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Pedagogical Content Knowledge of Pre-Service Mathematics Teachers Leading to Continual Improvement

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ABSTRACT

The Department of Education recently underwent curricular revamp from kindergarten to senior high school which paved the way to the inclusion of statistics and probability. In effect, the K to 12 curriculum posted a challenge on the ability of the future teachers in handling the additional content area. Hence, the pedagogical content knowledge of the thirty-nine pre-service teachers was explored. Concurrent triangulation mixed method design which is a combination of descriptive-comparative and multiple-case study methods was employed in the study. Data were gathered using pedagogical content knowledge test, interview, and lesson plans from thirty-nine pre-service teachers. The results revealed that the pre-service teachers had strong pedagogical content knowledge for teaching fundamental counting techniques and combinatorics but their pedagogical content knowledge for teaching inferential statistics, measures of variability, and measures of central tendency should be developed further. Thus, tertiary level institutions should strengthen the pedagogical content knowledge through focusing the instruction more on developing the conceptual understanding and in checking the misconceptions of the pre-service teachers, applying constructivist perspectives in pre-service teacher education, and integrating pedagogical content knowledge in the different subjects in the new mathematics curriculum for tertiary education.

Keywords: mathematics competencies, pedagogical content knowledge

INTRODUCTION

During the course of the past fifteen years, the mathematical performance of Filipino students competing in international and national competitions indicated alarming trends in the data. According to the findings of the Trends in International Mathematics and Science Studies (TIMMS) survey conducted in 2003, the performance of students in their second year of high school placed the country in position number 34 out of a total of 38 countries (Mullis et al., 2004). In the meantime, the results of the TIMSS advanced test that were conducted in 2008 showed that students in high schools that followed specialized curricula did the worst out of the ten nations that took part (Ogena, Lana, & Sasota, 2010). According to the findings of the Philippine Education for All 2015 National Review, the national average percent score of high school students who took the National Achievement Test in Mathematics over a period of eight years was lower than the target percentage of 75% that was set by the Philippine Education for All program (Salao, 2016). Years of stagnation in the academic performance of Filipino students opened the way for the introduction of the K to 12 Curriculum, which was begun to halt the stagnation, develop a high-performing and inclusive school education system, and reverse the decline (Sarvi, Munger, & Pillay, 2015).

In order to get ready for the K to 12 Basic Education program, the Philippine Department of Education (DepEd) collaborated with the Southeast Asian Ministers of Education Organization (SEAMEO) and the Regional Center for Educational Innovation and Technology (INNOTECH) to conduct a regional review of the educational programs in place in the four Southeast Asian countries of Brunei Darussalam, Malaysia, Singapore, and the Philippines. This was done in order to prepare for the implementation of the K to 12 Basic Education program. According to the findings of the regional comparison, one of the content criteria in the nations that have been benchmarked is statistics and probability (DepEd & SEAMEO INNOTECH, 2012). Aside from this, the examination of the results of TIMSS 2003 demonstrated that the performance of learners is affected by the TIMSS mathematical topics that are included in the curriculum that is being implemented. As a consequence of this, the lackluster academic performance of Filipino students might be explained by the fact that the curriculum taught in the Philippines included just sixty percent of the subjects. Significantly, the least concentrated learning area is data, where only thirty percent of the possible topics were included in the actual curriculum that was used (Mullis et al., 2004). As a result, statistics and probability are now part of the K–12 curriculum in the Philippines. This was done to maintain parity with the educational requirements of other countries in the region as well as with international benchmarks.

It is widely held that the implementation of the K-12 Curriculum will contribute, at least in part, to the holistic development of Filipinos (SEAMEO INNOTECH, 2012). Nonetheless, the expertise of teachers is of particular significance due to the fact that the K-12 Curriculum challenges instructors not only with new technique (Okabe, 2013), but but with new content as well (Ball, 2005). According to the findings of Cancino's (2016) research, Filipino teachers of mathematics in junior high schools are stronger in the areas of geometry and number sense than they are in the areas of statistics and probability. This suggests that out of all of the content standards that are covered in the K-12 Curriculum, the ones that present the most difficult conceptual challenge are statistics and probability. Aside from this, research on teachers' knowledge has shown that many teachers have misconceptions about mathematics and are unable to correct or anticipate the mistakes made by students, despite having taken the classes necessary to become teachers. This is despite the fact that many teachers have been in the profession for many years (Sorto, 2004). In addition to this, the results of the Teacher Education Development Study in Mathematics (TEDS-M) showed that prospective secondary teachers in the Philippines placed eighth in mathematics pedagogical content knowledge (MPCK) (Ingvarson et al., 2013). This indicates that the success in the implementation of the K-12 Curriculum can be achieved if the teacher education institutions ensure that the pre-service teachers possess the pedagogical content knowledge, particularly with regard to the inclusion of the subject areas of statistics and probability in the curriculum.
In spite of the fact that other researchers have investigated pedagogical content knowledge, one of the topics of research that has not yet been investigated in the Philippines is the potential of aspiring math educators to comprehend and instruct subjects such as statistics and probability. In light of the aforementioned circumstances, there is a compelling need to evaluate the pre-service secondary teachers' pedagogical subject knowledge in regards to the teaching of statistics and probability.

OBJECTIVES

The study focused on the pedagogical content knowledge for teaching of the pre-service teachers of Northeastern Philippines. In particular, it sought to explore the pedagogical content knowledge and compare the pedagogical content knowledge of the pre-service teachers across the domains of statistics and probability.

