaching-learning mathematics, so that mathematics can be learned not only faster and more creatively but also in a fundamentally different way. Schools need to be able to create an environment and conditions that arouse students' curiosity and enthusiasm so that students' eyes shine with joy when they go to online math classes.

There are research studies conducted, such as the study of Niet (2021), Sacristan (2017), and Cunska (2021), that show digital technology in mathematics education. However, these studies focus only on the teacher's technological integration and implementation of the resources. In addition, the complexity of online learning materials may also impact student learning. Teachers must use the ideal digital tools when creating learning experiences for their students that foster the development of higher-order and critical thinking abilities. A complicated design, for

instance, can cause students to lose interest in the lessons being taught. How the teacher enables online learning that fosters the development of higher-order thinking skills is another element that might influence how successful the learning material is online. Implementing these valuable materials may be enhanced and improved to maximize their educational usage. In this context, the issue of teachers' understanding of the factors that guarantee and promote quicker and more effective teaching and learning of online mathematics produced the inspiration for the study. Hence, this study focuses on teachers' understanding, performance, experiences, and perceptions in utilizing digital applications in teaching mathematics.

This study applied the concept of the ADDIE Model to determine the impact of Making Math Fun and Engaging via the use of Modern Technology: Capacity Building for Mathematics Teachers in selected public and private schools in Visayas and Mindanao Philippines for the school year 2021-2022.

The critical issue in the teaching profession is the need for educators' training programs. Some colleges and deep-rooted learning programs for teachers/instructors depend on hypothetical teaching that needs a solid interaction with the school environment. Subsequently, a theory-practice gap should be addressed to lead high-quality and well-trained teachers to excellent instruction. Teachers experienced unprecedented lesson challenges that made a need for speculation by updating their teaching aptitudes and competencies on the use of technology applications. Recently, teachers' advancement has gotten to be the best need in line with the DepEd and CHEDs objectives, this paper aims to present the use of digital applications through a five-phase methodological framework approach based on the ADDIE model, which includes Analysis, Design, Development, Implementation, and Evaluation– represent a dynamic, adaptable guideline for building successful training and support instruments.

Those five phases constitute a set of steps with specific results that work together to improve the overall outcome of the training on Capacity Building for Mathematics Teachers. Figure 1 depicts the five phases of Capacity Building for Math Teachers. Phase 1 is analysis and assessment of teachers' real training needs. the survey was conducted on the teacher's level of knowledge of apps to enhance Math teaching known technology applications. Phase 2 includes designing the competency framework for the training program on capacity building for Math Teachers via digital applications. Phase 3 consists of developing a training plan to enhance teachers' skills in using digital applications. Phase 4 is implementing the teachers' training, and Phase 5 is evaluating the process of determining the adequacy of the training and providing the information regarding its impact on the technological development of teachers.
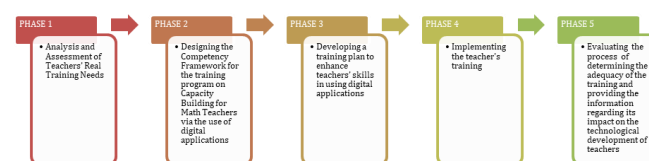

Figure 1. Conceptual Framework of the study: ADDIE Model

OBJECTIVES OF THE STUDY

The study aimed to determine the impact of an online training workshop named "Making Math Fun and Engaging via the use of Modern Technology: Capacity Building for Math Teachers." Correspondingly, it sought to answer the following specific objectives:

1. Determine the level of teachers' knowledge of digital taxonomy applications that can help develop students' higher-order thinking skills in teaching Mathematics.
2. Design and develop a training plan to enhance the teachers' knowledge and skills in using digital applications.
3. Determine the level of teachers' skills in utilizing digital applications in teaching Mathematics.
4. Find out the impact of the training in terms of acquired new learnings, pedagogical skills, action plans, actual applications to teaching online, action plans, and the consequences of the capacity-building activity.

METHODOLOGY

This study utilized the mixed quantitative and qualitative research methodology to determine the impact of using modern technology to make math more entertaining and engaging for math teachers. For the quantitative part, a survey instrument was used to collect the data. While for the qualitative part, a focus group discussion via zoom was used to gather the data, which was analyzed thematically. The study's participants were limited to 30 Math teachers from both public and private high schools for more interactive and hands-on activities.

