Cypriot Journal of Educational Sciences

Volume 15, Issue 3, (2020) 619-633

www.cjes.eu

Content knowledge level of elementary mathematics teachers: The case of a school district in the Philippines

Craig N. Refugio*, College of Education, Graduate School, Math Department and College of Engineering & Architecture, Negros Oriental State University, Dumaguete City 6200, Philippines. https://orcid.org/0000-0003-1374-6103

Patrick G. Galleto, College of Education & Graduate School, Jose Rizal Memorial State University, Dapitan City 7101, Zamboanga del Norte, Philippines. https://orcid.org/0000-0001-7534-6581

Clint D. Noblefranca, Negros Oriental Schools Division, Dumaguete City 6200, Philippines.

Hermie V. Inoferio, College of Education, Jose Rizal Memorial State University, Katipunan Campus, Katipunan 7109, Zamboanga del Norte, Philippines.

Arturo O. Macias, Jr., New Mexico Department of Education, New Mexico, USA

Dundee G. Colina, Instructor, College of Arts & Sciences, Foundation University, Dumaguete City 6200, Philippines.

Charles Y. Dimalig, MAMT, Principal 1, Siquijor Province Schools Division, Siquijor 6225, Philippines.

Suggested Citation:

Refugio, C.N., Galleto, P.G., Noblefranca, C.D., Inoferio, H.V., Macias, A.O., Colina, D.G., & Dimalig, C.Y., (2020). Content knowledge level of elementary mathematics teachers: The case of a school district in the Philippines. *Cypriot Journal of Educational Sciences*, *15*(3), 619-633. DOI: 10.18844/cjes.v15i3.4551

Received from October 13, 2019; revised from February 15, 2020; accepted from June 24, 2020.

Abstract

Demonstrating knowledge of content requires teachers to display extensive knowledge of the critical concepts in the discipline. This study was set up to provide a research-based landscape of the content knowledge level of elementary mathematics teachers viewed in the local district of Ayungon in the Division of Negros Oriental, Philippines. Survey and correlational methods of research were used in the study involving 95 non-randomly selected teachers. Results revealed that the content knowledge level of the teachers was approaching proficiency. The teachers' educational attainment, number of training attended, and the number of years in teaching mathematics were not significantly related to their content knowledge level. It was concluded that teaching experience and professional development in the form of pursuing graduate studies and attending training did not have bearing with the content knowledge level possessed by the teachers. However, the teachers were inferred as resourceful and committed to teaching mathematics despite their weaknesses in the content knowledge to share with their learners. Hence, enhancement training in all areas in mathematics is to be provided to elementary mathematics teachers by implementing the training design developed by the researchers. The ultimate goal is to develop further the content knowledge, mastery, and skills of the teachers to achieve the highest proficiency level in mathematics.

Keywords: Content knowledge, proficiency level, enhancement training design;

1. Introduction

Basic education in the Philippines has meaningfully adapted to changes expected by the current and future generations. The introduction of the K to 12 Curriculum is no longer an option but a necessity. The move has come not just from the potentiality of the new technology, pedagogy, and curricular reform, but from the teachers' content knowledge, which has been made most of the remotely located schools mostly usable. With this, the teachers' content knowledge is claimed as crucially helpful in overlong the stumbling blocks of growth and development among the learners of basic education institutions in the country despite the scarcity of physical and instructional facilities.

Accordingly, content knowledge refers to the amount and organization of experience in the mind of the teacher (Zhang, Liu & Cai, 2019). It describes the teachers' knowledge of the subject matter (Malik, Rohendi, & Widiaty, 2019; Kurt, 2019). It includes facts, concepts, structures, and rules that incorporate those facts and ideas (Ozudogru & Ozudogru, 2019) as well as the field's best practices and established approaches to communicating information to students (Kurt, 2019). Initially, teachers must have an in-depth knowledge of the subject matter to teach contents in logical and organized ways before mastering other aspects of teaching.

Demonstrating knowledge of content requires the teachers to display extensive knowledge of the critical concepts in the discipline. Teacher knowledge is the basis for teachers' instructional practices in their classrooms (Lee, Capraro & Capraro, 2018). The ideas to be taught should be related both to one another and to other disciplines. Conceptual interconnectedness provides a framework for students to explore how various disciplines interact with one another to form a complex whole that operates in the curriculum. The teachers must prove to understand of prerequisite relationships among topics and concepts. They also need to follow the link to necessary cognitive structures that ensure learner understanding.