METHODOLOGY

The study used concurrent triangulation mixed method design. In detail, it is a combination of descriptive-comparative and multiple-case study methods. The participants were thirty-nine fourth year Bachelor of Secondary Education students major in mathematics enrolled in Cagayan State University Andrews Campus, Isabela State University Cabagan Campus, and Quirino State University Diffun Campus during the Second Semester of the Curriculum Year 2016-2017. The names of the pre-service teachers were altered in this study to keep their identities confidential.
The tools used in gathering the data were pedagogical content knowledge test, interview guide, and lesson plans. Pedagogical Content Knowledge Test (PCKT)gauged the pedagogical knowledge in statistics and probability of the pre-service mathematics teachers. In particular, the instrument was an open-response type test which was scored using the rubric with a maximum score of 2 points per item. The scoring rubric that was utilized to assess the pedagogical content knowledge of the students was patterned in the scoring utilized by the Teacher Education Development Study in Mathematics (Tatto et al., 2008). Meanwhile, the interrater reliability of the pedagogical content knowledge component between two raters was measured using intraclass correlations (Landers, 2015). As shown in Table 1, there was an absolute agreement between the two raters across the learning areas with intraclass correlation values that range from 0.784 to 0.978. In detail, 71% of the learning areas manifested excellent reliability with intraclass correlation values greater than 0.9, while data presentation had a good reliability (Koo & Li, 2016). Furthermore, the overall intraclass correlation value of 0.958 supplemented that the pedagogical content knowledge test was reliable.

Table 1: Reliability Coefficients of the Pedagogical Content Knowledge Instrument Using Intraclass Correlations

Learning Areas	Intraclass Correlation-values
Data Presentation	0.784
Measures of Central Tendency	0.859
Measures of Variability	0.913
Inferential Statistics	0.921
Fundamental Counting Techniques	0.910
Probability	0.917
Random Variables and Probability Distribution	0.978
Overall	0.958

To triangulate the gathered data, interview guide was utilized to validate the responses of the students in the pedagogical content knowledge test and to get their explanations. Meanwhile, lesson plans of the pre-service teachers in statistics and probability during their final demonstration teaching were collected and subjected to documentary analysis for the validation of their pedagogical content knowledge.

During the initial phase, the pedagogical content knowledge test underwent the process of validation and test of reliability. The pre-service mathematics teachers were oriented on the nature of the study, and were given the option to stop their participation anytime without being required to explain in compliance with the Research Ethics Protocol. The researcher also assured them their identities would be kept confidential.

Initially, the researcher requested a copy of the final demonstration plans of the pre-service teachers. Then, the PCKT was administered to the pre-service mathematics teachers. The researcher personally administered the instrument to the participants. Before the administration of the instrument, the researcher oriented the participants on how to answer the test and the length of time expected to finish the exam. The participants were given three hours at most to complete the exam. After that, a schedule for interview was set for the interview. A 30-minute session per pre-service mathematics teacher was allotted for this purpose. They were informed that the responses were audio-recorded but have to express themselves freely. During the interview, the researcher asked questions related to their responses to the seven pedagogical content knowledge questions in their exam. This was done to validate their answers and get their explanations. After gathering the data from the participants, the interviews were transcribed and validated by the researcher. The interview transcripts, as well as details of each participant's work, were forwarded to the inter-raters for further analysis. Two external raters were tapped in the study.

For the treatment of data, frequency counts, percentages, mean percent scores, and standard deviations were employed to describe the pedagogical content knowledge for teaching statistics and probability of the pre-service teachers. In particular, the mean percent score of the pre-service teachers' pedagogical content knowledge was computed based on the evaluation of the two raters using the rubrics. The mean percent scores were computed by getting the sum of the scores of the pre-service teachers in each domain divided by the total possible score times 100. Moreover, the pedagogical content knowledge for teaching statistics and probability was interpreted using the quartile distribution of the mean percent score presented in Table 2 (Salao, 2016).

Table 2: Interpretation Guide for Pedagogical Content Knowledge

Mean Percent Score	Qualitative Interpretation
0.0% - 25.0%	Novice
25.1% - 50.0%	Emerging
50.1% - 75.0%	Accomplished
75.1% - 100.0%	Expert

Meanwhile, qualitative analysis was done to describe the pedagogical content knowledge of the pre-service teachers. In this process, the responses of the participants during the interview were transcribed. Then, the transcriptions were analyzed using thematic analysisby learning area. The thematic analysis was done by clustering the responses of the pre-service teachers to identify the commonalities and differences of their answers during the pedagogical content knowledge interview.

Lastly, repeated measures analysis of variance was used to determine if there exist significant differences in the mean percent scores of the pre-service teachers' pedagogical content knowledge for teaching across the domains of statistics and probability at $\alpha = 0.01$. Furthermore, Bonferroni test was used for posthoc pairwise comparison resulting from repeated measures analysis of variance.

RESULTS AND DISCUSSION

Pedagogical Content Knowledge

Table 3: Statistics and Probability Pedagogical Content Knowledge of the Pre-service Teachers along Content Areas

Level	Data Presentation		Measures of Central Tendency		Measures of Variability		Inferential Statistics		Fundamental Counting Techniques and Combinatorics		Probability		Random Variables and Probability Distributions		Overall	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
Expert	3	7.7	6	15.4	2	5.1	2	5.1	8	20.5	10	25.6	5	12.8	0	0
Accomplishe	3	7.7	4	10.3	10	25.6	4	10.3	20	51.3	0	0	14	35.9	18	46.2

d																
Emerging	25	64.1	17	43.6	7	17.9	9	23.1	3	7.7	23	59.0	6	15.4	10	25.6
Novice	8	20.5	12	30.8	20	51.3	24	61.5	8	20.5	6	15.4	14	35.9	11	28.2
Total	39	100	39	100	39	100	39	100	39	100	39	100	39	100	39	100.0
Overall	MPS** = 49.36(Em) SD* = 21.83		MPS** = 40.17 (Em) SD* = 29.79		MPS** = 37.82(Em) SD* = 33.38		MPS** = 30.77(Em) SD* = 30.06		MPS** = 64.74 (A) SD* = 31.79		MPS** = 55.13 (A) SD* = 32.03		MPS** = 50.00 (Em) SD* = 35.82		MPS** = 45.79 (Em) SD* = 19.00	

* standard deviation **mean percent score
Legend: 75.1% – 100.0% = Expert (Ex); 50.1% - 75.0% = Accomplished (A); 25.1% - 50.0% = Emerging (Em); 0.0% - 25.0% = Novice (N)

As seen in Table 3, 53.8% of the pre-service teachers exhibited at most emerging overall pedagogical content knowledge in statistics and probability. This is a manifestation that more than half of the pre-service teachers were hardly capable of demonstrating cognition on the pedagogical content knowledge that is essential for teaching statistics and probability.

