

Investigating Mathematical Knowledge of Teaching for Secondary Preservice Teachers in Papua New Guinea

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Abstract

This article examines the studies investigating the teacher's mathematics knowledge of teaching by secondary preservice teachers in Papua New Guinea. Previous research on Mathematics Knowledge for Teaching provided support for the study. This study was conducted in recognition of the ongoing problems with Papua New Guinea's curriculum, particularly the teaching of science and mathematics, which have led to a drop in students' performance in these subjects. Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK) are the two main domains that have been identified. These domains are further subdivided into Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT), and Knowledge of Content and Curriculum (KCC), respectively. Other subdivided areas include Common Content Knowledge (CCK), Specialized Content Knowledge (SCK), and Horizon Content Knowledge (HCK). To determine the relationship between SMK and PCK, research questionnaires were utilized as instruments that could accommodate the various areas of SMK and PCK. Given that the P-value is $0.22 > 0.05$, the study's findings indicate a marginally significant difference in SMK between years one and four. However, since the P-value was $0.007 < 0.05$, it was discovered that year fours have higher PCK than year one. Ultimately, the study has demonstrated that fourth years have higher MKT than first years. The diligent work of final-year preservice teachers in mathematics is what caused this difference. It is advised that the mathematics curricula in teacher colleges be reviewed following the findings and expanded to include material on SMK and PCK. The Secondary Teachers College Program Specification Document must include both what and how to teach mathematics.

Keywords: Mathematics Knowledge, Probability, Preservice Teachers, Pedagogical Knowledge, Papua New Guinea

Introduction

Background of the study

Numerous changes and issues with education have plagued the education system in Papua New Guinea. The government has changed the education system through the Corporate Plan (2019) and National Plan for Education (2004-2014) in response to these issues. The major obstacle confronting the nation's educational system is issues like the low rates of literacy and numeracy in English and mathematics. The largest problem facing schools is a shortage of qualified math teachers. These outcomes stem from the implementation of the Outcome Based Education system by the Education Department of Papua New Guinea (Asimi, 2014). Dr. Sinebare acknowledged that there has been a lot of public criticism in the last three years regarding the effects of outcomes-based education, or outcomes-based curriculum, as some refer to it in Papua New Guinea, according to the National Newspaper Sinebare (2014, August 11). It has been demonstrated, according to Meleisea et al. (2015), that the nation's

performance in mathematics has decreased across the board when compared to other Pacific Island countries. The decline in mathematics performance is caused by several factors, including the frequent changes made to the educational system without conducting adequate research. Many schools and colleges engage in cross-teaching as a result of the shortage of specialized mathematics teachers. Furthermore, there have been problems with the pedagogy and content of mathematics in the college curricula for primary and secondary teachers. Probabilities and statistics are integrated into the mathematics curriculum in schools, according to Puspitasari et al. (2019). Still, students struggle with probability and statistics. The difficulties that students face are related to understanding the problem, selecting and implementing a strategy, and computational processes (Arum et al., 2018). These are issues that students in Papua New Guinea also face. There is a significant problem that a lot of facilitators and students are dealing with. The difficulty of understanding the word problems in probabilities is the major challenge encountered by many learners at different levels of education in Papua New Guinea.

Hence the Department of Research Science and Technology has directed the administration of the college to do a review of all the programs based on the Program Specification Document (2020) for St Peter Chanel Secondary Teacher Education. This is because mathematics education is a serious problem that depends on the pedagogical approaches and subject-matter expertise of teachers.

Many educators are not proficient in mathematics, which is a prerequisite for good instruction. On Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK), various studies have been conducted. However, not enough research has been accomplished to demonstrate that PCK is posed by teachers in addition to the content (Ball et al., 2008). A relationship between SMK and PCK was observed (Ball et al., 2008). All of these subject areas work best when they are integrated into teaching and learning. As a result, the relationship between the two primary knowledge components was examined in this study. It also investigated how these two fields of knowledge utilized mathematics.

