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CHARACTERIZING MATHEMATICS TEACHERS' TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

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Abstract:
Technology integration requires every teacher to become skilled and competent users of computer technology in the delivery of the lesson alongside with their content and pedagogical expertise. Anchored on the Technological Pedagogical Content Knowledge Framework (Mishra & Koehler 2006), this cross-sectional correlational study aimed to investigate the technological pedagogical content knowledge of the secondary school mathematics teachers in the Division of Southern Leyte. Using an adapted standardized instrument, this study found out that mathematics teacher equipped with the necessary technological pedagogical content knowledge are generally novice, young and single female teacher who are knowledgeable in technology and technology integration and very knowledgeable in content and pedagogy. Regression analysis determines technological knowledge and technological content knowledge significantly predicts Technological Pedagogical Content Knowledge among mathematics teachers. The study concludes that strong and significant knowledge on technology, pedagogy and content and their interrelatedness defines teachers' creativeness and effectiveness in developing and delivering new mode of representations and solutions of mathematical content and problems making them responsive to the 21st century learners, and thereby recommends to strengthen mathematics teachers' knowledge through continuous attendance to conferences and/or workshops on technology-integration in mathematics classroom.

Keywords: TPACK, regression analysis, 21st century learners, technology-integration, cross-sectional correlation

1. Introduction

Enhanced and effective teaching and learning process requires not only the mastery of subject matter but also expert in pedagogy, more importantly the integration of

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technology and most especially the interrelatedness of these three. Technology integration requires every teacher to become skilled and competent users of computer technology in the delivery of the lesson alongside with their content and pedagogical expertise. This development requires mathematics teachers to be adept in the use of technology to maximize its benefits while being used in classroom instruction. It is, likewise, a recognition for the need of teachers to engage in continuing professional development to improve knowledge, understanding, skills in using technology, teacher's familiarity and ability (Hargreaves, 1992; Queensland College of Teachers, 2006; Australian Association of Mathematics Teachers, 2006; Wells, 2007; Sprague, 2007).

The K plus 12 Curriculum emphasized that the ultimate goal of Mathematics is the development of students' critical thinking and problem solving. Literatures revealed that technology integration supports both the learning of mathematical procedures, skills and proficiencies (Gadanidis & Geiger, 2010; Kastberg & Leatham, 2005; Nelson, Christopher, & Mims, 2009; Pierce & Stacey, 2010; Roschelle, et al., 2009, 2010; Suh & Moyer, 2007).

Technology integration in education enhances teaching and learning, students' motivation, instruction, and encourages communication and the sharing of knowledge (Sivin-Kachala & Bialo, 2000; Higgins, 2003; Ittigson & Zewe, 2003; Becta, 2003). The study of Bingimlas (2009) manifests that teachers really had a strong desire to integrate ICT into classroom discussion. In fact, these teachers are starting to use technology ranging from the use of software packages, instructional strategy and in lesson planning (Cuban, Kirkpatrick, & Peck, 2001; Srkin, et.al., 2004; Hardy, 2004; Swan & Dixon, 2006).

Apart from these, teachers were also sent to training for proper use of technology in the classroom as evident by the various programs and orders of the Department of Education (DO 121, s. 2010; DO 113, s. 2009; DO 105, s. 2009; DO 78, s. 2009; DO 62, s. 2009; DO, 28, 2009). Moreover, to intensify teacher readiness in the use of technology in the classroom and in line with the modernization program of the Department of Education, computer literacy among teacher-applicants is a basic requirement for hiring (DO 37, s. 1997).

Despite, however, of these moves of the Department of Education, quite a number of mathematics teachers are still reluctant in the use of technology in teaching mathematics due to some personal and technical barriers (Bingimlas, 2009; Newby, et. al., 2006). These technological barriers hinder the appropriate integration of technology in the mathematics discussion among mathematics teachers in Asia (Hudson, 2008) and in America (Sulia, 1998; Donald, 1998; D'Sousa, 2003; Palmer, 2002).

This intercontinental problem urges the researcher to probe into the local situation and investigate on the technology integration among mathematics teachers in the classroom. Different from other studies, this study tries to consider technology knowledge as inseparable entity of teachers' pedagogical and content knowledge.