Specifically, the pre-service teachers had an accomplished pedagogical content knowledge in 2 out of 7 or 29% of the statistics and probability learning areas in which they performed best in fundamental counting techniques and combinatorics (MPS = 64.74, SD = 31.79). This could be explained further in Table 4 which presents the distribution of their responses in fundamental counting techniques and combinatorics by accuracy of computation and its explanation.

Table 4: Distribution of Pre-service Teachers' Responses by Accuracy of Computation and Its Explanation in Fundamental Counting Techniques and Combinatorics

	Correct Computation	Incorrect Computation	Total
Correct Explanation	26	0	28
Incorrect Explanation	5	8	11
Total	31	8	39

In particular, the pre-service teachers in general manifested expert level of cognition given that 31 or 79% demonstrated correct computation. Twenty-six of those who gave the right solution explained the solution with accuracy. This means that majority of the pre-service teachers had the correct computational understanding and accurate reasoning in answering the problem in fundamental counting techniques and combinatorics. Alvin correctly computed that there were 2,205 possible combinations of tag codes and explained that there were two conditions in the three-letter tag code problem. The first one was that the first and last letters were consonants given that repetition was allowed, and the second one was that middle letter was a vowel. As a result, there were 21 ways to fill the first and third lines and 5 ways to fill the middle line.

On the other hand, there were five pre-service teachers who correctly computed the number of possible combinations of tag codes but came up with a flawed explanation. Zach explained that his final answer was 2,205, because the problem was simple probability and product rule was employed based on the condition.

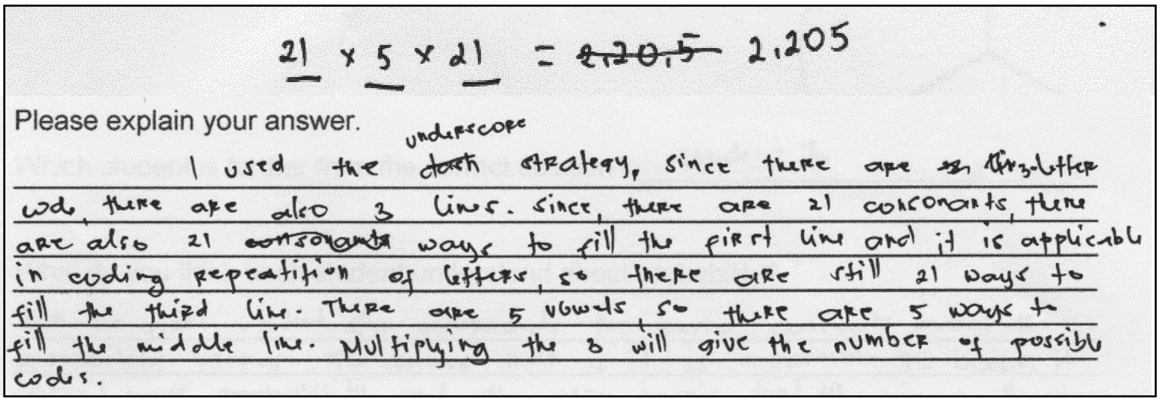
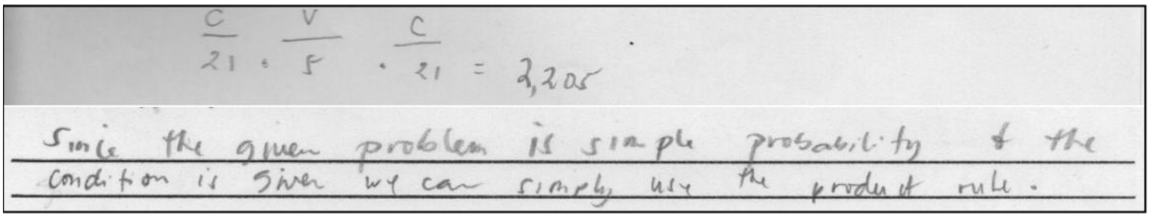


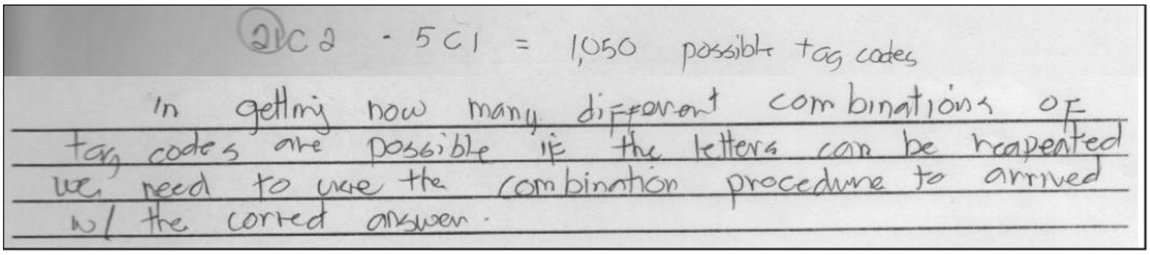
Figure 7: Alvin's Solution and Response on Fundamental Counting Techniques and Combinatorics


$\frac{C}{21} \cdot \frac{V}{5} \cdot \frac{C}{21} = 2{,}205$

Since the given problem is simple probability of the condition is given we can simply use the product rule.

Figure 8: Zach's Solution and Response on Fundamental Counting Techniques and Combinatorics

Lastly, eight of the pre-service teachers manifested misconceptions and computational error in fundamental counting techniques and combinatorics. Agatha answered that there were 1,050 possible tag codes based on the product of ${}_{21}C_2$ and ${}_{5}C_1$. During the interview, she elaborated that ${}_{21}C_2$ represented the condition that the first and third letters of each code were always consonants and ${}_{5}C_1$ represented taking 1 vowel out of 5 vowels.


21C2 · 5C1 = 1,050 possible tag codes

In getting how many different combinations of tag codes are possible if the letters can be repeated we need to use the combination procedure to arrived w/ the correct answer.