Unfortunately, a lack of content knowledge is problematic in teaching in classroom subject areas (Sinelnikov, Kim, Ward, Curtner-Smith, & Li, 2016). Evident to this commentary, Roces (2019) disclosed that Philippine education had declined a few years ago due to poor results from the National Achievement Test (NAT) conducted among elementary and secondary students. The NAT performance of the country for the school year 2018-2019 registered 54.66 percent and 44.33 percent average scores for sixth graders and junior high school students, respectively. The results were way below the minimum target mean rating of 75 percent set by the Department of Education. The disparity in the performance of students in the nationally administered test may be due to the low level of content knowledge that the teachers possessed.

Unarguably, teachers cannot teach what they do not know and what they do not know limits their students' learning (Kim, Ward, Sinelnikov, Ko, Iserbyt, Li, & Curtner-Smith, 2018). However, while teachers' content knowledge is crucially important to the improvement of teaching and learning, attention to its development and study has been uneven (Ball, Thames & Phelps, 2008). This scenario is also evident in the Division of Negros Oriental, particularly in Ayungon District 2. Historically, training of teachers in the district focused on many aspects of teaching, but more often than not, scant attention has been given to how teachers need to understand the subjects they teach. For this reason, this study was set up to provide a research-based landscape of teachers' content knowledge level to be viewed in the local district of Ayungon in the Division of Negros Oriental, Philippines. The study looked for with an end view of providing content enhancement training for teachers to address how much preparation teachers need in the content strands rather than on what type of content they need to learn.

2. Methods

2.1 Research design

Survey and correlational methods of research were used in the study. The survey method was employed since the researchers gathered data through a questionnaire checklist to profile the respondents' personal and demographic variables, including their content knowledge level. Creswell and Guetterman (2019) defined a survey as a research method used for collecting data from a pre-defined group of respondents to gain information and insights on various topics of interest. On the other hand, correlational research is a type of non-experimental research method, in which a researcher measures two variables, understands and assesses the statistical relationship between them with no influence from any extraneous variable (Bhat, 2019). A correlational analysis was performed to determine the significant relationship between the profile of the respondents and their content knowledge level.

2.2 Research respondents

Ninety-five mathematics teachers across the 15 elementary schools in Ayungon District 2 in the Division of Negros Oriental served as research respondents. The respondents were selected through non-random sampling. Table 1 shows the distribution of mathematics teachers in the 15 elementary schools.

Table 1. Number of mathematics teachers per elementary school

Elementary Schools (Coded)	Mathematics Teachers
A	4
B	5
C	11
D	9
E	5
F	6
G	6
H	4
I	6
J	6
K	6
L	6
M	6
N	8
O	7
Total	**95**

2.3 Research environment

The study took off in Ayungon District 2, which is one of the school districts in the municipality of Ayungon in the Division of Negros Oriental, Philippines. The municipality is 82 kilometers north of Dumaguete City. It has 15 elementary schools, 3 junior high schools, and 3 senior high schools. Moreover, the elementary level has 140 teaching personnel per Personal Services Itemization and Plantilla of Personnel of the division.

2.4 Research instrument

The questionnaire used in the study consisted of two parts: the profile of the respondents and the content knowledge scale. The profile included sex, age, highest educational attainment, number of hours of mathematics training attended, and number of years of teaching mathematics. The content knowledge scale covered the areas along with Numbers and Number Sense, Measurement, Geometry, Patterns, Functions and Algebra, and Data Analysis and Probability. The instrument was presented to the Mathematics Supervisors, Master Teachers & Mathematics Education research experts for content validation. Suggestions of the experts were incorporated, and the final form of the instrument was made. It was pilot tested to selected elementary mathematics teachers of the Division of Dumaguete City as well as adjacent school districts of Ayungon District 2. The instrument obtained Cronbach's Alpha of 0.79, a coefficient that indicates that the research tool was reliable, according to Aiken and Susane (2001); Tan, Refugio, & Bernaldez (2015); Refugio, (2018); Macias Jr, & Refugio (2018); Refugio, Macias Jr. & Inoferio, (2018); Refugio (2019); Refugio, Galleto, & Torres (2019); and Refugio, Bulado, Galleto, Dimalig, Colina, Inoferio, & Nocete (2020).

2.5 Data-gathering procedures

Before conducting the study, the researchers sought approval from the Schools Division Superintendent to undertake the study. The survey questionnaire was attached to the formal letter request for perusal. The researchers, with the help of the school heads, personally distributed the research tools to the respondents. Only the researchers had access to the data collected to ensure the utmost confidentiality, and no name was mentioned in any part of the study.