Table 1
The Respondents of the Study

Area	No. of Respondents	Percentage (%)
Bantayan Island	11	37.93%
Cagayan de Oro	8	27.59%
Cebu	11	37.93%
Total	**30**	**100 %**

The training webinar was participated by Math teachers coming from different places held via zoom: eleven (11) from Bantayan Island, Cebu; eight (8) from Cagayan de Oro, and ten (11) from Cebu during the academic year 2021-2022. Before conducting the study, the researchers created a self-evaluation instrument for Math teachers to use in digital taxonomy applications. Their doctoral professor and three (3) Math teachers helped to validate the instrument. The instrument has three sections: Part I assessed the use of digital applications in the classroom and the frequency with which math teachers employ digital apps in the classroom. Canva, Prezi, demos, GeoGebra, google apps, Animoto, PodOmatic, Edmodo, explain Everything, Quizlet, calculator emulator, book widgets, Mathway, Wordle, and Jeopardy were among the digital programs that were enquired about. On the other hand, Part II assessed digital teaching comprehension. It used a 15-item, 4-point Likert scale. The weighted scale labels are: at all times (3.26 - 4.00), most of the time (2.51 - 3.25), sometimes (1.76 - 2.50), and never (1.76 - 2.50), poor (1.00 - 1.75). Lastly, Part III is comprised of the respondent's profile and follow-up questions. Moreover, the researchers selected three participants to demonstrate the assigned digital application after the webinar - workshop. On a five-point Likert scale, they were graded as follows: outstanding (5), very satisfactory (4), satisfactory (3), unsatisfactory (2), and poor (1).

The researchers, who were classmates in a doctoral class at a state university in Cebu, brainstormed on how to assist in strengthening the quality of math during online teaching. They decided to conduct a webinar training workshop for Math teachers to assist them with the different apps they can use in online math teaching. They sent letters to the principals, asking permission to allow the researchers to conduct the webinar training and aid the administration in strengthening the competency of the teachers, starting with the math teachers about the use of modern apps and administering the research instruments to the participants. The answered questionnaires were gathered, and some participants were interviewed at the end of the webinar workshop.
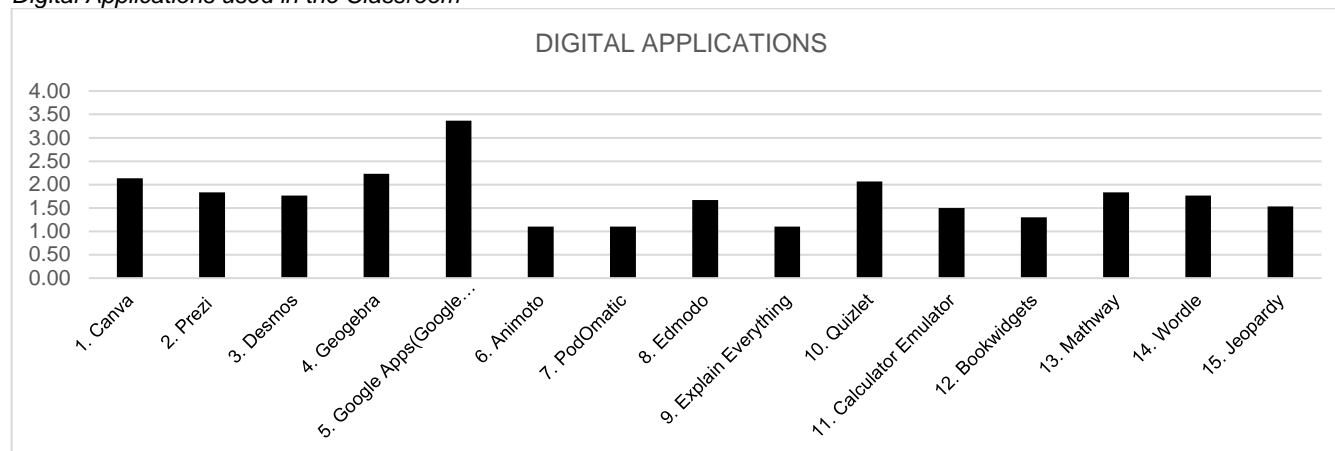
RESULTS AND DISCUSSIONS

1. Level of Teachers' Knowledge of Digital Taxonomy Applications

The results of the pre-assessment and conducted webinar workshop are shown and explained in this section, along with a comprehensive discussion. The ADDIE Model was divided into several sub-phases: Analyze, Design and Develop, Implementation, and Evaluation.