There are other issues dealing with the nation's education system besides the decline in math proficiency (Meleisea et al., 2015). Other obstacles encompass the development of teacher curricula and the emphasis on math and science education. Lack of Mathematics Knowledge for Teaching was one of the reasons mentioned (Hill et al., 2008). Smestad et al. (2014) assert that the field of mathematics has evolved and changed over space and time. As a result, it is believed that country-to-country variations exist in mathematics knowledge for teaching. Papua New Guinea is therefore not an exception. It was suggested to conduct audits and reviews to enhance the science and mathematics program that is offered to prospective, qualified math teachers. As a result, the study focuses on preservice 1 and preservice 4 student teachers and the results will enhance the programs that this organization offers. The objective of this is to raise the Mathematical Knowledge for Teaching (MKT) both nationally and within this organization.

Research Objectives

The objectives of this research are:

1. To investigate if there is a relationship in Mathematics Knowledge between SMK and PCK of year one and year four preservice teachers in a secondary teachers' college;
2. To investigate the content about the mathematics SMK and PCK between the year one and year four preservice teachers.

Literature Review

Mathematical Knowledge is necessary that every teacher needs at any level of education. When Shulman (1986) first published his work, he distinguished between the three primary domains of knowledge for educators: curriculum knowledge, pedagogy, and content knowledge. He claimed that SMK is the information that remains in a teacher's memory. PCK is the combination of pedagogy and content that helps students understand mathematical concepts. Understanding the terms and content topics used in the curriculum materials of a particular subject in a grade is regarded as curriculum knowledge. Comprehending the subjects and problems covered in the curriculum positions the instructor in a better position to lead the mathematics lessons in subsequent years Shulman (1986). Shulman's suggestion to determine the problems with PCK has been the subject of numerous studies. According to Ball et al. (2008), content knowledge is the fundamental understanding a math teacher needs to impart when instructing students in mathematics and assigning homework. When teaching, a teacher needs specialized content knowledge to help them solve complex problems using their foundational understanding of mathematics. While students' knowledge or instruction is not always necessary, mathematics resources are needed for common tasks in the classroom Hill et al. (2008). Furthermore, Ball defined Knowledge of Content and Students (KCS) as the subject matter expertise of students regarding their comprehension and knowledge of mathematics (Hill et al., 2008). Thabane (2015) states that although teachers of mathematics require a profound comprehension of mathematical content knowledge, they also need to possess other types of teacher knowledge to convert SMK into concepts that students can comprehend and solve. Shulman (1987).

Ball et al. (2008) separated the knowledge domains into SMK and PCK, which are related and necessary for instruction. The KCS served as the focal point of their theoretical framework, which also recognized other types of teacher knowledge. Ball et al. (2008) indicate that Common, Specialized, and Horizon Content Knowledge constitute SMK. Moreover, PCK is made up of KCS, Knowledge of Content and Teaching (KCT), and Knowledge of Content and Curriculum (KCC), as their theoretical framework illustrates.

The Common Content Knowledge (CCK) is one of the three parts. Morris et al. (2009) declare that CCK is the knowledge that educators need to teach mathematics. Specialized Content Knowledge provides the second element. Hurrell (2013) asserts that this is the information required by educators to establish connections between various mathematic topics and strands. Horizon Content Knowledge (HCK) is the third element. Hurrell (2013) argues that teachers must possess the knowledge necessary to help students comprehend mathematics content at a deeper level by providing connections between known and unknown mathematical concepts. Ball et al. (2008) classified PCK into the subsequent sub-

categories. They are KCC, KCT, and KCS. The data entry that was examined under different categories of teacher knowledge is displayed in the table.

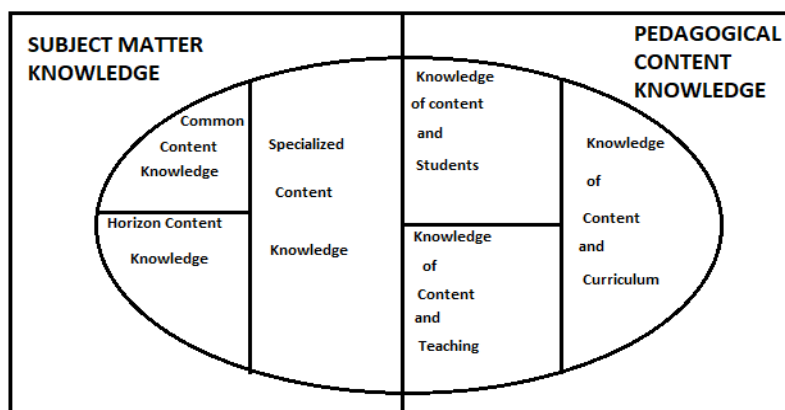


Figure 1. Subject Matter Knowledge and Pedagogical Content Knowledge.

