THE GOOD, BAD AND UGLY OF TECHNOLOGY INTEGRATION IN MATHEMATICS FROM THE LENS OF PUBLIC SCHOOL MATHEMATICS TEACHERS

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ABSTRACT: *Despite various researchers often call for widespread implementation of technology integration in education, more specifically in mathematics classrooms, in reality, mathematics teacher's encountered different and similar issues and struggles which prevented them to successfully obtain the benefits of integrating technology in mathematics teaching and learning. This study aimed at determining public school mathematics teachers in the Division of Cagayan de Oro City's actual teaching experiences, reflections, struggles, and the challenges they have met before, during, and after they implement and/or use technology in their respective classes. Data are collected and recorded using personal in-depth interviews and focus group discussions from these mathematics teachers. Based on the in-depth interview and FGD conducted, the mathematics teachers acknowledged the fact that integrating technology in mathematics allows students to be actively engaged in learning and deepen their mathematical understanding. However, various obstacles were encountered before and during implementation such as lack of school computer resources and internet connectivity/access and even some teachers do not know how to use and optimize the use of technological tools in the classroom. They also noted various disadvantages of integrating technology such as it is detrimental to health and teachers not utilizing it judiciously. Hence, it is recommended that training of teachers on how to use these different technological tools in mathematics across all levels may be considered by DepEd to capacitate mathematics teachers to use and integrate technology in their classes proficiently.*

Keywords: technology integration, mathematics teaching, mathematics learning, issues, and struggles

1. INTRODUCTION

Technology affects almost every aspect of a person's daily life, that is, life at work, at home, and leisure. Rapid developments and advancements in technology create new opportunities for teaching and learning, however, many school systems are struggling to keep pace with these changes [1]. Mathematics is a fundamental skill in many aspects of a student's life. The potential and relevance of using technology in the mathematics classroom have been widely accepted and recognized. The use of technology has been included in the professional standards in the teaching and learning of mathematics. The National Council of Teachers of Mathematics (NCTM) of the US and even in the Philippines Professional Standards for Teachers, as well as the Philippine Council of Mathematics Teacher Educators (MATHTEDs) Declaration on Mathematics Teaching and Learning for the K-12 Curriculum, claimed that technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology and should be driven by the needs of students as learners of mathematics and used when it aids the learning process and must be used judiciously [2, 3]. Research suggests that when technology is used effectively, it can enable ways of teaching that are much better matched to how children learn, as opposed to the resources of traditional classrooms [4, 5, 6, 7]. These researches also suggest that teachers need to continually involve themselves in professional development to gain confidence and knowledge on how to maximize the use of technology to support learning of mathematics concepts. The traditional mathematics classroom is now changing its landscape, slowly adapting the needs of global learners who were very enthusiastic when working with technology. Prensky referred to these learners as "digital natives". Digital natives have spent their entire lives surrounded by and using the technological tools of the digital age, and as a result, "think and process information fundamentally different from their predecessors" [8]. Teachers who were not born into the digital world, referred to as "digital immigrants" by Prensky, must reconsider their methodology and content. He further stated that "Teachers need to change how and what they teach, in ways that reflect their students' current and future realities. Changing the 'how' means creating a pedagogy that works for today's students. Changing the 'what' means creating a curriculum that is future-oriented and engaging to today's students, while remaining useful and rigorous." Unfortunately, teachers do not have the power to change the curriculum, but they do have the power to teach the curriculum material in creative and meaningful ways that is valuable for today's students. Researches also suggest that the use of technology helped improve students' achievement, attitude, and reduced anxiety towards mathematics [9].

However, even if the technology offers potential benefits in the teaching and learning of mathematics, in reality, some mathematics teachers were still hesitant and even negative in using technology in their classes. This study would provide vital information if mathematics teachers in the region are in compliant with the South East Asian Regional Standards for Mathematics Teachers highlighted that among the professional knowledge which mathematic teachers need to possess was the use of ICT in the teaching and learning of mathematical concepts. Furthermore, the results of this study would serve as a guide to provide strategic interventions for DepEd in formulating policies to improve and enhance the quality of mathematics teachers, structuring teacher education programs in in-service mathematics teacher preparation in higher education institutions (HEIs) like the USTP and for teacher professional development at a personal level and performance evaluation at school, division, regional and in the national level. In response, the results of this study would be utilized as a baseline data for the mathematics education department in designing a Technology Professional Development Training-Workshop (TPDTW) for mathematics teachers in the field which would serve as one of the departments' community extension project to be conducted for mathematics teachers in the division of Cagayan de Oro City and further for other divisions in the region.