2.6 Statistical treatment of the data

Frequency, percent, mean, and standard deviation were used to describe the profile and content knowledge level of the respondents. In Cohen (2001) and Berry (2001), a standard deviation of less than 3.00 denotes close clustering of the observations about the mean. It implies a higher degree of homogeneity of the values in a given set of data. Contrarily, a standard deviation greater than or equal to 3.00 means a wide scattering or spreading out of the observations about the mean and indicates a higher degree of heterogeneity of the values in a given set of data. Furthermore, a collection of data having a higher degree of homogeneity could also be classified as a relative or reasonably homogenous set of data, which means that the values within the collection are closed to each other. On the other hand, a set of data having a higher degree of heterogeneity could also be classified as a relative or reasonably heterogeneous set of data, which means that the values within the collection are far from each other (Cohen, 2001 & Berry, 2001).

Chi-square (χ^2) was used to determine the relationship between the number of hours of mathematics training attended (categorical variable) and the teachers' content knowledge level

(ordinal variable). On the other hand, Spearman rho (ρ) was used to determine the relationship between the highest educational attainment (ordinal variable) and content knowledge level (ordinal variable), and the number of years of teaching mathematics (ratio variable converted to an ordinal variable) and content knowledge level (ordinal variable). Responses were collated and analyzed using the Statistical Package for Social Sciences (SPSS) version 25 and Microsoft Excel 2016. Results obtaining p-value ≤ 0.05 were considered statistically significant. Before the computation of the test statistic, the respondents' highest educational attainment and the number of years of teaching mathematics were ranked, with one (1) as the lowest and five (5) as the highest as follows:

Highest Educational Attainment	**Rank**
Baccalaureate Degree	1
Baccalaureate with Master's Degree units	2
Master's Degree	3
Master's Degree with Doctorate Degree units	4
Doctorate Degree	5

Number of Years of teaching mathematics	**Rank**
0-5 years	1
6-10 years	2
11-15 years	3
16-20 years	4
More than 20 years	5

As to the interpretation of the value of ρ, the following guidelines suggested by Cohen (2001) was utilized.

Value	**Size of Correlation**	**Interpretation**
$\pm$ 0.50 to $\pm$ 1.00	large	high positive/negative correlation
$\pm$ 0.30 to $\pm$ 0.49	medium	moderate positive/negative correlation
$\pm$ 0.10 to $\pm$ 0.29	small	low positive/negative correlation
$\pm$ 0.01 to $\pm$ 0.09	negligible	slight positive/negative correlation
0.00		no correlation

On the other hand, content knowledge level was interpreted using the scale based on the Guidelines on the Assessment and Rating of Outcomes under the K to 12 Basic Education Curriculum (DepEd Order 73, s 2012).

Scale	**Verbal Description**	**Interpretation**
5 (4.20-5.00)	Advanced	The teacher respondent has 90-100% sufficiency of knowledge in mathematics content. It means that the teacher, at this level, exceeds the core requirements in terms of knowledge and understandings, and can transfer them automatically and flexibly through the delivery of the lesson.
4 (3.40-4.19)	Proficient	The teacher respondent has 85-89% sufficiency of knowledge in mathematics content. It means that the teacher, at this level, developed the fundamental

		knowledge and core understandings, and can transfer them automatically and flexibly through the delivery of the lesson.
3 (2.6-3.39)	Approaching Proficiency	The teacher respondent has 80-84% sufficiency of knowledge in mathematics content. It means that the teacher, at this level, has developed the fundamental knowledge and core understandings, and can transfer them automatically and flexibly through the delivery of the lesson with little guidance from the school head and/or some assistance from fellow teachers.
2 (1.80-2.59)	Developing	The teacher respondent has 75-79% sufficiency of knowledge in mathematics content. The teacher, at this level, possesses the minimum knowledge and core understandings but needs help throughout the lesson's delivery.
1 (1.00-1.79)	Beginning	The teacher respondent has 74% and below sufficiency of knowledge in mathematics content. At this level, the teacher struggles with his/her understanding; prerequisite and fundamental knowledge have not been acquired or developed adequately to aid in teaching.

3. Results and Discussions

Table 2. Profile of teachers in terms of sex

Sex	Frequency	Percent
Male	15	16.50
Female	76	83.50
Total:	91	100.00

Table 2 shows that female teachers dominated the management of schools in Ayungon District 2. It means that more women are holding a teaching position in schools in the area. One generalization could be understood that in today's population, there are generally more females compared to males.

Table 3. Profile of teachers in terms of age

Age	Frequency	Percent
18-40	62	68.13
40-65	29	31.87
Total:	**91**	**100.00**

Table 3 groups the respondents based on the developmental stages developed by Erikson (McLeod, 2018). It shows that a more significant proportion of the teachers (68.13%) fell under the 18-40 bracket. The figure implies that the more considerable bulk of mathematics teachers in Ayungon District 2 ranged in the early adulthood stage.