This study, therefore, delves into the interrelatedness of the teachers' knowledge in technology, content and pedagogy. The researcher believes that these three are inseparable for an effective use of technology gearing towards student-teacher teaching and learning interaction. Thus, a model of a teacher who is equipped with the technological pedagogical content knowledge is what this study aims to contribute in the fulfillment of the governments' effort to develop globally competent teachers for ASEAN integration.

2. Framework of the Study

This study is anchored on the Technological Pedagogical Content Knowledge (TPCK) framework by Mishra & Koehler (2006).

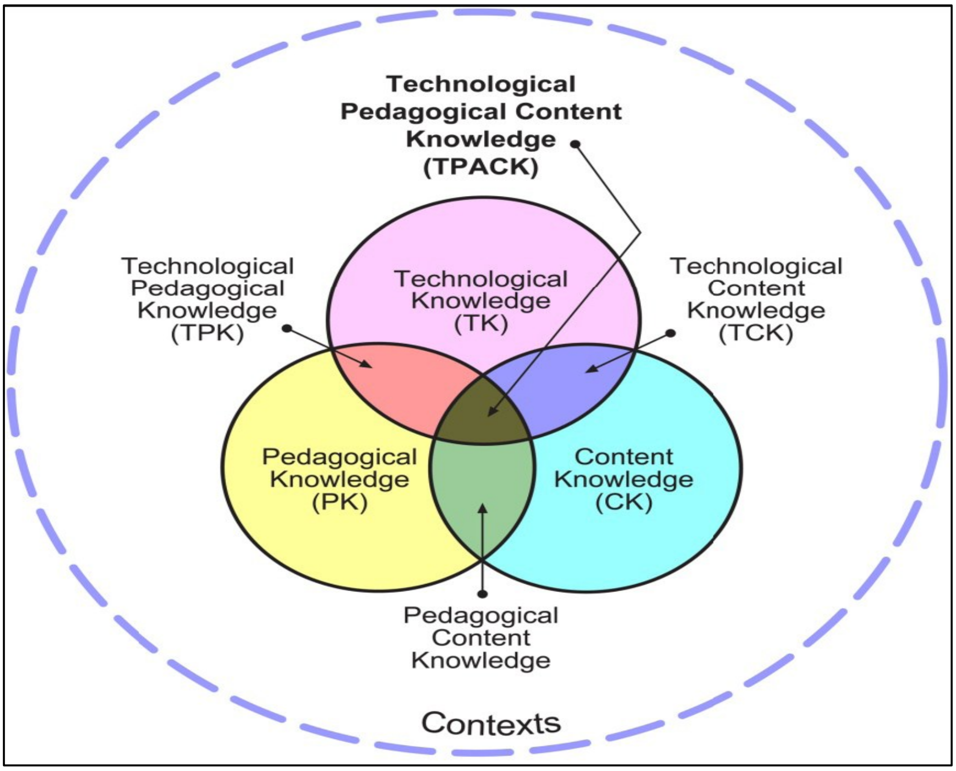

Figure 1: Technological Pedagogical Content Knowledge Framework
(Mishra & Koehler, 2006)

Technological Pedagogical Content Knowledge (TPCK) was introduced to the educational research field as a theoretical framework for understanding teacher knowledge required for effective technology integration (Mishra & Koehler, 2006). The TPCK framework acronym was renamed TPACK (pronounced "tee-pack") for the purpose of making it easier to remember and to form a more integrated whole for the three kinds of knowledge addressed: technology, pedagogy, and content (Thompson & Mishra, 2007–2008). The TPACK framework builds on Shulman's construct of Pedagogical Content Knowledge (PCK) to include technology knowledge as situated within content and pedagogical knowledge.

TPACK is a framework that introduces the relationships and the complexities between all three basic components of knowledge (technology, pedagogy, and content)

(Koehler & Mishra, 2008; Mishra & Koehler, 2006). At the intersection of these three knowledge types is an intuitive understanding of teaching content with appropriate pedagogical methods and technologies. Seven components are included in the TPACK framework.