2. CONCEPTUAL FRAMEWORK

Technology has become an integral part of society and it continues to improve year after year. Although technology has become readily available, problems on the underachievement of students in local and national assessments such as the National Achievement Test (NAT) as well as the Program for International Student Assessment (PISA) of the Organization for Economic Co-operation and Development (OECD) in 2018 still persist. The researchers cannot discount the fact on the impact of technology integration in mathematics classrooms and so it is, therefore, necessary to conduct an assessment on what and how technology was actually utilized by mathematics teachers in the field specifically in the division of Cagayan de Oro City.

The framework which this research study is primarily based was the Technological Pedagogical and Content Knowledge (TPACK) designed by Mishra and Koehler's [10]. TPACK, at its most foundational level, is the intersection between the development of knowledge of subject matter (content), with the development of technology, and the knowledge of teaching and learning (pedagogy). This framework, on a more global scale, combines appropriately selected technology with content-based learning experiences and pedagogical approaches. Within Mishra and Koehler's TPCK graphic (Figure 1), the overlapping of the discrete knowledge bases is obvious, as it is the centric overlap of all three. It is this area, when teachers can expertly understand and integrate all three knowledge bases, that the TPACK model postulates high quality and effective integration of technology, pedagogy, and content as part of the teaching and learning experience. As Foulger, Wetzel, Buss, and Lindsay contend, while teacher educators may be well versed in the pedagogies associated with specific disciplines, and may teach using modern technology; these individuals may not be experts in how to teach with technology. It is this distinction, however subtle it may be, where the nature of deconstructing the TPACK theoretical model into usable and practical applications becomes increasingly valuable [11].

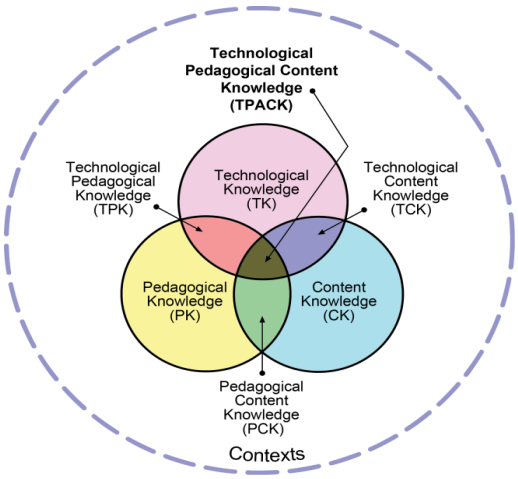

Figure 1. Technological Pedagogical and Content Knowledge (TPACK) Framework (Mishra and Koehler's, 2006)

Technology, pedagogy, and content-specific knowledge should be blended together to improve teaching and learning [12]. This model provides the framework to identify and connect the interrelationships between technology, pedagogy, and content towards developing modern teachers' effective and appropriate use of educational technologies in their teaching [10]. In the context of this present study, integrating technology in the mathematics classroom was well reflected in practice if mathematics teachers had successfully implemented the use of technology in teaching mathematical concepts.

3. METHODS

This study was descriptive in nature and data were collected through in-depth interviews and focus group discussion (FGD). This study was conducted in the select schools of the Department of Education (DepEd), Division of Cagayan de Oro City. Data were collected during the in-service training conducted and sponsored by DepEd. Respondents are gathered and was interviewed using a structured questionnaire developed by the researchers. Frequency count and the percentage were used to determine the profile of the respondents, while the responses of the participants were recorded and transcribed for the analysis of the good, bad, and ugly of integrating technology in mathematics classrooms.