The foundation of mathematical knowledge is PCK Thabane's (2015) idea. The cornerstones of a teacher's required instructional practices in the classroom are SMK and PCK. The primary objective of SMK is the mathematical organization of facts, concepts, and principles within the discipline. Inadequate knowledge of SMK causes misunderstandings and misinterpretations of the topic. The six components of mathematical knowledge are described in the journals written by Lee et al. (2018), Ball et al. (2008), and Hill et al. (2008).

The majority of teachers in "CCK" possess the fundamental mathematical knowledge required specifically for teaching mathematics. Specialized Content Knowledge (SCK) is the knowledge that combines the content with the knowledge of teaching and the knowledge that connects students' thinking to the mathematics content. Finding the underlying ideas that need to be comprehended to understand why those math problems arise is necessary.

Horizon Content Knowledge (HCK) is the mathematical knowledge that extends beyond the horizontal. It involves applying fundamental ideas in mathematics to solve more complex problems that require more mathematical understanding. Furthermore, the interpretation of Content Knowledge by students is referred to as KCS, similar to misconceptions in mathematics. Additionally, the connections between content knowledge and the available curriculum materials, as well as how content knowledge relates to teaching knowledge. Horizon Knowledge, as defined by Hill et al. (2008), is the understanding of the connections between the various mathematical topics covered in the curriculum.

According to Niemelä and Tirri (2018), Mathematics Knowledge is the knowledge that resides at the intersection of pedagogy and content incorporating what the scholars have referred to as the PCK as well as the SMK (Hill et al., 2008).

SCK is a specific mathematical knowledge required for teaching to connect a basic, well-known mathematical concept to an unknown mathematical concept, according to Ding (2016). Although it is difficult to develop with primary preservice teachers, it is an essential component for preservice teachers. This particular type of knowledge deals with the content and pedagogy of mathematics. Shulman (1986) defined content knowledge as the body of knowledge that educators need to grasp to be effective. This knowledge encompasses facts,

theories, concepts, ideas, and vocabulary. Instructors ought to be extremely knowledgeable about the subjects they teach as well as the related curricula. However, Hill et al. (2008) define mathematics common content knowledge as the knowledge that is learnt from primary and secondary schools that is common to all learners to solve and apply in mathematics use and daily life.

Ball and his colleague Chapman (2013) worked to mathematically represent Shulman's two categories of knowledge, "Content Knowledge and Pedagogical Content Knowledge," under the umbrella of Mathematics Knowledge for Teaching. According to Thabane (2015) the combination of content, teaching, and curriculum knowledge that a teacher needs to support lessons for students is termed pedagogical content knowledge. Journal articles by Steele (2013), UNESCO (2019), and Kulm and Wu (2004) state that when students think and know about the material, learning typically occurs.

Effective mathematics instruction incorporates both pedagogical and mathematical content knowledge, according to UNESCO (2019). Both pedagogical and mathematical content knowledge are required to help students build mathematical concepts in their minds (Steele, 2013). As per Barrett and Green's (2009) findings, teacher candidates can develop into skilled practitioners through two distinct team mechanisms. Various teacher programs incorporate these two concepts: reflective practice and the teacher as a researcher (Barrett & Green, 2009; Krauss, et.al 2008).