3. Methodology

3.1 Research Locale and Respondents

This study was conducted in the Division of Southern Leyte specifically to the randomly selected 13 public national high schools of the division. The target respondents were purposively identified and, considering the limited number of mathematics teachers assigned in the pacific area, all of these mathematics teachers (N=52, M= 10, F=42) were considered as the respondents of the study.

3.2 Research Design

This study employed the use of cross-sectional correlation research design. This design enabled the researcher to observed two or more variables at the point in time and was useful for describing a relationship between two or more variables (Breakwell, Hammond & Fife-Schaw, 1995). The design involved collecting data in order to determine whether, and to what degree, a relationship exists between two or more quantifiable variables (Gay & Airasian, 2000).

In cross-sectional correlational research, the data were collected from research participants at a single point in time or during a single, relatively brief time period (called contemporaneous measurement), the data directly applied to each case at that single time period, and relationship were made across the variables of interest. (Johnson, 2000).

This design best fit in this study because the latter aimed to correlate variables of interest describing the technological pedagogical content knowledge of the respondents in a certain period of time.

3.3 Research Instrument

This study utilized an adopted questionnaire developed and standardized for international use by Hosseini and Kamal (2012) and was used in the Philippines, particularly at University of San Carlos, Cebu City, by Ed van den Berg (2014).

Part I determined the profile of the respondents which covers the socio demographic information like sex, age, civil status and some education-related questions.

Part II was questions that assessed the availability of technology for mathematical instruction and the extent of its utilization by secondary mathematics teachers in the pacific area of the division of Southern Leyte.

Part III of the questionnaire constituted the assessment for the technological pedagogical content knowledge among the secondary mathematics teachers in the pacific area of the Division of Southern Leyte. Table 1 reflects the knowledge categories evaluated with their corresponding reliability index.

Table 1: Reliability Index of the Technological Pedagogical Content Knowledge

Knowledge Type	No. of Items	Reliability Index
Technological Knowledge	11	0.82
Content Knowledge	8	0.85
Pedagogical Knowledge	7	0.84
Technological Content Knowledge	6	0.80
Pedagogical Content Knowledge	10	0.85
Technological Pedagogical Knowledge	10	0.86
Technological Pedagogical Content Knowledge	7	0.92

Each item of the instrument was answered according to the respondents' degree of agreement and disagreement (4=strongly agree; 1=strongly disagree).

3.4 Data Gathering Procedure

The gathering of data for this research first started with the seeking of permission from the district supervisors and principals in the intended districts and schools of the Division of Southern Leyte, respectively. With the approval, the researcher fielded the questionnaires to the pre-identified target respondents in each school. Retrieval of questionnaires was on the day after the distribution to provide the respondents with enough time to fill the questionnaire with the necessary information needed. In case some teacher-respondents were not able to answer the questionnaires due to time constraints in their daily class schedule, the same were still retrieved as soon as they're finished.

3.5 Statistical Treatment of Data

The data gathered from the questionnaires for this study were subjected to statistical analysis and interpretations using appropriate statistical tools. These descriptive statistical tools included frequency counts, percentage, and weighted means. For inferential questions that seek significant relationships among the treated variables in this study, inferential statistical tools as t-test for independent samples, correlation analysis, multiple regression analysis, and cluster analysis.

4. Results and Discussion

4.1 Level of Technological Pedagogical Content Knowledge

Result of the analysis confirms that mathematics teachers of Southern Leyte division are very knowledgeable (M=3.26; stdev=0.61) in the pedagogical aspect of teaching and are knowledgeable ($M_{average}$=2.88; $stdev_{average}$=0.06), on the average, in the other types of knowledge.

As expected, teachers are experts in the use of appropriate methods and processes of teaching. This is well-evident in the result of this study where mathematics teachers are very knowledgeable (M=3.26; stdev=0.61) in the pedagogical aspect of teaching. This means that mathematics teachers in the pacific area are very much aware on the various methods, strategies and techniques of teaching-learning process, its cycles and procedures, including knowledge on classroom management, assessment, lesson plan development and student learning.