1.1. Analyze

Figure 2 shows that the least known applications were: (1) Explain Everything, (2) Animoto, and (3) PodOmatic, with a mean score of 1.10, while the Google Apps (Google docs, slides, sheets, drive, and Classroom) were the most known, garnering a mean score of 3.37, meaning teachers considered themselves "competent" in using them

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177

Figure 2
Digital Applications used in the Classroom

They have been using and demonstrating this digital application's efficiency, coordination, and confidence in Math class. Furthermore, in the results shown above, the researcher also considered their comments and suggestions as to what digital applications they wanted to learn, such as wordle, jeopardy, and quizziz. This implies that teachers need to explore digital applications that are very useful in making math fun and engaging via modern technology: capacity building for mathematics teachers.

2. Level of Understanding of Digital Taxonomy Applications

Table 2
Level of Understanding for Digital Teaching

Statements	Weighted Mean	Description
I found the digital applications in the lecture engaging.	3.3	High
I believe using digital applications helped me to discuss the topics/lessons quickly and efficiently.	3.3	High
I have a positive attitude toward the use of digital apps in teaching.	3.3	High
Digital applications provide adaptations or alternatives in activities, assessments, and materials for special	3.3	High
The use of digital applications helped me to exercise my creativity and innovation.	3.2	Moderate
The use of digital apps taught additional skills by doing first-hand experience and the ability to apply it in real-life	3.2	Moderate
I believe digital applications are used for higher cognitive task completion.	3.2	Moderate
I enjoy using digital applications for teaching and learning.	3.1	Moderate
The use of digital applications helped me to develop critical thinking skills.	3.1	Moderate
Digital applications are used as a tool to help students identify and solve authentic problems relating to an overall	3.1	Moderate
I need a better understanding of digital applications.	3	Moderate
Using digital apps is an excellent way to quickly assess students' understanding.	3	Moderate
I applied digital applications in giving lectures.	2.7	Moderate
I am confident in using digital applications	2.6	Moderate
I require my students to use digital applications in making their performance tasks/projects.	2.4	Low
Overall- Mean Rating	**3.1**	**Moderate**

With regards to the level of understanding of digital teaching, the teachers found the digital applications in the lecture engaging, helped them discuss the topics/lessons quickly and efficiently,

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178

adapted or substituted activities, assessments, and materials for special needs. Respondents have a positive attitude towards the use of the digital application in teaching rated high as all the time (WM = 3.3). High (Most of the time) in (WM = 2.51 - 3.25), the digital taxonomy application requires a higher grasp of digital applications, the use of digital applications in lectures, enjoyment, confidence, and assistance in developing critical thinking skills, and exercising creativity and invention, as well as a suitable means to assess students' understanding easily and quickly. They encourage their students to use digital programs to

complete their performance tasks or projects at (weighted mean= 2.40) low level of understanding.

2.1. Design and Develop

Based on the pre-assessment conducted by the researchers, a webinar workshop in two phases was developed to address the training needs of the teachers. The researchers selected the training of the five digital applications least known by the teacher respondents to increase their skills and knowledge about these apps, condensed into five (5) modules.

Table 3
Training Plan of the Webinar Workshop

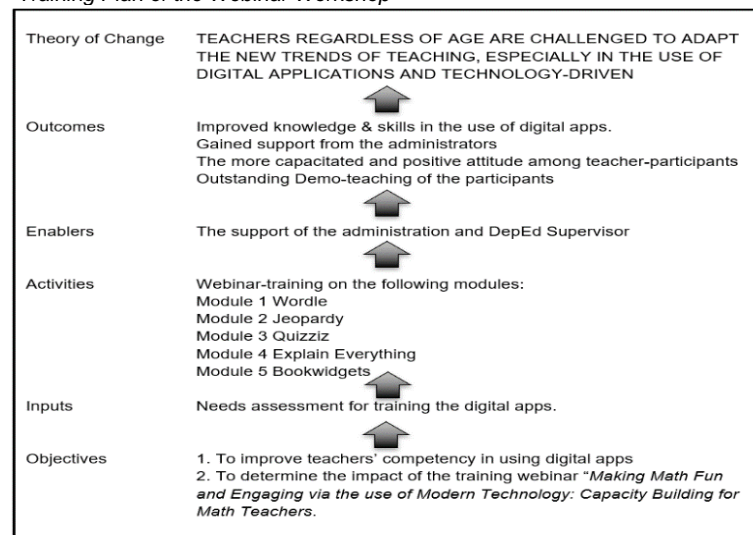|	
Theory of Change	TEACHERS REGARDLESS OF AGE ARE CHALLENGED TO ADAPT THE NEW TRENDS OF TEACHING, ESPECIALLY IN THE USE OF DIGITAL APPLICATIONS AND TECHNOLOGY-DRIVEN
Outcomes	Improved knowledge & skills in the use of digital apps. Gained support from the administrators. The more capacitated and positive attitude among teacher-participants. Outstanding Demo-teaching of the participants
Enablers	The support of the administration and DepEd Supervisor
Activities	Webinar-training on the following modules: Module 1 Wordle, Module 2 Jeopardy, Module 3 Quizziz, Module 4 Explain Everything, Module 5 Bookwidgets
Inputs	Needs assessment for training the digital apps.
Objectives	1. To improve teachers' competency in using digital apps 2. To determine the impact of the training webinar "*Making Math Fun and Engaging via the use of Modern Technology: Capacity Building for Math Teachers.*

