
MATHEMATICS LEARNING STRATEGY BOOK ON PEDAGOGICAL CONTENT KNOWLEDGE FOR ELEMENTARY SCHOOL PRE-SERVICE TEACHERS

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Abstract

The goal of this study is to describe the impact of a mathematics learning strategy book on elementary school pre-service teacher's pedagogical content knowledge.

The research method used is experimental research with poor experimental methods. A one-group pretest-posttest design was used. This study's sample size is 94 pre-service teachers or elementary school teacher education students. Tests and assessment sheets are data collection instruments for measuring PCK. The test is used to determine PK and CK levels. The Quizizz application is used to administer the test, which is in the form of multiple choice questions. PCK is measured using a score sheet. The data is analyzed using descriptive statistics and inferential statistics. To explain the distribution of PCK data, descriptive statistics are used. To test the research hypotheses, inferential statistics are used. The paired sample t-test was used to test the hypothesis.

The results show that pre-service teachers' PCK is in the high range. The hypothesis test results show that the mathematics learning strategy book used in learning is effective against pre-service teachers' PCK. Mathematics learning strategy books used in elementary schools not only contain theory and material, but also provide examples of student worksheets based on specific strategies/methods. This is what helps pre-service teachers understand so that it has an impact on increasing PCK.

Abstrak

Tujuan penelitian ini yaitu mendeskripsikan keefektifan buku strategi pembelajaran matematika terhadap pedagogical content knowledge calon guru sekolah dasar.

Metode penelitian yang digunakan yaitu penelitian eksperimen dengan metode poor experimental. Desain yang digunakan yaitu *one-group pretest-posttest design*. Sampel penelitian ini adalah calon guru atau mahasiswa pendidikan guru sekolah dasar sebanyak 94 mahasiswa. Instrumen pengumpulan data untuk mengukur PCK yaitu tes dan lembar penilaian. Test digunakan untuk mengukur PK dan CK. Test diberikan dalam bentuk pilihan ganda melalui aplikasi *Quizizz*. Lembar penilaian digunakan untuk mengukur PCK. Analisis data yang digunakan adalah statistic deskriptif dan inferensia. Statistic deskriptif digunakan untuk menjelaskan sebaran data PCK. Statistik inferensia digunakan untuk menguji hipotesis penelitian. Uji hipotesis yang digunakan adalah paired sample t-test.

Hasil penelitian menunjukkan PCK calon guru berada pada kategori tinggi. Hasil uji hipotesis menunjukkan buku strategi pembelajaran matematika yang digunakan dalam pembelajaran efektif terhadap PCK calon guru. Buku strategi pembelajaran matematika di SD yang digunakan dalam pembelajaran tidak hanya terdapat teori dan materi saja, tetapi diberikan contoh lembar kerja siswa berbasis strategi/metode tertentu. Hal inilah yang mendukung pemahaman calon guru sehingga berdampak pada peningkatan PCK.

INTRODUCTION

Educational students are those who are studying to become teachers. A teacher must possess a variety of skills. According to the Law on Teachers and Lecturers, teachers must possess a variety of skills, including pedagogical and professional abilities (Law Number 14, 2005). Pedagogical and professional skills are also known as pedagogical content knowledge (PCK). The PCK concept was developed by Shulman (1987). PCK is a synthesis of pedagogical knowledge (PK) and content knowledge (CK) (CK). According to Shulman (1987), teachers must have pedagogical skills to understand students from a cognitive perspective so that they can condition the class, choose appropriate evaluation strategies and techniques in learning, and have content knowledge in order to master the concepts of the material to be taught to students. Hurrell (2013) defines PCK as a combination of fundamental knowledge of the material, pedagogy, and context. The findings indicate that PCK plays an important role in the professional development of teachers and pre-service teachers (Anwar et al., 2014). PCK levels in teachers have also been studied, demonstrating the importance of PCK on learning quality (Haron et al., 2021; Khalid & Awang, 2009).

Teachers in Indonesia do not fully recognize the value of pedagogical and professional skills. Teachers in Indonesia are dealing with a lack of content mastery and literacy (Nofrion et al., 2018). The findings of Wasono's research (2019) found that one of the teacher problems that arise is that there are still few teachers who conduct classroom action research to improve teaching skills and solve problems that exist in the teaching and learning process in the classroom. There are still many teachers whose level of mastery of teacher professional competence is not yet optimal. Such as the tools and learning methods used by the teacher are still not optimal. The learning tools made by the teacher still use copies from previous years and some of them have not included character education in them. According to Wiryatmo et al. (2021) that there are still teachers who carry out learning by not using learning media and also teaching aids so that they seem monotonous. Another learning problem revealed by Sahira et al. (2021) that not all students can understand the material taught by the teacher, this happens because students do not understand the task given by the teacher because the teacher does not explain it in detail about the task.