This further implies that after years of teaching, these teachers have come into a realization on the importance of strategies in the effectiveness of teaching mathematics (Daguplo, Consul, & Consul, 2015). This realization encourages these teacher-respondents on the combination of the traditional but effective strategies and the modern pedagogical techniques which increases demonstration and validation of various topics in mathematics. Such realization is important because the nature and complexity of mathematics requires effective teaching which is brought about by understanding and utilizing various strategies that enables teachers to continually evaluate and improve teaching-learning activities (Devela, et. al., 2000). The use of these various strategies supports the claim of Vega (2008) who stressed that there is no single standard strategy to teaching in the various field of education.

With reference to the other types of knowledge where mathematics teachers are knowledgeable ($M_{average}$=2.88; $stdev_{average}$=0.06), result implies that mathematics teachers are aware on the average extent on the content and technology issues of teaching secondary mathematics. This further implies that teachers are still in need of continued learning to technology-content integration to equip themselves with the thorough understanding on the knowledge of mathematical contents and the strategic delivery of these contents using technology (Adediwura & Tayo, 2007).

The challenge for mathematics teachers in the 21st century is to think on how to step into a digital learning environment to strengthen their knowledge on how to integrate technology to content and pedagogy in various ways (Garofalo, Drier, Harper, Timmerman, & Shockey, 2000) to meet the needs of the 21st century learners. Literatures revealed that content-based activities using technology address worthwhile mathematics concepts, procedures, and strategies, and should reflect the nature and spirit of mathematics (Jiang & McClintock, 2000; NCTM, 2000; Waits & Demana, 2000). Mathematics classroom activities should support sound mathematical curricular goals and should not be developed merely because technology makes them possible. Indeed, the use of technology in mathematics teaching should support and facilitate conceptual development, exploration, reasoning and problem solving, as described by the NCTM (1989, 1991, 2000).

The result of the study, in relation to TPACK as a framework, reveals that mathematics teachers, despite of their effort to integrate technology in the classroom, are still behind compared to other more advance institutions in and outside the country. With the present data provided in this study, there is a need to revisit and re-evaluate teachers' role in implementing various programs to appropriately integrate technology at par with other schools globally in the contemporary society by making a concrete analysis and evaluation of their performance in the area of technology, pedagogy and content as reflected in the various students' performance in mathematics locally, regionally, nationally and globally. As the literature said, "*A teacher who can navigate between these interrelations acts as an expert who is different than a sole subject matter, pedagogy, or technology expert*" (Mishra & Koehler 2006). It is, therefore, not just enough for a teacher to be expert separately in content, in pedagogy, and in technology, rather, mathematics teacher should know and master how to integrate this three bodies of knowledge navigating its interrelatedness to surely uplift teaching outcome.

Recent studies in mathematics achievement highlight the importance of the teachers as main factors affecting performance in the subject. As quoted from U.S. Department of Education's White Paper Report (2003) "*…high quality teachers are the most important factor in a child's education*". Teachers' competency and effectiveness impact learning and promote higher level of achievements (TIMMS, 2000). The quality of instruction and effective instructional design are necessary to alleviate problems related to teaching and learning mathematics (Dursun & Dede, 2004). This generalizes that teachers quality contributes a lot in the effectiveness of the school, hence quality instruction produces high achievement.

Table 2: Mathematics Teachers'' Level of Technological Pedagogical Content Knowledge

Type of Knowledge	Mean	stdev	Qualitative Description
• Technology Knowledge	2.54	0.72	Knowledgeable
• Content Knowledge	3.22	0.62	Knowledgeable
• Pedagogical Knowledge	3.26	0.61	Very Knowledgeable
• Pedagogical Content Knowledge	3.14	0.61	Knowledgeable
• Technological Content Knowledge	2.74	0.70	Knowledgeable
• Technological Pedagogical Knowledge	2.84	0.71	Knowledgeable
• Technological Pedagogical Content Knowledge	2.77	0.76	Knowledgeable

Note: 1.00 – 1.74 (Not Knowledgeable); 1.75 – 2.49 (Moderately Knowledgeable); 2.50 – 3.24 (Knowledgeable); 3.25 – 4.00 (Very Knowledgeable)

4.2 Relationship between the Respondents' Profile and their Level of Technological Pedagogical Content Knowledge

Analysis on the relationships between the respondents' profile and their level of technological pedagogical content knowledge reveals that majority of the variables in the respondents profile has a weak linear relationship with the various type of technological pedagogical content knowledge ($.01 < r < .30$). Only the variable "Number of years in service" is moderately related to technology-based type of knowledge ($0.31 < r < 0.70$). This implies that respondents' profile does not explain much of their knowledge level on the various technological pedagogical content knowledge. Having a weak linear relationship means that the change in one variable cannot be attributed fully to the change in the other variable. It might be that the relationship is spurious, or the variables are multi-collinear, or that the variables are related because of some other variable.