Table 3 showcases the flow of the two-day webinar training - workshop implemented. The researchers invited the Regional Math Director of Region VII for an inspirational message that greatly inspired all participants. The resource speakers who shared their expertise in utilizing these digital applications motivated the teacher-participant to engage more in their online classes.

2.2. Implementation

Webinar training on the following modules:

Module 1. Wordle. A Welsh software developer, Josh Wardle conceived and developed

the website word game "Wordle." Students are given six chances to guess a five-letter word. For each guess, students receive feedback in colored tiles that show which letters match or are in the right place. Each day's Wordle answer is the same, and all students try to guess the same word. Wardle (2002). This online tool encourages pupils and provides them with pre-activities.

Module 2. Jeopardy. The game's goal is to test participants'/students' knowledge of several trivia categories. The online group can play Jeopardy in various ways, including through apps, websites, and zoom. Virtual Jeopardy is 179 name for online jeopardy.

Module 3. Quizziz. With the help of the online assessment tool Quizziz, teachers, and students can create quizzes and share them. A quiz can be given to students with a unique access code and then presented live as a timed contest or utilized as homework with a set due date. The tests are over, and students can check their responses. To examine trends and determine which areas would require the most significant attention in the future, the teacher is also provided with a clear picture of the student's performance from the resulting data, which is gathered into a spreadsheet.

Module 4. Explain Everything is an impressively versatile digital whiteboard that can use in the classroom, remote teaching, and any version of the hybrid learning model. Engage students with real-time collaborative activities, give eye-catching lectures, create fun explainer videos, and much more, all with one tool.

Module 5. Bookwidgets allow teachers to create a ton of different types of interactive content. Examples of each type of widget are available as a template to start, and a tutorial walks you through the steps. There are 40 different widgets you can create that can be shared through a link, a QR code, an email, and Google Classroom. Simple assessments that can integrate include exit slips, quizzes, and worksheets.

Students can practice and review skills with flashcards, puzzles, or games such as hangman or bingo.

3. Level of Teachers' Skills in Utilizing Digital Applications

Results depict that the level of teachers' skills in utilizing digital applications in teaching Mathematics greatly impacted the webinar workshop on Making Math Fun and Engaging via the use of Modern Technology: Capacity Building for Math Teachers, which showed an outstanding performance having an overall mean of 4.26. The highest norm among the performance indicator showed that teachers implemented and integrated digital applications in the math lessons having a 4.75 mean score which indicates an outstanding performance. In contrast, the lowest mean was attained by the lesson's objectives having a 3.92 mean score, indicating a very satisfactory performance indicator. This proves that teachers understood and incorporated these digital applications into their respective school and work settings.

Table 3
Evaluators Rating for the demonstration teaching of selected participants

Performance Indicator	Mean	Description
1. Clearly formulate the objectives of the lesson.	4.25	Very Satisfactory
2. Attained the objectives of the lesson.	3.92	Very Satisfactory
3. Presented the lesson in a way that captured the learners' interest.	4.17	Very Satisfactory
4. The demo engages participants to think critically and develops higher- order thinking skills	4.08	Very Satisfactory
5. Appropriate, appealing visuals, media, and technology are incorporated as learning supports.	4.42	Outstanding
6. Plan is thoughtful and deliberate; it includes the assessment.	4.25	Outstanding
7. Implement and integrate digital applications into the lesson	4.75	Outstanding
Overall Mean	**4.26**	**Outstanding**

2.3. Evaluation

The following four major themes surfaced in the results, with subthemes that were reflective of the experiences of the faculty- participants:

Theme 1. New Learnings in integrating digital apps

Technology has surrounded today's environment. However, today's teaching forces are not equally prepared for their technologically advanced future. To meet the needs of faculty for their digital future, educational institutions and related agencies tried to provide extensive digital application training and transformation. The COVID-19 pandemic has forced schools and education to undergo such a transformation quickly and dramatically.