4. RESULTS AND FINDINGS

The interpretation and analysis of the data collected were presented in the following tables in accordance with the problems stated in the previous chapter. Meanwhile, the demographic profile of the teacher-respondents was also presented in the following tables:

Table 1. Demographic Profile of the Teacher-Respondents

Profile of the Teacher-Respondents	Frequency	Percentage
Level		
Elementary	20	20.83
Secondary	76	79.17
Gender		
Male	27	28.13
Female	69	71.87
Length of Teaching Experience		
5 years and below	60	62.50
6 – 10 years	20	20.83
11 – 20 years	9	9.38
20 years and above	7	7.29
Highest Educational Attainment		
Baccalaureate Degree	23	23.96
With Masters' Units	62	64.58
Masters Graduate	5	5.21
With Doctoral Units	6	6.25
Doctoral Graduate	0	0.00
OVERALL	**96**	**100.00%**

The respondents' demographic profile was presented in the above table and it can be gleaned from the table that the majority mathematics teachers who participated in this study are female from the secondary high schools in the division of Cagayan de Oro City and had been in the government service for less than five (5) years and already

earned Master's degree units either in their field of specialization or in educational management or administration.

The following discussion shows the mathematics teacher's response on the structured questionnaire during the Focus Group Discussion (FGD):

Question # 1: What are the technologies you utilized in your mathematics classroom in support of students' learning of mathematics concepts?

- *Some mathematics teachers commented that they are using GeoGebra, Geometers' Sketchpad, Graphing Calculators, and DESMOS but they stressed that they wanted first to discuss the concepts before introducing these technologies to their students. Also, some teachers also make some innovations of their traditional instructional materials to make their lessons practical and innovative. However, one teacher commented that some of the teachers are using these technologies only when they are observed by their Master Teachers or School Principals. They also commented that they are using also the Learning Resource Management Delivery System (LRMDS). It is also surprising to note that one mathematics teacher is using drones in their mathematics class. Other teachers sometimes used MINITAB, SPSS or SAS and other statistical packages in their statistics classes to demonstrate how to analyze their data collected in their statistical classes.*

Question # 2: How long they have been using such tools and what are the effects on their student's learning?

- *Some teachers noted that they are not using these technologies every day because of the issue of access and availability of these technologies. Other teachers noted that since their schools have internet WIFI connections so they were able to take advantage of this provision and integrate technology in the classroom.*

Question # 3: What are the advantages and disadvantages of using these tools for the teachers and the students?

- *The mathematics teachers noted the integrating technology is really advantageous for the kind of learners they have who are technology savvy but they noted that using technology in the classroom is time-consuming and some teachers are not trained so making the work tedious or it is difficult to implement. However, they also noted that video lessons are helpful most especially when the teachers are not physically present because of other school assignments or work-related commitments.*

Question # 4: Which technological tools teachers found the most reliable and effective?

- *They noted that GeoGebra, DESMOS, and Graphing Calculators as the most available to them which they think are reliable because they are more familiar. Other mobile applications and technologies are relatively new and thus they want to be exposed and taught how to use it.*

Question # 5: What are the challenges mathematics teachers encounter when using these digital tools?

- *The digital tools are new to them and they don't know how to use it.*
- *There is an issue with the access and availability of these technologies.*
- *There is a monopoly in the use of internet connection.*
- *Computer resources are scarce.*
- *The class size is big.*
- *It is time-consuming and expensive. Some teachers do not laptops.*

Question # 6: How technology integration in the classroom affect their teaching?

- *Technology integration can make their work easier because some of the teaching or learning guides can be downloaded and therefore can be easily accessed and transferred.*
- *Students are motivated, excited, and attentive and their interests are aroused when using technology in the classroom.*
- *The technology-rich environment can make their class enthusiastic and very eager to learn new things with the use of technology*.

Question # 7: What are the teachers' recommendations in using technological tools in their mathematics classroom?

- *The mathematics teachers need to be trained on how these technologies are effective in improving the performance of students.*
- *Since not all topics in mathematics cannot be presented using technology, the teachers recommended specific topics may be identified and presented during the seminar-workshop on technology integration in the mathematics classroom.*
- *They recommended using DESMOS because aside from improving mathematics performance but also their creativity.*
- *Since their class size is big, they requested that more computers may be provided to them so they can integrate technology in their mathematics class.*
- *The budget allocation for internet connection may be reviewed so all stakeholders can benefit.*
- *They also want to request an amendment on DepED Order No. 18 prohibiting students using cellphones in the classroom because when the teacher uses it for classroom instruction, then it should be allowed in the classroom.*