Figure 9: Agatha's Solution and Response on Fundamental Counting Techniques and Combinatorics

"For my solution, we have combination of 21 taken 2 at a time times combination of 5 taken 1 at a time is equal to 1,050 possible tag codes. Because from the combination from the given we have 21 consonants. So, we have combination of 21, from that one, the first and third letters of each code are always consonant. So it means we can… from 21 pwede tayong makakuha ng dalawang consonant taken two (from 21 we can get 2 consonants taken 2). So, combination of 21 taken 2 at a time. From the vowels, we have 5 vowels. From that situation, the middle letter is always a vowel so sa limang (in five) vowels, pwede nating gamitin ang isa (we can use one). So, combination of 5 taken 1 at a time. So, we have 1,050 possible tag codes". (Agatha)

Moreover, the pre-service teachers were also asked how they would explain, model, and/or demonstrate this item to their students who did not understand. Table 5 shows that almost 62% of the pre-service teachers had responded that they planned to utilize direct instruction in teaching fundamental counting techniques and combinatorics.

Table 5: Distribution of Pre-service Teachers' Responses on Strategies in Teaching Fundamental Counting Techniques and Combinatorics

Strategies	f	%
Direct Instruction	24	61.54
Manipulatives, Models or Representations	11	28.21
Cannot Tell / No Answer	4	10.26
Total	39	100

In particular, Ian intended to explain the concept of permutation and combination first before helping the student analyze the given item and let the student answer a similar problem. Afra answered that she would use tree diagram for the optimal learning of her students. However, Zach's answer that the item should be read more than once for the student to understand was a manifestation that he failed to come up with a strategy that would show his pedagogical understanding. This is in line with the study of Boz and Boz (2008) that one of the preferred teaching approaches of the pre-service teachers was through explanation.

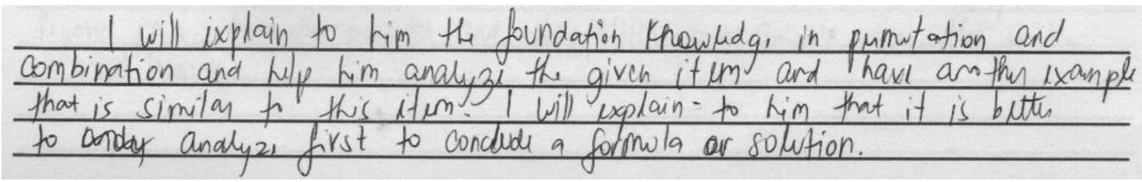

I will explain to him the foundation knowledge in permutation and combination and help him analyze the given item and have another example that is similar to this item. I will explain to him that it is better to analyze first to conclude a formula or solution.

Figure 10: Ian's Response on Strategies in Teaching Fundamental Counting Techniques and Combinatorics

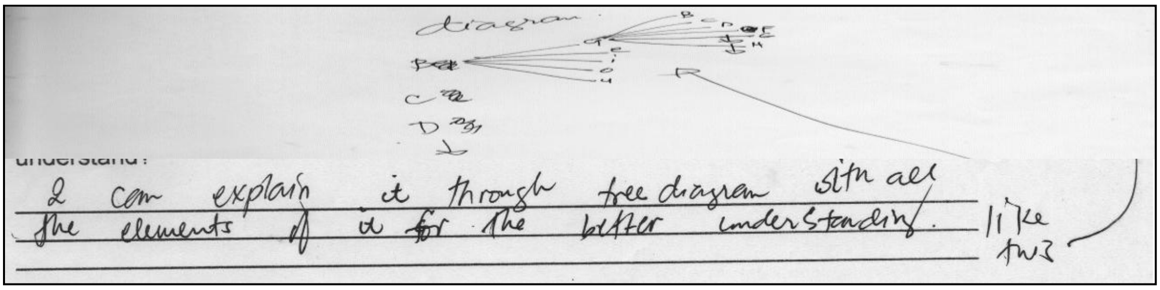


Figure 11: Afra's Response on Strategies in Teaching Fundamental Counting Techniques and Combinatorics

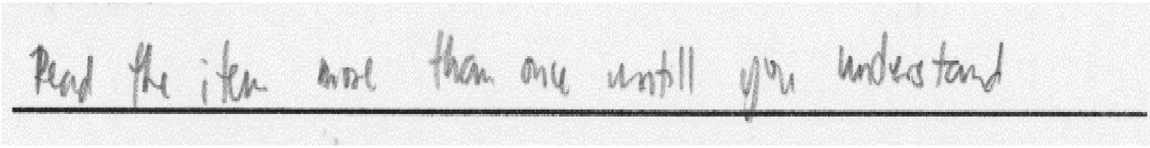


Figure 12: Zach's Response on Strategies in Teaching Fundamental Counting Techniques and Combinatorics

As a whole, the pre-service teachers had good computational and conceptual understanding of fundamental counting techniques and combinatorics as well as the ability to transfer their knowledge to their students through direct instruction. This is in line with the study of Valderama (2014) that demonstrating in the class how to solve a particular type of problem was among the leading practices of secondary schools mathematics teachers. The pre-service teachers' preference for direct instruction might be due to their exposure to conventional lecture-discussion during their schooling and that they regard it to be more effective for it is more informative, reasonable, and comprehensible (Cosgun Ögeyik, 2016).

Their high content and pedagogical content knowledge in fundamental counting techniques and combinatorics is a manifestation that the pre-service teachers were not just knowledgeable regarding content but also in the pedagogy. As Kleickmann et al. (2013) posited, higher content knowledge may lead to higher uptake of learning opportunities to acquire pedagogical content knowledge, thus compensating effects of the quantity of learning opportunities. This means that good content knowledge of the pre-service teachers may give them better chance to come up with good pedagogical content knowledge.

On the other hand, it was apparent that they had the lowest performance in inferential statistics. Table 6 shows the distribution of their responses in inferential statistics by accuracy of computation and its explanation.

Table 6: Distribution of Pre-service Teachers' Responses by Accuracy of Computation and Its Explanation in Inferential Statistics

	Correct Computation	Incorrect Computation	Cannot Tell/ No Answer	Total
Correct Explanation	11	6	0	17
Incorrect Explanation	6	7	8	21
Cannot Tell/ No Answer	0	0	1	1
Total	17	13	9	39

Around one-fourth of the pre-service teachers were able to compute and explain the relationship between temperature and total sales of the dataset. Patricia correctly computed for the r-value which was equal to 0.927. She also claimed that if the computed r-value, 0.927 was higher than the critical value, 0.576, then there was a significant relationship between atmospheric temperature and total sales. She even mentioned that the positive value implied a direct relationship between the two variables which means that the temperature increases as the number of units sold in a fruit shake store increases.