Table 4. Profile of teachers in terms of highest educational attainment

Highest Educational Attainment	Frequency	Percent
Baccalaureate degree	38	41.80
Baccalaureate degree with master's degree units	47	51.60
Full-fledged master's degree holder	6	6.60
Total:	**91**	**100.00**

Table 4 reflects that about 60 percent of the teachers (58.2%) earned units in master's degree programs. However, more than 40 percent of these teachers (41.80%) remained bachelors' degree holders. It means that a proportion of elementary mathematics teachers in Ayungon District 2 does not prioritize taking graduate education. It may because graduate education is costly in which take-home pay of the teachers could not afford to send themselves to school and take graduate programs.

Table 5. Profile of teachers in terms of mathematics training attended for the past three years

No. of Training Hours in Mathematics for the Past Three Years	Frequency	Percent
1-2 days (8-16 hours)	63	69.20
3-5 days (24-40 hours)	17	18.70
6-10 days (48-80 hours)	7	7.70
More than 10 days (More than 80 hours)	4	4.40
Total:	**91**	**100.00**

Table 5 presents that all teachers in Ayungon District 2 were sent to training. However, about 70 percent of these teachers attended only to no more than 16 hours. One plausible reason may be because some training required only a few participants, especially in the division and regional levels.

Table 6. Profile of teachers in terms of Years of teaching mathematics

Years of Teaching Mathematics	Frequency	Percentage
0-5 years	34	37.40
6-10 years	23	25.30
11-15 years	14	15.40
16-20 years	9	9.90
More than 20 years	11	12.10
Total:	**91**	**100.00**

Table 6 divulges that about 40 percent of the elementary mathematics teachers (37.4%) in Ayungon District 2 was in the service for at most five years. This proportion of new teachers is equal to those who were more than ten years in teaching (37.4%). It means that a higher percentage of teachers are gaining experience in the field, especially in mathematics teaching.

Table 7. The teachers' content knowledge level in the area of numbers and number sense

Indicators	Mean ± SD	Verbal Description
1. Describing the structure and properties of complex numbers correctly: real numbers (counting, whole, integers, fractions, decimals, percent, ratio & proportion, rational, irrational numbers) and non-real numbers	3.70 ± 0.96	Proficient
2. Solving problems involving these numbers	3.59 ± 0.88	Proficient
3. Posing problems involving these numbers	3.40 ± 1.12	Approaching Proficiency
4. Making correct conjectures based on observed numerical patterns and relationships, and verifying results	3.49 ± 0.85	Proficient
5. Proving fundamental theorems involving numbers	3.24 ± 1.01	Approaching Proficiency
Aggregate Mean and Standard Deviation	**3.49 ± 0.98**	**Proficient**

Table 7 reveals that the teachers in Ayungon District 2 were homogeneously proficient in numbers and number sense. It means that the teachers possess 85-89% sufficiency of knowledge in the area. It implies that they have developed the fundamental knowledge and core understandings, and can transfer these automatically and flexibly through the delivery of the lesson.

Table 8. The teachers' content knowledge level in the area of measurement

Indicators	Mean ± SD	Verbal Description
1. Defining the different terms in measurement and describing the attributes of each: length, mass, weight, time, temperature; perimeter, circumference, area, surface area, volume, angle measurement, scales, rate, speed, velocity	3.34 ± 1.10	Approaching Proficiency
2. Deriving the formula for perimeter, area, volume, and surface area of various shapes and solids	3.29 ± 0.98	Approaching Proficiency
3. Describing and comparing mathematical and real-world objects using well selected and appropriate units and tools	3.38 ± 0.97	Approaching Proficiency
4. Solving problems involving these measurement ideas	3.22 ± 1.03	Approaching Proficiency
5. Posing problems involving these measurement ideas	3.18 ± 0.86	Approaching Proficiency
6. Making conjectures on measurement	2.97 ± 1.10	Approaching Proficiency
Aggregate Mean and Standard Deviation	**3.23 ± 1.01**	**Approaching Proficiency**

Table 8 discloses that the teacher-respondents had an approaching proficiency level in all of the indicators in the area. As a whole, the content knowledge of teachers in measurement was homogeneously approaching proficiency ($\bar{x}$ = 3.23, SD = 1.01). It goes to show that the teacher-respondents had 80-84% sufficiency of knowledge in Measurement. It implies that the teachers have developed the fundamental knowledge and core understandings, and can transfer them automatically and flexibly to the learners with little guidance from the school head and/or some assistance from fellow teachers.