Understanding different teaching methods, learning objectives, and instructional materials are all part of curriculum knowledge. Instructors frequently use a variety of curriculum materials from which to select appropriate resources. Educators must understand that they have access to additional resources, that there are different approaches to course design and curriculum development, and that they may select from a variety of instructional strategies (Morris et al., 2009). Even though teaching experience plays a crucial role in PCK development, it does not have the same impact as a teacher's opportunity to reflect on their content knowledge. Furthermore, they put forth two models: integrative and transformative. According to the integrative model, teaching itself offers an opportunity for integration because pertinent knowledge bases are developed independently (Turnuklu & Yesildere, 2007; UNESCO, 2019). The transformative model, on the other hand, acknowledges the importance of synthesized knowledge, the fundamental alteration of knowledge, and the production of new knowledge. Hurrell (2013) proceeded to expand on the knowledge domains providing thorough examples that corresponded to each teacher's area of expertise.

Table 1

Examples of Questions Supporting the Domains of Teacher's Knowledge

Domain	Example of question
SMK	CCK <ul style="list-style-type: none"> • Obtaining the correct answers on a particular math topic? • Accurately solving a mathematics problem related to a particular subject? • Can you confidently instruct a particular mathematics topic?
	SCK <ul style="list-style-type: none"> • When asking questions about presenting mathematics ideas; • Providing examples to clarify a specific mathematics points; • Recognizing mathematics representations in a problem; • Connecting the dots between teaching and math content.
	HCK <ul style="list-style-type: none"> • Connecting topics in mathematics • Connecting different mathematics strand

Domain	Example of question	
PCK	KCS	<ul style="list-style-type: none"> Identifying misconceptions in mathematics problems Predicting interesting and motivating math examples. Anticipating easiness and difficulty in math problems Listening and interpreting students' incomplete ideas
	KCT	<ul style="list-style-type: none"> Putting mathematics content in sequential order Adding more depth and clarity to the mathematical examples
	KCT	<ul style="list-style-type: none"> Articulating the strands in mathematics Understanding the mathematics curriculum

Speer et al. (2015) claim that MKT is impacted by teachers' knowledge and the facilitator's roles in forming the teaching practice, which in turn affects the decisions and practices of teachers to achieve their learning objectives. These earlier supporting materials have inspired me to investigate the differences that have developed throughout preservice secondary teachers' study of mathematical knowledge for teaching, with a particular focus on probability problem-solving.

A significant percentage of students, ranging from elementary school to postsecondary institutions, lack a fundamental understanding of probability and statistics, according to Garfield and Ahlgren (1988). This is the result of poor abstract reasoning and mathematical abilities. Furthermore, the way that students conceptualize mathematical facts obstructs their ability to learn sound statistical reasoning.

According to Boland and Nicholson (1996), learning of statistics and probability has influenced by computing in the countries; USA, Ireland and UK and hence it is continuing to have dramatic effect on how to develop probabilities including statistics.

The impact of technology on probability and statistics has prompted efforts to explore new pedagogies for teaching these subjects in educational institutions. However, when solving problems by hand, a lot of students are unaware of the steps involved. These circumstances also arise in Papua New Guinean schools.

In higher education, students continue developing misconceptions about probability, according to Astuti et al. (2020). Students struggle to understand the problem. It will be evident that many students make procedural mistakes when proving. Furthermore, students' comprehension of application problems is lacking. Students can compute probabilities of events incorrectly at times. These false beliefs are widespread in Papua New Guinean classrooms.

Methods

Conceptual Framework

The theoretical literature that was previously reviewed provides empirical support for the construction of this framework. The year one and year four teachers were given test paper questionnaires that included various domains of teacher knowledge, as illustrated in Figure 2, by this conceptual framework. The two-year groups' mathematics knowledge for teaching was assessed using the results.