It is also reflected in the result that sex, age, civil status, number of years in service and number of trainings attended is not significantly related to content and pedagogy. This means that teachers' knowledge of mathematics cannot just be explained immediately through their socio-demographic profile. We might, therefore, take a hypothetical assumption that teachers' knowledge in pedagogy and content comes naturally as they studied, learned and embraced the idea of becoming a teacher and not only because of their age, sex, civil status, number of training attended and number of years in service.

A discussion of the nature of teacher knowledge and pedagogy is connected on the belief that effective teaching is a skill that can be acquired through years of study and learning (Darling-Hammond et al., 2009). Effective teachers are made over time, through education, perseverance, practice and guidance (Knapp, 2012).

Specific results revealed that age (r=-0.27) and years in service (r=-0.32), despite a weak relationship, are significantly related to technological knowledge (*p-value* < *.05*). It cannot be denied somehow that these two variables (age and years in service) measures the same concept, "the length of time", which can be considered as an inseparable entity. With a negative linear relationship, it can further be explained that mathematics teachers with younger age and are new in service are more exposed to technologies. From this perspective, mathematics teachers of the division of Southern Leyte who joined the education force recently are more aware and technology-oriented compared to those teachers who are having longer years in service. These are the kind of teachers who are more equipped with knowledge in transferring and integrating mathematical content with technology.

Oftentimes, many schools have high numbers of teachers who may lack experience and qualification in terms of technology integration in class. These teachers are those who joined the teaching force a longer time meaning their age are older, the time when technology is not yet in trend. In many cases, these teachers often do not receive additional professional development or support as of this time. Thus, only those teachers who grow up during the emergence of the technology are also good at it and these are the younger teachers or newer in service.

Table 3: Relationship between the Respondents' Profile and their Level of Technological Pedagogical Content Knowledge

Variables	**Profile**				
Knowledge Type	**Sex**	**Civil Status**	**Age**	**No. of Years in Service**	**No. of Trainings**
Technological	-0.05	0.14	-0.27*	-0.32*	0.11
Content	0.04	0.30	0.08	0.16	0.05
Pedagogical	0.03	0.14	0.02	0.07	0.04
Pedagogical Content	0.08	0.10	0.02	0.10	-0.23
Technological Content	0.07	0.19	-0.29*	-0.37*	-0.15
Technological Pedagogical	0.13	0.03	-0.24	-0.33*	-0.08
Technological Pedagogical Content	0.05	0.06	-0.20	-0.23*	0.17

*significant at 5% level of significance

Note: 0.01 < r < 0.30 = linear relationship is weak; 0.31 < r < 0.70 = linear relationship is moderate; 0.71 < r < .99 = linear relationship is strong (Maples, 2014)

To describe the relevance of age and years in service in teaching, Carroll (2008), president of the National Commission on Teaching and America's Future reports that a third of the nation's teachers are baby boomers who are wedded to a stand-and-deliver teaching process. Carroll stated, *"We have a new group of young Generation teachers. They're in their 20's and were hired recently and while they often share the values of the '[baby] boomers' they tend to be very idealistic and very oriented to teamwork, collaboration, constant communication, multi-tasking, and technology"*.

Therefore, teachers in this age belongs to what they termed "baby-boomers" who are more eager and willing to learn more especially in integrating technology in teaching. This generation of teachers, are now starting to change the way contents are being taught in the classroom by using modern approaches in teaching together with the appropriate use of technologies that motivate and enhances learning especially in the field of mathematics.