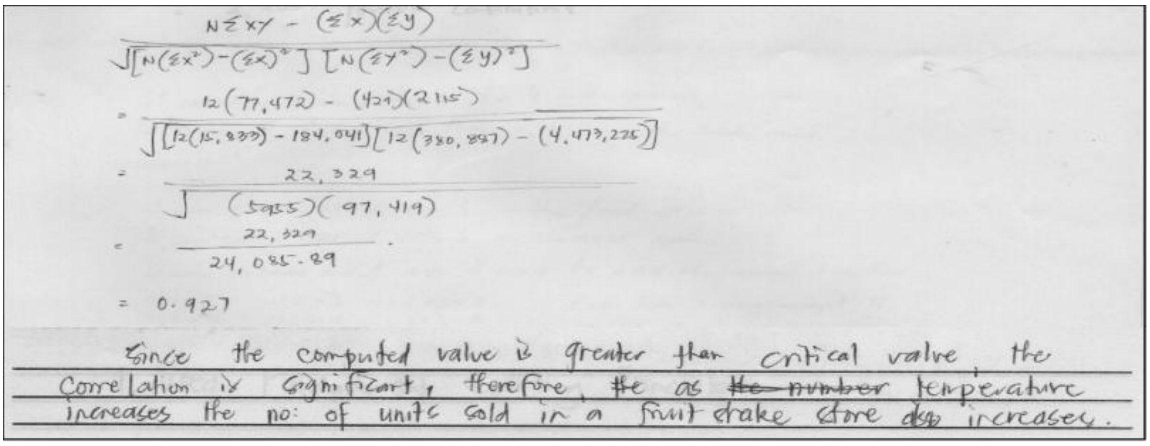
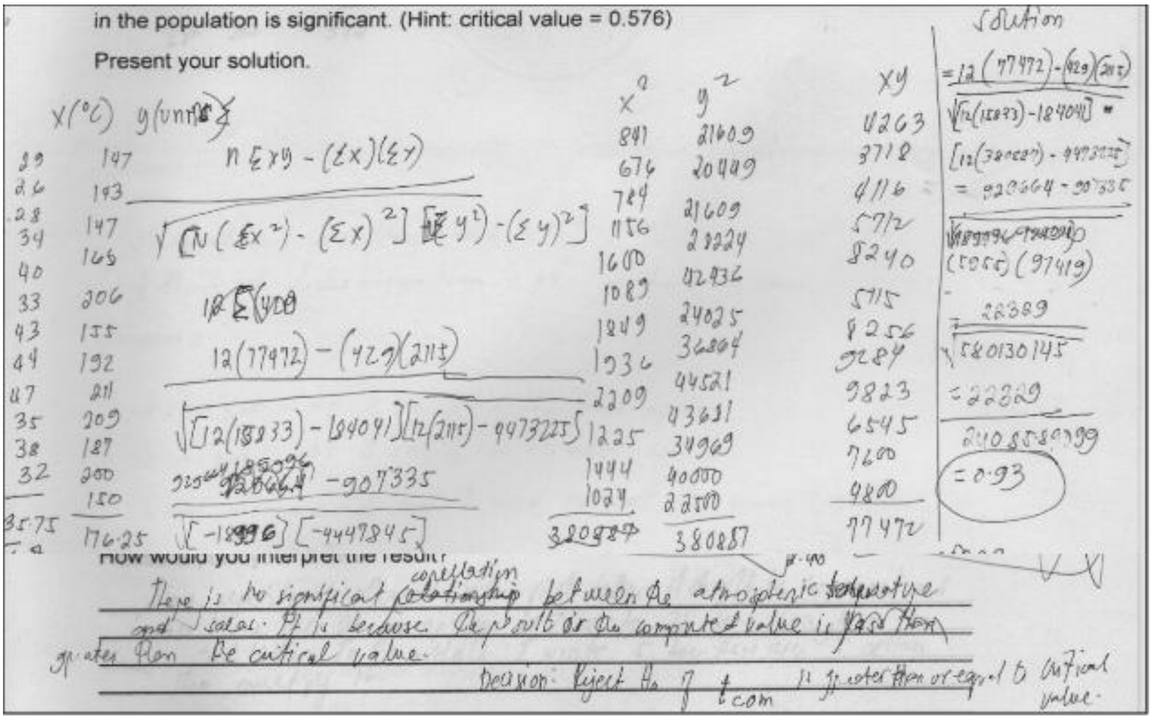

$$\frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N(\Sigma x^2)-(\Sigma x)^2][N(\Sigma y^2)-(\Sigma y)^2]}}$$
$$= \frac{12(77,472) - (429)(2115)}{\sqrt{[12(15,833) - 184,041][12(380,887) - (4,473,225)]}}$$
$$= \frac{22,329}{\sqrt{(5955)(97,419)}}$$
$$= \frac{22,329}{24,085.89}$$
$$= 0.927$$
Since the computed value is greater than critical value the correlation is significant, therefore, the as ~~the number~~ temperature increases the no: of units sold in a fruit shake store also increases.

Figure 13: Patricia's solution and response on Inferential Statistics

Table 9

Interviewer:	Given that the computed Pearson r-value is 0.927, what does it mean?
Patricia:	It means that I have greater computed value, I will reject the null hypothesis.
Interviewer:	What would then be your conclusion?
Patricia:	I think almost perfect correlation. Positive, so therefore if a temperature increases the total sale also increases.
Interviewer:	What does the positive Pearson r-value mean?
Patricia:	Positive value…direct, direct relationship between two variables.
Interviewer:	What does it imply if there is a direct relationship between temperature and total sales?
Patricia:	It means that as the temperature increases the total sales also increases.