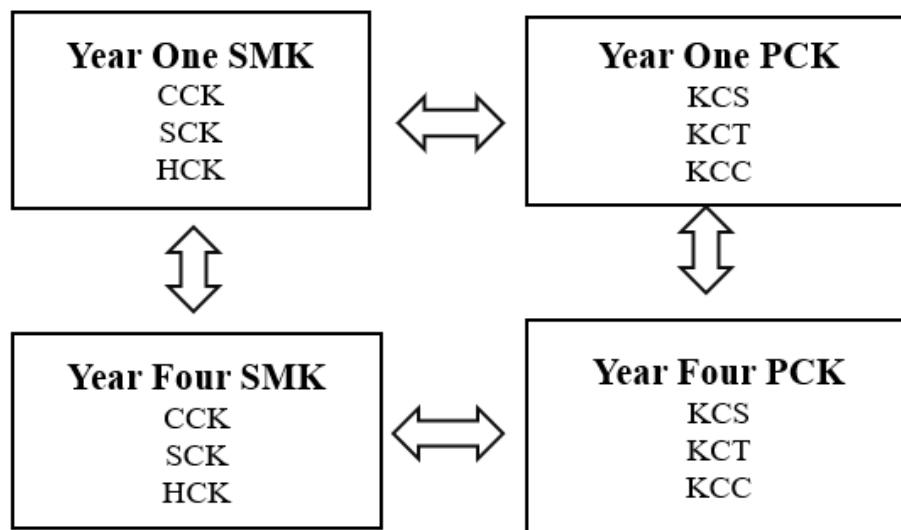


Figure 2. Conceptual Framework.

Research Approaches

This quantitative study was conducted using data from Thabane's (2015) earlier investigation into Pedagogical Content Knowledge Ball et al. (2008). The COVID-19 Pandemic required the research to be completed online. The survey outline that was provided to the participants is presented in Table 2.

Table 2

Table Showing the Knowledge Domains in the Questionnaire

	Knowledge domain	Multiple Choice	Short Answers	Marks
SMK	CCK	Questions 1-4	Questions 13,14 & 15	30 marks
	SCK	Questions 5,6 & 7	Question 16	
	HCK		Question 17	
PCK	KCS	Questions 8,9 &10	Questions 18 & 19	20 marks
	KCT	Question 11	Question 20	
	KCC	Question 12	Question 21	
MKT				50 marks

Some Questions Used in This Survey

The following are some of the questions that were employed in this survey.

Common Content Knowledge

In a Grade eight class, 20 students sat for the National Examinations. Out of the 20 students, 8 students sat for the English Examination and 5 students sat for both Mathematics and English Examinations. What is the probability of students that sat for the Mathematics Examination only?

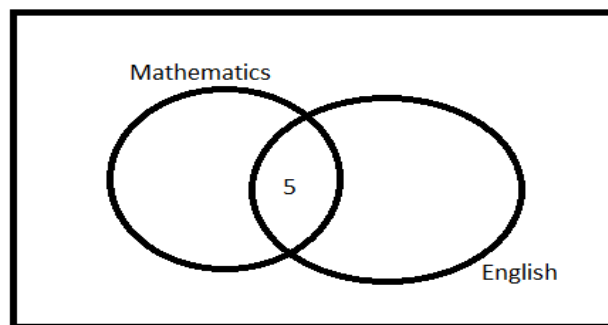


Figure 3. Venn Diagram showing students sat for the National Examination.

Specialized Content Knowledge (SCK)

A math teacher provided his students with the tasks listed in the table below and asked them to identify the steps required to solve the problems in his class.

For the following problems, indicate whether each would be solved by drawing a probability tree or not by putting a Tick (✓) for the correct choice.

Table 3

Problems with SCK

Problem	Would be answered by drawing a probability tree	Would not be answered by drawing up a probability tree
A) A coin is tossed 3 times. What is the probability of tossing a coin and getting no tail?		
B) In a family there are three kids, what is the probability of the 1 st child being a boy, 2 nd child being a boy, last child being a girl?		
C) There are two green and three blue marbles. John at random selects a marble. Is there the possibility of selecting a second blue marble if the first blue marble is returned to the box?		
D) There are seven blue and three green tickets. Peter at random selects a marble. If the first blue ticket was <u>not</u> put back into the box, what is the probability of picking a 2 nd green ticket?		

Horizon Content Knowledge

There are 3 blue marbles and 2 green marbles. John draws a marble randomly three times with replacement. How might a probability tree be drawn? In a table with the outcomes, probabilities, and total probability, how would you present the data? Can you identify a theorem here? What is that?

Knowledge of Content and Students

Two coins are spined. The probability of getting a head and a tail is $\frac{1}{3}$ because the results are: Head and Head, Head and Tail or Head and Tail. What is the misconception that the student has made?