The results collected showed the following sub-themes:

Sub-theme 1. Most Useful or Valuable Learnings

Some of the teacher-participants said:

"…The integration of Digital applications in teaching Mathematics, particularly the utilization, was very helpful and I appreciate how they were applied in class… "(P1)

"…The new tools I learned are interesting, and the content aspect-all the digital apps was useful, stimulating, and fun. It provides additional opportunities for learners to see and interact with different concepts…." (P5)

The findings of the study agree with the investigations of Niet (2021), Sacristan (2017), and Cunska (2021), which showed a positive correlation between the use of digital technology in mathematics education and the math engagement of the students.

Sub-theme 2. New Pedagogical Skills Developed

Other participants described the training in the following terms:

"…Adaptability, Scaffolding, and Differentiation Facilitating interactive and game-based activities, Computer navigation skills, Holistic approaches, Modelling using of applications, assessment using technology, Pedagogical competence in the integration of various Digital applications in teaching are among the pedagogical skills that I have developed the most while attending the training..." (P4)

Theme 2. Actual Applications to Teaching Online

Another theme that surfaced was applying what the teachers learned in their online Math teaching. Some participants explained the following:

"…I was able to utilize the Quizziz/Kahoot, google classroom, GeoGebra, Google Jamboard, Explain Everything, Bookwidgets, and other similar applications…" (P5)

The study's findings corroborated the analysis of Costley (2014) that targeted the students' higher-order thinking skills and the teachers' creativity, covering the presentation of mathematical concepts, problems, and solution process steps, as well as the practical integration of student-teacher interaction.

Theme 3. Consequences of the Capacity Building Activity

Further, some participants also remarked on the following:

"…Problems were addressed, such as setting interface and intermittent internet connection for both teacher and students, how to navigate the various features of digital applications and the processor of the laptop…." (P9)

"…There are many factors affecting teachings such as teacher-student relationship, socioeconomic conditions, policy and motivation of schools…" (P5)

181

"…In online learning, the devices are factors if they are compatible technology and accessibility…" (P4)

"…In the recent set-up in education, the factors that could affect teachers-teaching could be the teacher's computer literacy and proficiency. While in the part of the students-learning, it could be the student's character, how they perceive the usefulness or significance of what they are learning, the course content and design…" (P 3)

The findings of the study affirmed the results of the studies of Glass et al. (2008), NCTM (2000), and Hattie (2009), which showed the factors affecting teaching-learning of mathematics in utilizing modern technology.

Theme 4. Impact on the Use of Digital Applications in Teaching and Learning

Besides, the participants also expressed the following:

"…Digital learning tools used effectively in the Classroom can boost student engagement, assist teachers in creating better lesson plans, and promote individualized instruction. It significantly affects the pupils' mastery and learning process. Additionally, it aids pupils in acquiring crucial 21st-century abilities.…." (P5)

"…Digital applications make the student experience better. Students became active participants in the learning process, feedback is quick, and students are more motivated…" (P3)

"…It can increase student engagement and eventually improve their views/preference of the subject matter. It helps cultivate motivation in learning among our students and mitigates boredom among students during classes…." (P1)

"…It catches students' interaction and increases their engagement in class discussions. On the other hand, if not planned well, it may cause cognitive overload and inappropriate design of learning…" (P7)

CONCLUSIONS

Participants of the training found the capacity building on digital applications very engaging, helped them discuss the topics/lessons quickly and efficiently, and provided adaptations or alternatives in activities, assessments, and materials. In the process, they developed a more positive attitude toward using digital applications in teaching. Nevertheless, they also experienced challenges, such as the setting interface and intermittent internet connection, difficulty navigating the various features of digital applications, and the laptop's processor. Even though they completed the said training, some teachers, ages 50 and above, found knowledge and skills in technological aspects very challenging.

RECOMMENDATIONS

The study recommends the following to encourage and motivate teachers to use modern technology to quickly adopt the new trends in teaching for better student learning. Moreover, it is suggested that School administrators may consider providing technical assistance to teachers for the continuous use of digital apps in teaching, or financial allowance to teachers for connectivity and gadgets with high specifications. Lastly, is to conduct training and regular mentoring on educational technology.

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182

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183