4.3 Relationship among Types of Knowledge

Correlation matrix below shows the relationship among the types of knowledge using Bayesian probability. As observed, all except content and pedagogical knowledge are significantly related to technological pedagogical content knowledge. This kind of result implies that teachers' knowledge in technology cannot be determined through their knowledge in content and in pedagogy. This can be thought and explained in such a way that a teacher may have mastered all of the contents or the subject matter in mathematics but of less knowledge in technology, or a teacher can be very creative in terms of strategies and methods in teaching without the integration of technology. But this does not mean that these two types of knowledge (content and pedagogy) are less important that technological knowledge. The fact, however, remains that the integration of these three types of knowledge is still the best.

This belief was carried out by the mathematics teachers in the pacific area of Southern Leyte which understands the importance of these three bodies of knowledge in the attainment of higher student learning output. They believed that at the heart of good teaching, are three core components: content, pedagogy, and technology, plus the relationships among and between them. The interactions between and among the three components, playing out differently across diverse contexts, account for the wide variations seen in the extent and quality of educational technology integration. These three knowledge bases (content, pedagogy, and technology) form the core of the technology, pedagogy, and content knowledge (TPCK) framework (Mishra and Koehler, 2006).

Result further indicates, that pedagogical knowledge (r=0.181) is not significantly related to technological pedagogical content knowledge (*p-value>0.05*). This implies that teachers' knowledge in the methods and processes of teaching including knowledge in classroom management, assessment, lesson plan development, and student learning does not necessarily explain or explicate the teachers' knowledge in technological pedagogical content. A teacher which happens to be brilliant in terms of classroom strategies and methods may or may not be well-equipped in technological pedagogical knowledge. It might be that the teacher is just very good in pedagogy but not in technological pedagogical content. This explains why technological knowledge is not necessarily significantly related to pedagogical knowledge of teachers. One may be equipped technologically but not pedagogically, and vice versa.

Table 4: Correlation Matrix on the Relationship among Types of Knowledge

Knowledge Type	TK	CK	PK	PCK	TCK	TPK	TPCK
Technological (TK)	1	.273	.085	.250	.479**	.422**	.570**
Content (CK)		1	.572**	.586**	.436**	.448**	.378**
Pedagogical (PK)			1	.832**	.331*	.306*	.181
Pedagogical Content (PCK)				1	.401**	.428**	.295*
Technological Content (TCK)					1	.740**	.730**
Technological Pedagogical (TPK)						1	.618**
Technological Pedagogical Content(TPK)							1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

4.4 Significant Predictors of Technological Pedagogical Content Knowledge

This study hypothesized that there is no significant predictors of technological pedagogical content knowledge. Results, however, rejects this hypothesis and found out that technological knowledge and technological content knowledge are significant predictors (p-value < 0.5) of technological pedagogical content knowledge of secondary mathematics teachers.

The result implies that the technological pedagogical content knowledge of the teachers can be predicted through their level of technological knowledge and technological content knowledge. Which means that the level of technological pedagogical content knowledge of the mathematics teachers can be identified based on the level of technological knowledge and technological pedagogical content knowledge. Having significant predictors, we can say that this finding is true not only to this group of respondents but could also be possibly true to the entire secondary mathematics teachers as a whole.

Table 5: Significant Predictors of Technological Pedagogical Content Knowledge

Knowledge Predictors	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
Constant	.204	.461		.443	.660	-.724	1.133
Technological	.297	.128	.257	2.330	.024	.040	.554
Content	.100	.147	.084	.676	.502	-.197	.396
Pedagogical	-.130	.217	-.108	-.599	.552	-.567	.307
Pedagogical Content	.018	.217	.015	.084	.933	-.419	.455
Technological Content	.539	.155	.511	3.475	.001	.226	.851

Technological Pedagogical	.120	.144	.120	.830	.411	-.171	.411

Note: predictor is significant if p-value < 5% level of significance.

With these predictions, confusions may bother teachers and questions like "*What is the role of pedagogy then?*" may rise. A universal tenet explains that "*Nobody can teach what he/she does not understand*", and "*teaching is not possible without methods and strategies*", this might answer this confusions. As cited from Onyeachu (1996), teaching is a multidimensional construct of subject mastery, effective communication, lesson preparation, presentation, strategies and methods. One can shortly say that a teacher who masters the lesson knows the best strategy to utilize in order to make that lesson better understood by students. This implies that with content knowledge, pedagogical knowledge also comes. This is well-reflected in the significant relationship established between content and pedagogical knowledge of teachers.