Knowledge of Content and Teaching

Teachers learned various approaches to solving probability word problems at the professional workshop on mathematics, specifically probability. This is one of the word problem that the teachers were required to solve. If a K1 coin is tossed twice, what is the probability of getting two heads? As one of the teacher attendees, how would you solve this problem in two ways?

Knowledge of Content and Curriculum

One of the teachers' colleges' math lecturers in Papua New Guinea was reviewing the material on probability and statistics for the Grade 12 General Mathematics curriculum. The teacher instructed students to select a lesson topic and create lesson plans. If you are a Grade 12 General Mathematics teacher, what would be the specific lesson topic that you would have developed from the Standard Based Curriculum (SBC) Syllabus?

Participants and rubrics

A random sample of 15 preservice teachers from each year group was chosen to participate in this survey on problem solving in probability among the preservice teachers in years one and four. The paired T-test was employed to analyze the data. The p-value was used to test the means of SMK and PCK to determine whether there is a significant difference between the two.

Students utilize specialized courses in probability during their preservice studies, such as basic probability problem-solving, probabilities of dependent and independent events, and Venn diagram drawing. Therefore, the questionnaires were designed to investigate whether the students have the knowledge in the areas of SMK and PCK in these specific probability contents.

The 21 test questions addressed the two primary domains, PCK and SMK. CCK, SCK, and HCK were further subdivided into SMK. PCK was split into KCS, KCT, and KCC similarly. Each question obtained a mark under a different category related to teacher knowledge, and these marks were added together to determine the overall mark for mathematics knowledge for teaching.

15 questions were multiple-choice questions, and 6 questions were short answers. The total mark on the paper test was 50. A comparison of each teacher's knowledge between the first and fourth years was conducted using statistical values, specifically the mean, standard deviation, and t-test.

Additionally, a connection between SMK and PCK was discovered. Furthermore, there was a comparison of SMK between the two-year groups. Comparing PCK across the two-year groups was performed as well in a similar manner.

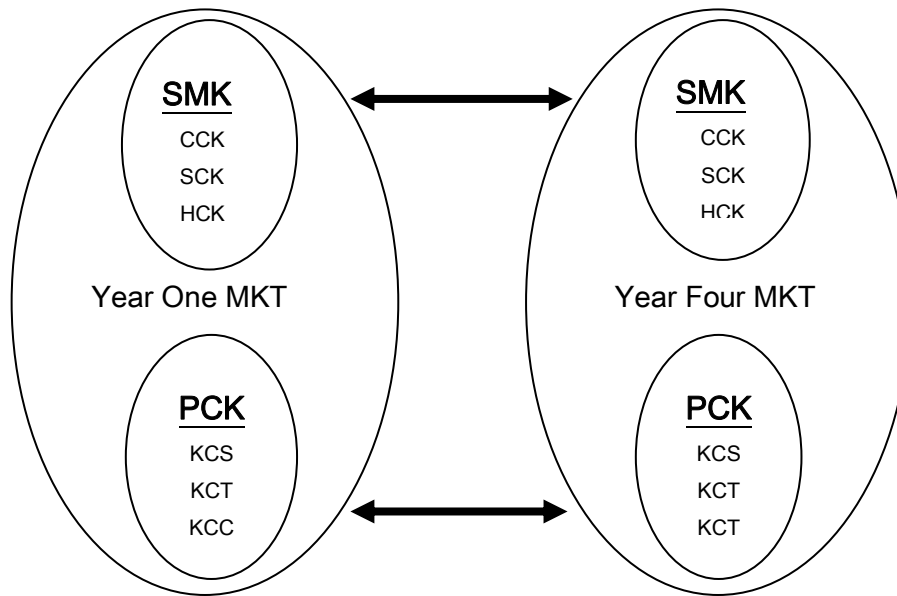


Figure 4. Comparison of teacher knowledge

Results and Discussion

The Excel spreadsheet and the R Studio programming tool were employed to analyze the achievement test results under the various categories of teacher knowledge. The statistical differences in teacher knowledge between the first-year and fourth-year preservice students are investigated using the t-test. The primary areas of teacher knowledge are PCK and SMK, which are further separated into additional categories. The test results support some of the earlier research on mathematical knowledge for teaching (MKT), which varies based on students' mathematical thinking across a range of mathematical topics.