Table 9. The teachers' content knowledge level in the area of Geometry

Indicators		**Mean ± SD**	**Verbal Description**
1.	Describing properties and relationships of basic concepts in the axiomatic Euclidean geometry (points, lines, planes, and angles)	3.30 ± 1.04	Approaching Proficiency
2.	Using appropriate objects or manipulative materials to represent geometric terms	3.36 ± 0.82	Approaching Proficiency
3.	Demonstrating geometric connections	3.34 ± 0.92	Approaching Proficiency
4.	Describing properties of plane and solid figures	3.40 ± 0.89	Proficient
5.	Free-hand drawing of geometric figures based on a given description	3.30 ± 0.85	Approaching Proficiency
6.	Constructing geometric figures based on a given description using a compass	3.20 ± 0.82	Approaching Proficiency
7.	Classifying attributes of different kinds of shapes	3.53 ± 0.92	Proficient
8.	Demonstrating the use of algebra to verify the properties of plane and solid figures	3.18 ± 0.95	Approaching Proficiency
9.	Solving and posing problems involving geometric figures	3.14 ± 0.88	Approaching Proficiency
10.	Proving theorems involving geometric concepts using inductive and deductive reasoning	3.07 ± 0.85	Approaching Proficiency
11.	Making conjectures about properties of shapes including transformations and combinations of shapes, and verifying these conjectures	3.07 ± 0.81	Approaching Proficiency
Aggregate Mean and Standard Deviation		**3.26 ± 0.90**	**Approaching Proficiency**

Table 9 displays that the teachers in Ayungon District 2 obtained the approaching proficiency level in Geometry. The result indicated that the teacher-respondents had 80-84% sufficiency of knowledge in Geometry. In reflection to DepEd Order 73, s. 2012, teachers were homogeneously described to have developed the fundamental knowledge and core understandings. They can transfer them automatically and flexibly to their learners with little guidance from the school head and/or some assistance from fellow teachers.

Table 10 shows that teachers in Ayungon District 2 were approaching proficiency in all learning areas of patterns, functions, and algebra. In general, the respondents averaged an approaching proficiency ($\bar{x}$ = 3.05, SD = 0.95). The result reveals that the teacher respondents had 80-84% sufficiency of knowledge in the area. DepEd Order 73, s. 2012 supports that the teachers had developed the fundamental knowledge and core understandings, and can transfer them automatically and flexibly through the delivery of the lesson with little guidance from the school head and/or some assistance from fellow teachers. However, the respondents have not yet demonstrated the right amount of knowledge in this area (SEI-DOST & MATHTED, 2011).

Table 10. The teachers' content knowledge level in the area of patterns, functions, and algebra

Indicators	**Mean ± SD**	**Verbal Description**

1.	Solving equations and inequalities	2.98 ± 1.05	Approaching Proficiency
2.	Solving mathematical problems based on real-world situations, which include non-routine problems	3.18 ± 1.00	Approaching Proficiency
3.	Posing algebraic problems based on real-world situations	3.05 ± 0.92	Approaching Proficiency
4.	Using different representations and models of a given real-world situation	3.16 ± 0.92	Approaching Proficiency
5.	Recognizing patterns and making conjectures based on these observed patterns using functions	3.07 ± 0.93	Approaching Proficiency
6.	Proving properties of equations and inequalities	2.99 ± 0.94	Approaching Proficiency
7.	Working with all types of functions (e.g., algebraic and non-algebraic)	2.92 ± 0.88	Approaching Proficiency
Aggregate Mean and Standard Deviation		**3.05 ± 0.95**	**Approaching Proficiency**

Moreover, the standard deviations for the content indicators and the aggregate standard deviation in the area of Patterns, Functions, and Algebra were all less than 3.00. It indicates that there was a close clustering of the responses around the mean. It means that there was a greater homogeneity of the teachers' content knowledge level in Patterns, Functions, and Algebra.

Table 11. The teachers' content knowledge level in the area of data analysis and probability

Indicators		**Mean ± SD**	**Verbal Description**
1.	Demonstrating skills of collecting, organizing, reading, representing and interpreting data	3.13 ± 0.96	Approaching Proficiency
2.	Describing terms in counting techniques and probability	3.01 ± 0.90	Approaching Proficiency
3.	Solving problems involving the measures of central tendencies, and measures of dispersions	2.86 ± 0.86	Approaching Proficiency
4.	Making predictions about outcomes and verifying these predictions using intuitive approaches	2.90 ± 0.89	Approaching Proficiency
Aggregate Mean and Standard Deviation		**2.97 ± 0.91**	**Approaching Proficiency**

Table 11 displays that the teachers in Ayungon District 2 obtained a content knowledge level of approaching proficiency in all learning areas of data analysis and probability. The overall result of approaching proficiency ($\bar{x}$ = 2.97, SD = 0.91) indicates that the teacher-respondents also had 80-84% sufficiency of knowledge in the area. Furthermore, the standard deviations for the content indicators and the aggregate standard deviation in the area were all less than 3.00, which indicates that there was a close clustering of the responses about the mean. It means that there was also a higher degree of homogeneity of the teachers' content knowledge in data analysis and probability.