The 2016 Global Education Monitoring report organized by UNESCO shows the low quality of Indonesian teachers, which is in position 14 of 14 developing countries (UNESCO, 2016). According to the UNESCO report, the results of the Teacher Competency Test (UKG) in Indonesia continue to fall short of the mark. The average score for the teacher's combined pedagogical and professional aspects is 54.05. From Figure 1 it is known that the average UKG score in the Provinces of DIY, DKI Jakarta, and Central Java, which are the provinces with the highest average score, did not reach a score of 70. The highest average professional and pedagogical knowledge was achieved by teachers in DIY Province with a score of 69.62 and 60.94, respectively. This value is far from the standard set by the government, which is 90.00.

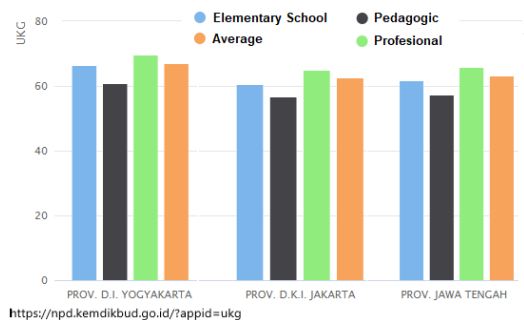


Figure 1. UKG results for DIY, DKI Jakarta, and Central Java Provinces
 (Source: npd.kemdikbud.go.id).

Teachers with low pedagogical and professional ability include all teachers, including elementary school (SD) teachers. Figure 1 shows that the UKG results for elementary school teachers in the DIY Province were only 66.36. This is one of the issues in the world of education because elementary school teachers play a critical role in developing superior human resources. This is due to the fact that elementary school teachers are the first teachers to be met at the primary and secondary education levels, and they will serve as facilitators for students for the next six years.

Elementary teachers will be responsible for teaching all subjects, including mathematics. The success of mathematics learning in elementary schools will be determined by teachers' pedagogical and professional abilities.

Aribowo et al. (2020) professional competence is the ability of teachers to master learning materials in guiding students to get maximum learning outcomes. Professional competence includes mastery of materials by

teachers, mastery of SK and KD in, development of creative learning materials, developing a sustainable professional attitude, and being able to utilize technology and communication. Handayani et al. (2022) the forms of information needed by teachers in developing competence include teaching materials, learning tools, curriculum, learning media, learning methods, and moduls.

An elementary school mathematics unlike other subjects, has an abstract concept of study. The concept of abstract mathematics studies contradicts elementary school students' level of thinking. Piaget defines elementary students as those aged 6 to 12 years old, with a thinking level that is at the concrete operational stage (Langford & Langford, 2018). Therefore, the pedagogical and professional skills of elementary school teachers in learning mathematics must be prepared since university when the teacher was still a student of Elementary School Teacher Education.

According to Santoso et al. (2019) Pedagogical Content Knowledge (PCK) ability of teacher candidates in preparing the Learning Implementation Plan (RPP) can be seen from the aspect of the suitability of the material with the strategy, resources, media, and evaluation of learning. Based on this opinion, it can be stated that students or pre-service teacher can improve their pedagogical and professional skills by using a variety of learning resources. One of the learning resources that can be used is books.

Many experts have written books on elementary school mathematics learning strategies. Wahyudi's (2014) elementary school mathematics learning book, published by UNS Press, includes strategies and materials for elementary school mathematics learning. Syafri's book for teaching mathematics education to elementary/MI teachers (2016), published by Graha Ilmu, includes SD/MI learning theory, the PAIKEM learning model, cooperative learning, CTL, and PMR. Priatna and Yulardi's (2019) mathematics learning book for elementary school teachers and prospective elementary school teachers is published by Rosda Karya and contains learning theory and mathematics materials in elementary schools. These books can be a source of learning for both teachers and students, but more books must be created. One of them is the book's strategy or approach to learning mathematics in elementary schools, which still needs to be added. Some of them are about the psychology of elementary school students learning mathematics, as well as strategies and approaches to learning

mathematics in elementary schools such as ethnomathematics and the Montessori method. Furthermore, these books do not provide examples of student worksheets based on the theories presented.

The Mathematics Learning Strategy book in elementary school is one of the learning resources that can be used to study elementary mathematics learning. This book focuses on the cognitive theory of elementary mathematics learning, as well as various elementary mathematics learning strategies and examples of student worksheets based on mathematics learning strategies.

Based on the description provided, the purpose of this study is to describe the effectiveness of an elementary school mathematics learning strategy book on the PCK of pre-service elementary school teachers. Pre-service teachers in this study used a textbook on mathematics learning strategies in elementary schools as a learning resource. Pre-service teachers will also practice creating worksheets using the examples in the book as a guide. According to the findings of Haryani et al. (2018), the activity of designing student worksheets increases pre-service teachers' PCK.

METHODS

The design used is a one-group pretest-posttest design. The experimental group was measured and observed before and after treatment (Fraenkel & Wallen, 1993). Figure 2 depicts the research design.

O ₁	X	O ₂
<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>

Figure 2. one-group pretest-posttest design.