Table 4
Year One and Year Four Statistical Values

Year one	SMK				PCK				MKT
	CCK	SCK	HCK	Sub-Total	KCS	KCT	KCC	Sub-total	
Sub-Total	17	7	6	30	7	7	6	20	50
Mean	8.1	4.6	2.7	15.4	3.1	2.5	3	8.8	24.1
Stand Dev	3	1.8	2	5	1.7	1.6	2	3.1	7
P-value	0.11								
Correlation	0.49								
Year four	CCK	SCK	HCK	Sub-Total	KCS	KCT	KCC	Sub-total	
Sub-total	17	7	6	30	7	7	6	20	50
Mean	9.5	4.9	3.2	17.7	5.1	4.3	3.5	12.9	30.6
Stand Dev	1.6	1.4	1.97	3.7	1.2	2.5	2.2	3.6	6.1
P-Value	0.000433 (Y4 SMK vs Y4 PCK)								
Correlation	0.3960 (Y4 SMK vs Y4 PCK)								
P-value	0.22067 (Y1 SMK vs Y4 SMK)				0.007243926 (Y1PCK vs Y4 PCK)				
Correlation	0.216477 (Y1 SMK vs Y4 SMK)				0.045781606 (Y1 PCK vs Y4 PCK)				

P-value	Y1 MKT vs Y4 MKT	0.0013
Correlation	Y1MKT vs Y4 MKT	0.12

Subject Matter Knowledge

The three parts of SMK are CCK, SCK, and HCK. This is the total knowledge when the accomplishments of CCK, SCK, and HCK are mentioned.

In terms of CCK, the Year One's mean is 8.1, the Year Four's mean is 9.5, while Year One's standard deviation is 3 and Year Four's standard deviation is 1.6. Year Four has a higher CCK than Year One because its standard deviation is lower in Year Four than it is in Year One. Since year one students were in the first year of content coverage with primary and secondary content knowledge, the primary factor contributing to year four students' higher CCK was the extensive study of advanced probability-related topics.

Concerning SCK, year ones' mean is 4.6 and year fours' mean is 4.9. However, year one standard deviation is 1.8 and year fours' standard deviation is 1.4.

The standard deviation of year four students is smaller than that of year one, indicating that year four students possess more specialized content knowledge. This is a result of their superior content coverage, which has enabled them to operate more effectively.

Regarding HCK, the mean and standard deviation are 2 and 2.7 for year one and 3.2 and 1.97 for year four, respectively. Year fours have a higher SCK than year one since their standard deviation is lower in year four than it is in year one. Again, there are several contributing factors, but the most evident one is the content covered in the four years of study, which led to higher HCK by year four.

To identify which group has the higher SMK, a T-test analysis was done. According to the result, the p-value is $p > \alpha = 0.22 > 0.05$, therefore there is no difference in the means of SMK for the two-year groups. Since $0.22 > 0.05$, the null hypothesis was accepted. Despite this, year four students have outperformed year two students in all three teacher knowledge domains; nevertheless, statistically speaking, there is minimal variation in the SMK performance of the two-year groups. This is because each person did not possess any prior knowledge.

Pedagogical Content Knowledge

In terms of KCS, the mean for year one is 3.1 with a standard deviation of 1.7, and the mean for year four is 5.1 with a standard deviation of 1.2. Year four students have a higher KCS than year one students, indicating that many of them scored in the range of the mean since the year four standard deviation is lower than the year one standard deviation. The exposure to alternative mathematics curriculum programs in year four over the four years accounts for the higher KCS.

In terms of KCT, the mean for year one is 2.5, with a standard deviation of 1.6, and the mean for year four is 4.3, with a standard deviation of 2.5. Although year four's mean is higher than year one's, year four has performed better even though year one's standard deviation is lower. Year fours have a higher KCT than year one as a result. This is once more an outcome of year one students not being exposed to professional programs in mathematics.