Table 12. Summary of the teachers' content knowledge level

Areas	**Mean ± SD**	**Verbal Description**
Numbers and Number Sense	3.49 ± 0.98	Proficient
Measurement	3.23 ± 1.01	Approaching Proficiency
Geometry	3.26 ± 0.90	Approaching Proficiency

Patterns, Functions, and Algebra	3.05 ± 0.95	Approaching Proficiency
Data Analysis and Probability	2.97 ± 0.91	Approaching Proficiency
Grand Mean and Standard Deviation	3.21 ± 0.96	Approaching Proficiency

Table 12 reveals that the overall content knowledge level of the elementary mathematics teachers in Ayungon District 2 was approaching proficiency (x = 3.21, SD = 0.96). DepEd Order 73, s. 2012 describes that the teachers had developed the fundamental knowledge and core understandings, and can transfer them automatically and flexibly through the delivery of the lesson with little guidance from the school head and/or some assistance from fellow teachers. The table also indicates that the teachers' content knowledge is tightly clustered around the mean, as evidenced by the SD = 0.96. It means that there was a higher degree of homogeneity of knowledge among the teachers. However, the teachers have not yet demonstrated the right amount of knowledge in mathematics content (SEI-DOST & MATHTED, 2011).

In an interview, teachers posited that they yielded the highest mean in Numbers and Number Sense since it was the most confortable area. The teachers were able to simplify abstract concepts to its concrete form. Moreover, most teachers focus on this area since it deals with mathematics fundamentals (e.g., numbers, operations). On the contrary, the teachers obtained the lowest mean in Data Analysis and Probability because they found the topic "difficult." They argued that in the previous curriculum, statistics was taught in the higher grade (i.e., Grades 5 and 6). However, in the K to 12 Curriculum, the course is now introduced as early as Grade 1. This finding was similar to the discovery of Ferrer (2017).

It is essential to note that Pompea and Walker (2017) emphasized the value of content knowledge for the development of the curriculum. On the same note, SEI-DOST & MATHTED (2011) concluded that the amount and depth of mathematics the teachers learned were essential for teaching proper and correct mathematics to students. By having a deep understanding of mathematics, teachers can guide students in learning mathematics well. However, the results revealed that respondents only had 80-84% sufficiency of knowledge on mathematics content. It indicates that the elementary mathematics teachers in Ayungon District 2 did not yet possess a strong understanding of the subject. It was probably because the respondents were elementary mathematics teachers. Elementary mathematics teachers focus more on teaching the rudiments of the subject. They introduce the fundamental concepts since these are entry points to a higher form of mathematics. However, it should not mean that the elementary mathematics teachers' knowledge should only remain at the level where it is now. There is a need for them to update and upgrade their experience in mathematics content so that they can be classified as highly competent mathematics teachers.

Table 13. Relationship between the teachers' highest educational attainment and their content knowledge level

Variables	*ρ*	p-value	Degree of Relationship	Remarks
Highest educational attainment and content knowledge level	0.11	0.29	Low positive correlation	Not Significant

Table 13 reflects that the relationship between the highest educational attainment of teachers and their content knowledge level, which registered rho value of 0.11 with a p-value of 0.29 higher than the 0.05 level of significance, was a small, low positive correlation, and not significant. It means that there was no significant relationship between the teachers' highest educational attainment and their

content knowledge level. The finding was parallel with the study of Myrberg and Ros (2003, as cited in Ochieng, Kiplagat & Nyongesa, 2016), indicating that a master's degree was not found to be associated with improved teacher competence in delivering mathematical content. On the contrary, it refuted the finding of Ragma (2017) wherein he discovered that teachers with higher educational attainment had higher content competence.

Moreover, the teachers' interview revealed that the nature of their master's degree might be one plausible reason that might explain why there was not enough evidence to claim the relationship between their content knowledge and the highest educational attainment. Most teachers pursued graduate studies that focus on managerial work and personnel management (e.g., MA in Educational Management, MAEd in Administration and Supervision). They did not specialize in a specific field. Another reason might be due to the teachers' undergraduate education. Teachers might have undergone a general education program that does not cover the areas mentioned in the framework resulted in their content knowledge in mathematics.

Table 14. Relationship between the mathematics teachers' training attended for the past three years and their content knowledge level

Variables	χ^2	**p-value**	**Remarks**
Mathematics teachers' training attended for the past three years and content knowledge level	4.98	0.96	Not Significant

The result in Table 14 indicates that there was no significant relationship between the mathematics teachers' training attended and their content knowledge level. The teachers supported the finding when they revealed in the interview that the training they went through was more on pedagogy. In contrast, other training focused on the least academic competencies in mathematics. They revealed further that there were teachers who failed to cascade what they learned from the training they attended because of time constraints. However, Garet et al. (2001, as cited in Boudersa, 2016) disclosed that teachers who participated in professional development programs gained more excellent subject matter knowledge.