Table 6: Stepwise Regression Model for Technological Pedagogical Content Knowledge

Knowledge Predictors	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
Constant	.186	.316		.588	.559	-.450	.822
Technological	.625	.109	.593	5.733	.000	.406	.845
Technological Content	.331	.119	.286	2.768	.008	.091	.571

Stepwise Regression Model: TPCK = 0.186 + 0.331 TK + 0.625 TCK
Note: The model is significant at 1% level of significance and explains 60% of the variability of the dependent variable

To specifically create a model for predicting technological pedagogical content knowledge, a stepwise regression analysis was made to objectively include only significant predictors. Result of stepwise regression analysis is a model

$$TPCK = 0.186 + 0.625TK + 0.331TCK \qquad \text{(Model 1)}$$

The regression model is significant at 1% level of significance and explains 60% of the variability of the technological pedagogical content knowledge of secondary mathematics teachers. This can be understood that the model can significantly explain the variability of teachers TPACK by 60% - explaining the differences of TPACK level more than 50%. This implies that technology knowledge and technological content knowledge as predictor of technological pedagogical content knowledge plays a very important role in the field of effective teaching and learning. This means that high TPACK is a function of an integrated relationship between knowledge of subject matter and knowledge in technology (Glaser, 1984; Putnam & Borko, 2000; Shulman, 1986, 1987). This reflects the deep historical relationship between technology and content.

Knowledge in technology is not just "The wave of the future"; it is likewise the wave of the present. It is a systematic and organized process of applying modern technology to improve the quality of education. It is a systematic way of conceptualizing the execution and evaluation of the educational process like learning and teaching and help with the application of modern educational teaching techniques. It includes instructional materials, methods and organization of work and relationships (Pedagoški leksikon, 1996).

Understanding the impact of technology on the practices and knowledge of a given discipline is critical to developing appropriate technological tools for educational purposes (Koehler & Mishra, 2006). Adequate knowledge in the content areas would be essential for any teacher to perform competently. The acquisition of knowledge and understanding of any subject would not be just a matter of collecting facts and information about the subject, more importantly; it is learning to think in a way that is characteristic of that discipline (Daguplo, et. al, 2015).

4.5 Characteristics of Teachers Equipped with Technological Pedagogical Content Knowledge

Below are the characteristics of a model teacher equipped with technological pedagogical content knowledge. Two clusters were developed through cluster analysis: first, the characteristics of mathematics teachers highly equipped with TPCK and second, the characteristics of mathematics teachers less equipped with TPCK.

Secondary mathematics teachers in the pacific area of Southern Leyte that are highly equipped with TPCK are characterized as:

1. Mathematics teachers that are knowledgeable in technology, technological content and technological pedagogical;
2. Mathematics teachers that are very knowledgeable in content, pedagogy and pedagogical content;
3. Usually young, single female and are novice in the teaching profession.

Teachers needs to be knowledgeable in technology, technological content and technological pedagogical in order to be well-equipped in technological pedagogical aspect. Being knowledgeable in technology means that teachers need to be familiar about various technologies and applications that can be utilized appropriately in teaching mathematics. It also focuses on the practice of using ICT to facilitate learning and improve performance by applying appropriate technological processes and resources (Richey, 2008), thus, knowledge in technological pedagogical takes into picture. They should know how to manipulate these technologies and applications so that they can create a meaningful and more motivational technique which can be applied and used in classroom settings and can be learned by the students.

As Tallerico (2013) emphasized, to be an effective teacher of the new standards, one must give students substantially different instructional resources that promote application of their learning in authentic situations. This transformation of new standard requires that teachers can face their new tasks in a more flexible way and be prepared for their new roles. Their main challenge, however, is not just teaching concepts for understanding, rather, it is finding appropriate applications of the concepts to deepen and enrich students' learning which directly points knowledge on technological content.

Teachers highly equipped with technological pedagogical knowledge also need to be very knowledgeable in content, pedagogy and pedagogical content. It is a well-known fact that teachers' subject knowledge has an influence on students' learning in the classroom settings. And it is a fact however, that teachers are very knowledgeable in terms of subject matter and strategies and methods in teaching. Four years of studying education program hone this kind of abilities of teachers. Historically, knowledge bases of teacher education have focused on the content knowledge of the teacher (Shulman, 1986; Veal & MaKinster, 1999).