About KCC for both year groups, the mean for year one is 3 and the standard deviation is 2, meanwhile the mean for year four is 3.5 and the standard deviation is 2.2.

The year fours have a higher mean than the year ones, although the year ones' standard deviation is lower. As a result, year four students have outperformed year one students. This is because students participate in practice problems in mathematics classes and are exposed to the mathematics curriculum.

KCS, KCT, and KCC compose PCK. A T-test analysis was performed to determine which group had the higher PCK. Based on the results, there is a difference in the PCK average for the two-year groups ($p < 0.007 < 0.05$). The null hypothesis was rejected because $0.007 < 0.05$, indicates that there is a statistically significant difference in PCK performance between the two-year groups. This is because fourth-graders are exposed to the mathematics curriculum and engage in teaching practice at the expense of first-graders.

Relationships between Teacher Knowledge Domains

The correlation (r) between the first-year PCK and SMK was determined to be 0.49 through R-studio programming, indicating a medium relationship between the two. The findings demonstrate that although first-year preservice teachers have greater subject-matter knowledge, they are deficient in pedagogical content knowledge. Despite incorporating educational courses in their first year of study, the results indicate that preservice students lack Pedagogical Content Knowledge. There is a significant difference in Subject Matter Knowledge and Pedagogical Content Knowledge since their P-value of $2.83095E-05$ is less than 0.05. The R-studio programming demonstrated a correlation (r) of 0.39 in the relationship between year four PCK and SMK, indicating a weak relationship between the two. As the P-value of 0.000433 is below 0.005, it can be inferred that there is a noteworthy distinction in their comprehension of SMK and PCK. Therefore, it has been demonstrated that there is a statistically significant difference in preservice teachers' comprehension of SMK and PCK even after they have completed all of the courses. The lack of prior knowledge is the cause of this. The above table illustrates that the correlation between the year one SMK and the year four SMK is 0.216 when compared to the year one and year four SMK. This indicates that the year one and year four SMK have a weak relationship. Their P-value, however, is 0.22, above the 0.05 threshold. As a result, despite the fact year four students are in their last year of study, there is no discernible difference between year one and year four students. Each student's prior knowledge is to blame for this. The correlation coefficient between the PCK data for years one and four is found to be 0.046. This demonstrates the poor correlation between year one and year four PCK. The weak correlation suggests that, in comparison to year four students, some year one students know less about PCK. Year four students, on the other hand, have high PCK.

Mathematics Knowledge

The overall teacher knowledge essential for teaching mathematics consists of SMK and PCK. Therefore, the MKT for the two groups was compared by examining the p-value of the T-test after the achievement for SMK and PCK for each year group was added. Based on the data analysis, the p-value is $0.0013 < 0.05$. There is no mean difference in the MKT because $0.0013 < 0.05$. The null hypothesis is thus disproved. Consequently, there is a statistically significant difference in MKT between the preservice year one and year four students. The final-year students' four years of diligent study throughout their studies were responsible for

this notable difference. This covers each student's past mathematical knowledge. Furthermore, year four students participated in the mathematics curriculum and teaching practice, whereas first-year students did not participate in these programs.

Conclusion

There is a significant difference in the PCK between year one and year four, but there is no significant difference in the SMK, according to the analysis of the students' responses. There exists a noteworthy disparity in Mathematics Knowledge for Teaching (MKT) between first-year students and fourth-year students due to the disparity in PCK. MKT is higher in year four than in year one. However, the overall performance of PCK and SMK in year one is unimpressive, indicating a deficiency in these skills by the first year. As a result, the SMK and PCK must be examined and added to the first-year mathematics curriculum.

The SMK and PCK of year one are unrelated to one another. Moreover, there is no connection between PCK and SMK of year fours. Additionally, the study uncovered no connection between the PCK of year ones and fours. This indicates that there is a minimal conversation about pedagogical content knowledge and probability content between year ones and year fours. In general, many students lack mathematical knowledge on SMK and PCK on the content probability, although there are some differences in PCK.

One of the major challenges that was encountered during the data collection was the travel restriction caused by the COVID-19 Pandemic. Hence, the data used in this study was collected online. As a result, this has affected the study's findings.

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