Table 15. Relationship between the teachers' number of years in teaching mathematics and their content knowledge level

Variables	**ρ**	**p-value**	**Degree of Relationship**	**Remarks**
Teachers' number of years in teaching mathematics and their content knowledge level	0.04	0.74	Slight positive correlation	Not Significant

Table 15 discloses that the relationship between the teachers' number of years in teaching mathematics and their content knowledge level, which registered rho value of 0.04 with a p-value of 0.74 higher than the 0.05 level of significance, was negligible, slight positive correlation, and not significant. It means that there was no significant relationship between the teachers' number of years in teaching mathematics and their content knowledge level. This finding refuted the study of Ragma (2017), whose research revealed that teachers with a higher number of years in teaching had higher content competence. In the interview, however, the teachers claimed that one reason might be

linked to the curriculum itself. Currently, the K to 12 Curriculum is adopting a spiral progression model. It means that a topic is already taught in the lowest grade level and is gradually increasing in difficulty in the next higher levels. It necessitates that mathematics teachers, even in the early grades, should have content knowledge of the subject's different areas. Another plausible reason was the number of years of teaching on a specific grade level. Some teachers had been teaching a grade level for a long period and were familiar with the mathematics content only in that grade level. Their knowledge might have been accustomed only to what they had been teaching for a more extended period.

4. Conclusions

The elementary mathematics teachers in Ayungon District 2 in the Division of Negros Oriental, Philippines, are equally equipped with the content knowledge in mathematics at the approaching proficiency level. Likewise, teaching experience and professional development in the form of pursuing graduate studies and attending training do not have bearing to the content knowledge level possessed by the teachers since these endeavors are not related to the mathematics content development. However, the teachers were inferred as resourceful and committed to teaching mathematics despite their weaknesses in the content knowledge to share with their learners.

5. Recommendations

Enhancement training in all areas in mathematics is to be provided to elementary mathematics teachers by implementing the training design developed by the researchers. The ultimate goal is to develop further the content knowledge, mastery, and skills of the teachers to achieve the highest proficiency level.

Acknowledgment

The authors acknowledge the financial support of the Mathematics Teachers Association of the Philippines -Tertiary Level (MTAP-TL) and the Basic Education- Math Teachers Society (BE-MTS). Sincere appreciation is further extended to Negros Oriental State University, Jose Rizal Memorial State University, Ayungon District 2 of Negros Oriental Schools Division and Siquijor Province Schools Division.

References

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education,59*, 389–407. DOI:10.1177/0022487108324554

Berry, W. (2001). *Understanding Regression Assumptions.* Newbury Park, California: Sage Publishing, Inc.

Bhat, A. (2019). What is a correlational study? – Definition with examples. Retrieved from https://www.questionpro.com/blog/correlational-research/

Cohen, J. (2001). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences.* Second Edition. USA: McGraw Hill, Inc.

Creswell, J.W. & Guetterman, T.C. (2019). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research* (6th Ed.). New York: Pearson

DepEd Order No. 73, s 2012. Guidelines on the Assessment and Rating of Outcomes under the K to 12 Basic Education Curriculum. Retrieved from https://www.officialgazette.gov.ph/downloads/2012/09sep/20120905-DepEd-DO-0073-BSA.pdf

Ferrer, I. (2017). The competence level of grade 10 mathematics teachers in Pangasinan, Philippines. Retrieved from http://psurj.org/wp-content/uploads/2017/12/2017-JEMS-03.pdf

Kim, I., Ward, P., Sinelnikov, O., Ko, B., Iserbyt, P., Li, W., & Curtner-Smith, M. (2018). The influence of content knowledge on pedagogical content knowledge: An evidence-based practice for physical education. *Journal of Teaching in Physical Education, 37*(2), 133–143. DOI:10.1123/jtpe.2017-0168

Kurt, S. (2019). TPACK: Technological Pedagogical Content Knowledge Framework. Educational Technology. Retrieved from https://educationaltechnology.net/technological-pedagogical-content-knowledge-tpack-framework/

Lee, Y., Capraro, R.M. & Capraro, M.M. (2018). Mathematics Teachers' Subject Matter Knowledge and Pedagogical Content Knowledge in Problem Posing. *International Electronic Journal of Mathematics Education, 13*(2), 75-90. https://doi.org/10.12973/iejme/2698