However, there were six pre-service teachers who accurately computed for the Pearson r value but failed to explain the concept. Although Ulysses was able to compute the Pearson r value, he misinterpreted it by saying that there was no significant correlation between atmospheric temperature and total sales because the computed value was greater than the critical value. Furthermore, he also had a misconception in saying that the positive computed value meant the correlation was high.


in the population is significant. (Hint: critical value = 0.576)

Present your solution.

How would you interpret the result?

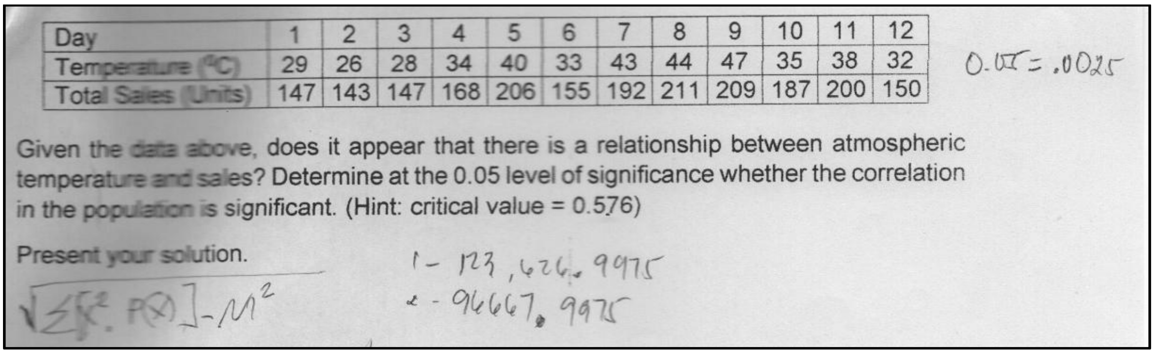
There is no significant correlation between the atmospheric temperature and sales. It is because the result or the computed value is greater than the critical value.

Figure 14: Ulysses' solution and response on Inferential Statistics

Table 10

Interviewer:	Assuming that the computed value is significant, what would then be your conclusion?
Ulysses:	The temperature affects the total sales.
Interviewer:	Given that the computed value is positive, what does it mean?
Ulysses:	The correlation is high.

On one end, six of them failed to compute the relationship between two variables but were able to explain the concept. Amanda knew that the appropriate treatment for the problem was Pearson r but she attempted to employ the incorrect formula which is $\sqrt{\Sigma \quad [X^2 \cdot P(X)] - \mu^2}$. Moreover, she verbalized that the relationship could be determined without doing actual calculations by keenly observing the data values in the given table. As such, she concluded that significant result denoted the existence of a relationship between the two variables and positive computed value implied a direct relationship between atmospheric temperature and total sales.



Day	1	2	3	4	5	6	7	8	9	10	11	12
Temperature (°C)	29	26	28	34	40	33	43	44	47	35	38	32
Total Sales (Units)	147	143	147	168	206	155	192	211	209	187	200	150

0.05 = .0025

Given the data above, does it appear that there is a relationship between atmospheric temperature and sales? Determine at the 0.05 level of significance whether the correlation in the population is significant. (Hint: critical value = 0.576)

Present your solution.

$\sqrt{\Sigma[x^2 \cdot P(x)] - \mu^2}$

1 - 123,626.9975
2 - 96667.9975

Figure 15: Amanda's response on Inferential Statistics

Table 11

Interviewer:	If you were to determine the relationship between the two variables, what statistical tool are you going to apply?
Amanda:	Pearson r.
Interviewer:	Why did you choose Pearson r?
Amanda:	Parang ma'am is relationship nila. (It is like it is a relationship between the two.)
Interviewer:	What is your basis in selecting this formula $\left(\sqrt{\Sigma \quad [X^2 \cdot P(X)] - \mu^2}\right)$?
Amanda:	Nag-base po kasi ako dun sa may p of x tapos ito (μ) ginagamit kasi ito sa level of significance. (I based it on the p of x and then this (μ), it is used for the level of significance.)
Interviewer:	Based on the given data, can you determine if there is a relationship between temperature and total sales without doing actual calculations?
Amanda:	Yes ma'am. Kasi dito ma'am is mataas. Halimbawa, sa day 5 ang total sales niya is 206. Tumaas ang temperature. Pumunta tayo sa day 6, day 5 to 6, bumaba 'yung total sales niya, bumaba din 'yung temperature pero parang hindi siya as in kuwan… dito kasi sa day 7 is 92 ang total sales niya. Ngayon tumaas agad ang temperature. So may effect talaga 'yung total sales sa pagbenta ng fruit shake sa temperature. (Yes, ma'am. Because this is high. For example, the total sales for day 5 is 206. Temperature rose. If we go to day 6, day 5 to 6, total sales dropped, the temperature also decreased but it's not as if… here in day 7, the total sales is 92. Now temperature rose quickly. Therefore, temperature affects the total of sales for fruit shakes.)
Interviewer:	Assuming that the computed value is significant, what would then be your conclusion?
Amanda:	There is a significant relationship in the total sales with the temperature.
Interviewer:	What if the computed value is positive, what would it mean?
Amanda:	So meron silang relationship na 'pag tumataas ang total sales niya, tumataas ding ang temperature. (So, there is a relationship between the two

	variables in which the total sales increases as the temperature increases.)

Meanwhile, seven of them incorrectly computed for the correlation coefficient and failed to explain the concept at the same time. Daffny knew the formula in computing for the Pearson r value however she had a computational error. So, she misconstrued that there was a relationship between atmospheric temperature and total sales based on the result that the computed value was less than the critical value. Moreover, she came up with incorrect conception in claiming that significant result suggested the strength of associations between the two variables and a negative value meant no relationship between two variables.