More recently, teacher education has shifted its focus primarily to pedagogy, emphasizing general pedagogical classroom practices independent of subject matter and often at the expense of content knowledge (Ball & McDiarmid, 1990). Different approaches toward teacher education have emphasized one or the other domain of knowledge, focusing on knowledge of content or knowledge of pedagogy. Shulman (1986) creates an advanced thinking about teacher knowledge by introducing the idea of pedagogical content knowledge (PCK). He claimed that the emphases on teachers' subject knowledge and pedagogy were being treated as mutually exclusive domains in research concerned with these domains. The practical consequence of such exclusion was production of teacher education programs in which a focus on either subject matter or pedagogy dominated (Shulman, 1987).

Table 7: Characteristics of Teachers Equipped with Technological Pedagogical Content Knowledge

Variable Categories	Highly Equipped with TPCK	Less Equipped with TPCK
• Technological Knowledge	Knowledgeable	Moderately Knowledgeable
• Content Knowledge	Very Knowledgeable	Knowledgeable
• Pedagogical Knowledge	Very Knowledgeable	Knowledgeable
• Pedagogical Content Knowledge	Very Knowledgeable	Knowledgeable
• Technological Content Knowledge	Knowledgeable	Moderately Knowledgeable
• Technological pedagogical Knowledge	Knowledgeable	Knowledgeable
• Age	30.88	46.05
• Sex	Female	Female
• Civil Status	Single	Married
• Training	1.48	2.15
• Experience	5 year	19 years

Note: 1.00 – 1.74 (Not Knowledgeable); 1.75 – 2.49 (Moderately Knowledgeable); 2.50 – 3.24 (Knowledgeable); 3.25 – 4.00 (Very Knowledgeable)

Results further shows that mathematics secondary teachers highly equipped with technological pedagogical content knowledge are young (M=30) single, and usually female. It is somehow recognizable that teachers at these stage are more technology - oriented and that they are more into these kinds of stuffs. They love to explore, dig things out as to what can make their lessons more meaningful and livelier to gain students attention and interests. They are these teachers who are novice in teaching field (at least 5 years in service), even acquiring minimal trainings related technology.

Several study was conducted to investigate more clearly and decisively the relation between teacher effectiveness and age over time. It was predicted that, as with research productivity, performance as a teacher would decline as the faculty member aged or as it lasts longer in service (Harry et.al, 1989). Other studies, on the other hand, have found no change or a decline in the level of teacher efficacy over the years of teacher education (Lin & Gorrell, 2001; Plourde, 2002; Yeo, Ang, Chang, Huan, & Quek, 2008). Yeo and colleagues (2008) found that Singaporean teachers who had been teaching for five or more years reported stronger efficacy in teaching than their pre-service counterparts.

According to Peralta & Costa (2007), teachers with more experience with computers have greater confidence in their ability to use them effectively. Gorder (2008) revealed that effective use of computer was related to technological comfort levels and the liberty to shape instruction to teacher-perceived student needs. A survey of almost 3000 teachers, Russell, O'Dwyer, Bebell and Tao (2007) argued that the quality of ICT integration was related to the years of teacher service.

Baek, Jong & Kim (2008) claimed that experienced teachers are less ready to integrate ICT into their teaching. Similarly, in United States, the (U.S National Centre for Education Statistics, 2000) reported that teachers with less experience in teaching were more likely to integrate computers in their teaching than teachers with more experience in teaching. According to the report, teachers with up to three years teaching experience reported spending 48% of their time utilizing computers, teachers with teaching experience between 4 and 9 years, spend 45% of their time utilizing computers, teachers with experience between 10 and 19 years spend 47% of the time, and finally teachers with more than 20 years teaching experience utilize computers 33% of their time. The reason to this disparity may be that fresh teachers are more experienced in using the technology.

5. Conclusion

Strong and significant knowledge on technology, pedagogy and content and their interrelatedness defines teachers' creativeness and effectiveness in developing and delivering new mode of representations and solutions of mathematical content and problems making them responsive to the 21st century learners.

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