Macias Jr, A & Refugio, C. (2018). Extent of Utilizing Innovation in Public & Private Mathematics Teachers of the Division of Dumaguete City: An Exploratory Factor Analysis. *International Review of Social Sciences* Vol. 6, No.1, 2018. Retrieved from http://irss.academyirmbr.com/papers/1516086284.pdf

Malik, S., Rohendi, D., & Widiaty, I. (2019). Technological Pedagogical Content Knowledge (TPACK) with Information and Communication Technology (ICT) Integration: A Literature Review. 5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018). Atlantis Press.
DOI:10.2991/ictvet-18.2019.114

McLeod, S. (2018). *Erik Erikson's stages of psychosocial development.* Retrieved from https://www.simplypsychology.org/Erik-Erikson.html

Ochieng, K.R., Kiplagat, P., & Nyongesa, S. (2016). Influence of Teacher Competence on Mathematics Performance in KCSE Examinations Among Public Schools in Nyatike Sub-county, Migori County Kenya. *International Journal of Secondary Education, 4*(5), 44-57. Retrieved from http://article.sciencepublishinggroup.com/html/10.11648.j.ijsedu.20160405.11.html

Ozudogru, M. & Ozudogru, F. (2019). Technological Pedagogical Content Knowledge of Mathematics Teachers and the Effect of Demographic Variables. *Contemporary Educational Technology, 10*(1), 1-24. https://doi.org/10.30935/cet.512515

Pompea, S.M. & Walker, C.E. (2017). The importance of pedagogical content knowledge in curriculum development for illumination engineering. 14th Conference on Education and Training in Optics and Photonics, ETOP 2017, 2017, Hangzhou, China. https://doi.org/10.1117/12.2270022

Ragma, F. (2017). Content and pedagogical competence of mathematics teachers in the secondary schools in La Union, Philippines. *Proceeding of the 3rd International Conference on Education, 3*, 402-408. DOI: https://doi.org/10.17501/icedu.2017.3139

Refugio, C. (2018). Self-Efficacy and Basic Statistics Performance. *International Review of Social Sciences* Vol. 6, No.1, 2018. Retrieved from http://irss.academyirmbr.com/papers/1516085857.pdf

Refugio, C. (2019). Explanatory analysis for the Licensure Examination for Teachers (LET) performance. The Asian EFL Journal, 22(3), 226-252. Retrieved from https://www.asian-efl-journal.com/11647/monthly-journals/2019-monthly-journals/volume-22-issue-2-2019/#squelch-taas-tab-content-0-1

Refugio, C., Galleto, P., & Torres, R. (2019). Competence landscape of grade 9 mathematics teachers: Basis for an enhancement program. *Cypriot Journal of Educational Sciences*, *14*(2), 241-256. https://doi.org/10.18844/cjes.v14i2.4125

Refugio, C. Macias Jr. A. & Inoferio, H. (2018). Teaching Practices in a Culturally Diverse Geometry Classes. *International Review of Social Sciences* Vol. 6, No.8, 2018. Retrieved from http://irss.academyirmbr.com/papers/1532678564.pdf

Refugio, C., Bulado, M. I. E. A., Galleto, P., Dimalig, C., Colina, D., Inoferio, H., & Nocete, M. L. (2020). Difficulties in teaching senior high school General Mathematics: Basis for training design. *Cypriot Journal of Educational Sciences*, *15*(2), 319-335. https://doi.org/10.18844/cjes.v15i2.4589

Roces, A.R. (2019). The decline in the quality of Philippine education. Retrieved from https://www.philstar.com/opinion/2019/11/21/369945/decline-quality-philippine-education

SEI-DOST & MATHTED (2011). *Framework for Philippine mathematics teacher education.* Manila: SEI-DOST & MATHTED. Retrieved from http://www.sei.dost.gov.ph/images/downloads/publ/sei_mathteach.pdf

Sinelnikov, O.A., Kim, I., Ward, P., Smith, M.C., & Li, W. (2016). Changing the beginning teachers' content knowledge and its effects on student learning. *Physical Education and Sport Pedagogy, 21*(4), 425-440. https://doi.org/10.1080/17408989.2015.1043255

Tan, E., Refugio, C., & Bernaldez, C. (2015). Expenditure of National Games Contingents: Economic Impact on the Local Economy of Negros Oriental, Philippines. *Prism*, *20*(1). Retrieved from http://www.norsuprism.com/index.php/norsuprism/article/view/1

Zhang, S., Liu, Q. & Cai, Z. (2019). Exploring primary school teachers' technological pedagogical content knowledge (TPACK) in online collaborative discourse: An epistemic network analysis. *British Journal of Educational Technology, 0*(0), 1-19. Retrieved from http://www.epistemicnetwork.org/wp-content/uploads/sites/3/2019/09/willey.pdf