5. CONCLUDING STATEMENTS

It is imperative for mathematics teachers to have tools in order to allow students to understand profoundly the mathematical concepts and a well-balanced of traditional and innovative pedagogical methods of teaching can

enhance students' mathematical abilities. Technological tools in mathematics are essential in teaching and learning because they can positively influence what is taught and enhances students' learning. Mathematics is not only a mere subject; it actually relates to many things in every student's daily life. Its study provides students with sure basic life, skills, and processes that will prepare them to be productive members of society [13]. These make technology integration a good practice for all teachers. However, it is a sad reality that mathematics teachers are not even familiar and do not use them because either they do not know how to use or they find it very difficult to implement considering their current situation. Although a number of teachers noted that they know some of the technological applications and it is so promising to implement them in their respective classes but still problems exists especially those teachers assigned in hinterland barangays where internet connectivity, access, the signal is really limited or none and the majority of their students do not have gadgets and schools may have limited resources in terms of computers and among others which led to failure to implement and integrate technology in their classes. Even in urban schools, class size is big, and therefore not every student can be accommodated to use computer laboratories. These might be the bad things in integrating technology as perceived by mathematics teachers. Finally, the ugly thing about technology integration is that according to the mathematics teachers, technological tools can also make their students lazy and become so dependent on technology that even writing notes, it has become absurd for them. Moreover, the overuse of technology can also have harmful effects on the students' and more so for the teacher's health. Hence, teachers need to regulate also the use of technology in the classroom. More importantly, as mentioned by MATHED, technology should not be regarded as a substitute for students' understanding of quantitative concepts and relationships. Caution is needed to ensure that there is no loss of proficiency in basic computation and technique that would impede later mastery of mathematics. Students and teachers do not need modern and sophisticated tools all the time.

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REFERENCES

[1] Gilksman, S. (2013). Ipad in Education For Dummies. Hoboken, New Jersey: John Wiley & Sons.

[2] National Council of Teachers of Mathematics. (2008). The role of technology in the teaching and learning of mathematics. Retrieved from http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Technology%20final.pdf

[3] The Philippine Council of Mathematics Teacher Educators (MATHED) Declaration on Mathematics Teaching and Learning for K-12. Retrieved from http://mathted.weebly.com/.

[4] Keengwe, J., & Onchwari, G. (2011). Fostering meaningful student learning through constructivist pedagogy and technology integration. International Journal of Information and Communication Technology Education, 7, 1+. Retrieved from http://go.galegroup.com.myaccess.library.utoronto.ca/ps/i.do?id=GALE%7CA270150227&v=2.1&u=utoronto_main&it=r&p=AONE&sw=w&asid=f7d358bc3ab9b73c48f55c52323d50c1.

[5] Morgan, H. (2014). Maximizing Student Success with Differentiated Learning. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 87(1), 34-38. doi:10.1080/00098655.2013.832130.

[6] Poole, B., & Evans, J. (2009). Technology Use in Teaching and Learning: What's the Return on Investment? In Education for an Information Age: Teaching in the Computerized Classroom (7th ed.).

[7] Roschelle, J., Pea, R., Oadley, C., Gordin, D., & Means, B. (2001). Changing how and what children learn in school with computer-based technologies. The Future of Children, 10(2), 76-101.

[8] Prensky, M. (2012). From digital natives to digital wisdom: Hopeful essays for 21st Century learning. Thousand Oaks, Calif.: Corwin.

[9] Roble, D. (2014). The Geometer's Sketchpad: A Technological Tool Enhancing Junior High School Students' Mathematics Achievement, Attitude towards Mathematics and Technology, American Journal of Educational Research, Vol. 4, No.15, Science and Education Publishing.

[10] Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)?. Contemporary issues in technology and teacher education, 9(1), 60-70.

[11] Foulger, T. S., Wetzel, K., & Buss, R. R. (2019). Moving toward a technology infusion approach: Considerations for teacher preparation programs. Journal of Digital Learning in Teacher Education, 35(2), 79-91.

[12] Hakverdi-Can, M., & Dana, T. M. (2012). Exemplary Science Teachers' Use of Technology. Turkish Online Journal of Educational Technology-TOJET, 11(1), 94-112.

[13] Capuno, R., Revalde, H., Etcuban, J. O., Aventuna, M., Medio, G., & Demeterio, R. A. (2019). Facilitating Learning Mathematics Through the Use of Instructional Media. International Electronic Journal of Mathematics Education, 14(3), 677-688.