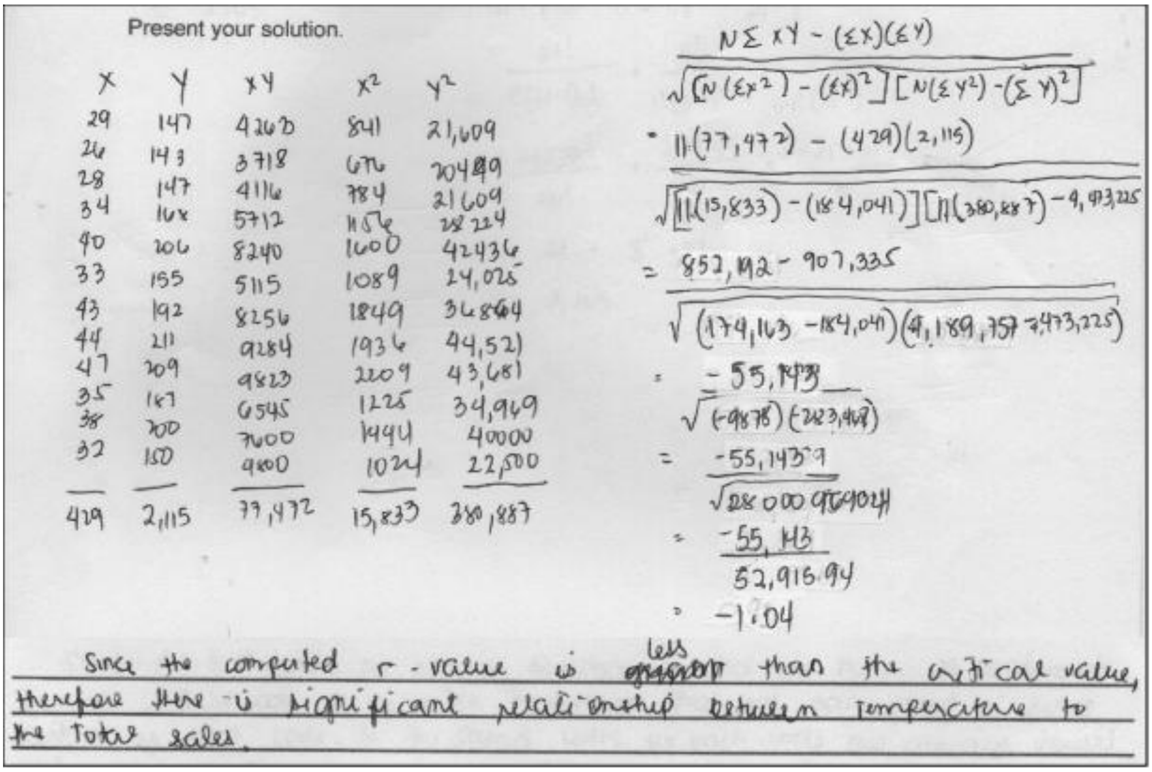


Figure 16: Daffny's response on Inferential Statistics

Table 12

Interviewer:	Do you think you could have identified if there is a relationship between the two variables without doing the actual calculations?
Daffny:	Yes, ma'am through observing the two variables ma'am. As you can see here ma'am, if the temperature is higher, the total sales is higher ma'am.
Interviewer:	Suppose your computed value is significant, what does it mean?
Daffny:	Significant means there is the strength of associations of the two variables.
Interviewer:	What is strength of associations?
Daffny:	'Yung relationship nila ma'am. If the two variable is… mas mataas 'yung relationship nilang dalawa. (The relationship between the two variables ma'am. If the two variables is… the relationship between the two variables is higher.)
Interviewer:	Given that your computed value is negative, what does it mean?
Daffny:	Negative ma'am, it means there is no relation, relationship between the two variables.

Unfortunately, 8 of the pre-service teachers did not compute for the Pearson r value. Natalie knew that when the computed value was higher than the critical value, then there was a significant relationship between the two variables. However, she misconstrued that significant result signified that the two variables had the same trends and positive computed value implied higher.

Table 13

Interviewer:	Assuming that you were able to compute for the Pearson r-value and given that the computed value is significant, what would then be your conclusion?
Natalie:	'Pag mas mataas 'yung computed t-value kaysa diyan sa level of significance, therefore i-aaccept 'yung kwan…there are significance between the two. (If the t-computed value is higher than the level of significance, therefore accept the… there are significance between the two.)
Interviewer:	If the computed Pearson r-value is significant, what would then be your conclusion?
Natalie:	Pareho sila ng trends. (They have the same trends.)
Interviewer:	Paano kapag positive 'yung na-compute mong value, anong ibig sabihin nun? (How about if your computed values is positive, what would it mean?)
Natalie:	Higher.

It was apparent from the results that majority of the pre-service teachers incorrectly computed for the Pearson r value and were not able to explain the concept.
Also, the pre-service teachers were asked to explain, model, and/or demonstrate this item to their student who did not understand. Table 7 shows the distribution of their responses on strategies in teaching inferential statistics.

Table 7: Distribution of Pre-service Teachers' Responses on Strategies in Teaching Inferential Statistics

Strategies	f	%
Direct Instruction	19	48.72
Problem-based Learning	3	7.69
Cannot Tell / No Answer	17	43.59
Total	39	100

Almost 49% of the pre-service teachers responded that they intended to employ direct instruction in teaching inferential statistics. Harold answered that he would teach the item to someone who did not understand by explaining the formula and process in answering the problem, while Abraham answered that he would make the students understand the concept by engaging them to real-life situations. On the other hand, Tina's response was that the students must have the knowledge on statistical method/tool. These results illustrated the preference of the pre-service teachers in using direct instruction to teach inferential statistics concepts.

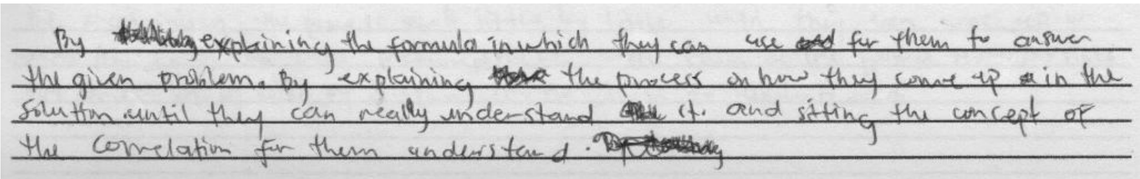

By explaining the formula in which they can use for them to answer the given problem. By explaining the process on how they come up in the solution until they can really understand it. and sitting the concept of the Correlation for them understand.

Figure 17: Harold's response on Strategies on Teaching Inferential Statistics

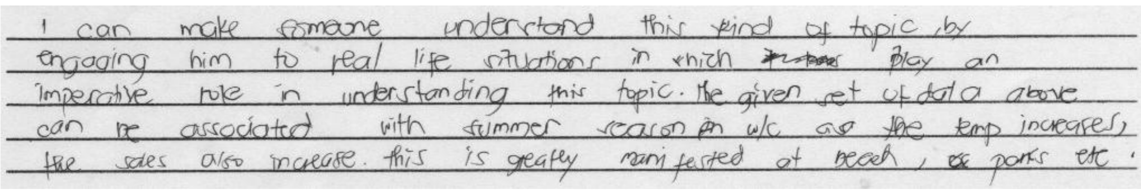

I can make someone understand this kind of topic, by engaging him to real life situations in which play an imperative role in understanding this topic. The given set of data above can be associated with summer season on w/c as the temp increases, the sales also increase. this is greatly manifested at beach, parks etc.

Figure 18: Abraham's response on Strategies on Teaching Inferential Statistics

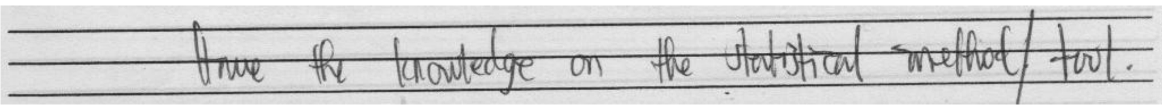

Have the knowledge on the statistical method/tool.

Figure 19: Tina's response on Strategies on Teaching Inferential Statistics

In general, there were more pre-service teachers who correctly computed for the Pearson r value. This means that they had a good procedural understanding of Pearson r. However, when asked to interpret the computed value, the majority of the pre-service teachers failed to give a sound interpretation. This is an indication that there is a need to strengthen the capability of the pre-service teachers to draw inferences out of the computed data. Meanwhile, the pre-service teachers exhibited that they were inclined to teaching concepts using the procedural method of instruction. This is similar to the findings of Cankoy (2010) that strategies proposed by the high-school mathematics teachers to foster topic-specific pedagogical content knowledge were mainly procedural which fosters memorization rather than conceptual understanding. This indicates that the approaches suggested by teachers in teaching mathematics tended to direct toward rote learning (Simsek and Boz, 2016). This can be explained by their tendency to teach the way they were taught and that they cannot be a constructivist teacher because they did not experience constructivist approach during their school experiences (Basturk & Donmez, 2011).

Comparison in the Pre-service Teachers' Pedagogical Content Knowledge for Teaching across the Domains of Statistics and Probability

Table 8: Repeated Measures Analysis of Variance on Significant Difference in the Pedagogical Content Knowledge across the domains of Statistics and Probability

Domain	MPS	SD	F-value	df	p-value
Data Presentation (DP)	49.36	21.83	6.126**	6	0.0001
Measures of Central Tendency (MCT)	40.17	29.79			
Measures of Variability (MV)	37.82	33.38			
Inferential Statistics (IS)	30.77	30.06			
Fundamental Counting Techniques and Combinatorics (FCTC)	64.74	31.79			
Probability (P)	55.13	32.03			
Random Variables and Probability Distributions (RVPD)	50.00	35.82			

**significant at 0.01 level
Bonferroni: FCTC > IS ($p < 0.01$); FCTC > MV ($p < 0.01$); and FCTC > MCT ($p < 0.01$)

It can be seen in Table 8 that the results of the repeated measures ANOVA revealed significant variation in the mean percent scores on pedagogical content knowledge of the pre-service teachers along the seven learning areas (F-value = 6.126, p-value < 0.0005). This indicated that the pre-service teachers had different levels of pedagogical content understanding on the different learning areas in statistics and probability. In particular, the pedagogical content knowledge of the pre-service teachers in fundamental counting techniques and combinatorics was statistically better than their mean percent scores in inferential statistics (mean difference = 33.97), measures of variability (mean difference = 26.92), and measures of central tendency (mean difference = 24.57). This could be because fundamental counting techniques and combinatorics under the K-12 Curriculum are taught to Grade 8 and Grade 10 students (DepEd, 2013). This means that the pre-service teachers who were assigned to teach the said grade levels might have been exposed to those competencies. This suggests that more focus should be given in strengthening the pedagogical content knowledge of the pre-service teachers on the content areas inferential statistics, measures of variability, and measures of central tendency. This was in line with the findings of Depaepe et al. (2013), that teachers' pedagogical content knowledge differed across mathematics subdomains thus they favored topic-specific pedagogical content knowledge rather than a general mathematics conceptualization of pedagogical content knowledge.

CONCLUSION

The teachers' pedagogical content knowledge for teaching is essential in ensuring the success in the implementation of a new curriculum. It is apparent that the pre-service teachers of Northeastern Philippines lacked understanding of the pedagogical content knowledge for teaching statistics and probability. In particular, they manifest some misconceptions along the different content areas in statistics and probability. Along with this is the fact that their strategies were mainly procedural which tended to direct toward rote learning and foster memorization rather than conceptual understanding. Moreover, the pre-service mathematics teachers had strong knowledge of teaching fundamental counting techniques and combinatorics but their pedagogical content knowledge for teaching along inferential statistics, measures of variability, and measures of central tendency should be developed further.

RECOMMENDATIONS

Based on the findings and conclusions, the following are hereby recommended:

1. The pedagogical content knowledge for teaching of the pre-service teachers should be strengthened. This means that:

1.1. The educators who are handling statistics and probability courses should focus more on developing the conceptual understanding and in checking the misconceptions of the pre-service teachers.
1.2. The practices in tertiary level schooling should be based on constructivist perspectives in pre-service teacher education.
1.3. Pedagogical content knowledge should be integrated in the different subjects in the new mathematics curriculum for tertiary education.
2. There is a need to strengthen the pedagogical content knowledge of the pre-service teachers especially on the content areas inferential statistics, measures of variability, and measures of central tendency.
3. Continued research on the pedagogical content knowledge should be done to produce more sound results for the development of secondary teachers with exemplary pedagogical content knowledge for teaching any content area.

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