The sample of the research was the students of Ahmad Dahlan University Elementary School Teacher Education who took the Mathematics Learning Development and Practice course in Elementary School. The research sample consisted of 320 students divided into eight classes: A, B, C, D, E, F, G, and H. The sampling technique was done at random, but the class was not. Classes C and D were chosen as experimental classes based on random sampling. The sample size for classes C and D is 94 students. The experimental method used is called Poor Experimental. There is no control class in this method, so both classes are used as experimental classes.

The following research procedures were used in the study:

1. Conduct a pretest to measure initial PCK ability.
2. Provide learning treatment using the Learning Strategy book in SD systematically through Google Classroom and Google meet. Figure 3 depicts the book's cover.



Figure 3. Book's cover
 (Source: Private document)

3. Give a posttest to measure PCK after being given treatment.

Tests, assessment sheets, and interview are data collection instruments for measuring PCK. The test is used to determine PK and CK levels. The Quiziz application is used to administer the test, which is in the form of multiple choice questions. PCK is measured using a score sheet. The assessment sheet is used to evaluate the outcomes of pre-service teachers' Student Worksheets and Lesson Plan. The normal curve is used to further categorize the average PCK value. Table 1 shows the ideal assessment category.

Table 1. Category (Azwar, 2012)

Interval	Category
$0 \leq X \leq 25$	Very Low
$25 < X \leq 41,67$	Low
$41,67 < X \leq 58,33$	Medium
$58,33 < X \leq 75$	High
$75 < X \leq 100$	Very High

The data is analyzed using descriptive statistics and inferential statistics. To explain the distribution of PCK data, descriptive statistics are used. To test the research hypotheses, inferential statistics are used. The paired sample t-test was used to test the hypothesis. Prior to testing the hypothesis, the prerequisite tests for normality and homogeneity must be completed. The SPSS program was used to help with the data analysis process.

RESULT AND DISCUSSION

Table 2 shows the study's findings in the form of descriptive data from the PCK pretest and posttest results.

Table 2. PCK Descriptive Data

Descriptive Analysis	Pretest	Posttest
Mean	54,38	74,58
Std. Deviation	8,50	7,42
Maximum	70,00	88,43
Minimum	30,00	55,58

(Source: Private document)

Table 2 shows that the average PCK of pre-service teachers increased from the pretest and posttest scores. Based on the categories of Table 1, the average PCK of pre-service teachers is in the High category. An increase also occurs in the maximum and minimum values. The average of each aspect of PCK in the posttest results is shown in Table 3.

Table 3. PCK Aspect Average

Aspek	Rata-rata	Kategori
PK	75,51	Very High
CK	78,04	Very High
PCK	70,21	High

(Source: Private document)

The PK and CK aspects are in the Very High category, as shown in Table 3. This demonstrates that pre-service teachers can explain various learning strategies that can be used in learning mathematics, determine appropriate evaluations, and determine appropriate learning media on a material, as well as master pedagogical competencies such as the theory of student cognitive development. The very high content knowledge also demonstrates that pre-service teachers understand elementary school mathematics learning materials such as numbers, geometry, and statistics. PCK is in the high category indicating that pre-service teachers are able to develop lesson plans and mathematics modules using various learning strategies such as

problem-based learning, contextual teaching and learning, Real Mathematics Education, etc. Tables 4 and 5 also contain a recapitulation of the normality and homogeneity tests.

Table 4. Normalitas Test Result

	Asymp. Sig.
Pre-test	0,150
Post-test	0,200

(Source: Private document)

Table 5. Homogenitas Test Result

	Asymp. Sig.
Between group	0,060

(Source: Private document)

Table 6. output SPSS paired t-test

	Mean	Std. Deviation	Std. Error Mean	Paired Differences		t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 pre - post	-20.20248	2.41976	.35296	-20.91295	-19.49202	-57.238	46	.000

(Source: Private document)

The results of the normality test using the Kolmogorov-Smirnov test in Table 4 show that the significance value is greater than 0.05, indicating that the normality requirements are met. The homogeneity test results show a value, indicating that the homogeneity requirement is also met. Table 6 also includes the results of hypothesis testing using the paired t-test. The SPSS paired t-test output shows an average increase of 20.20 points from pretest to posttest. The paired t-test significance value is 0.00 or less than 0.05, indicating that there is a significant average difference after learning to use mathematics learning strategy books in elementary schools. This significant difference in average demonstrates the efficacy of the learning method used. This is consistent with the findings of Wulandari and Iriani (2018), who discovered that the teaching materials used are effective in improving teachers' pedagogical competence. The same result was also expressed by Budiyo, et al. (2014) which stated that the teaching materials developed increased pedagogical competence and were expected to increase professional competence.

Mathematics learning strategy books in elementary schools that are used in learning do not only contain theory and material, but are given examples of student worksheets based on certain strategies/methods. Examples of student

worksheets in the module are student worksheets based on guided discovery, problem-based learning, contextual teaching & learning, and ethnomathematics. Based on the results of interviews with pre-service teachers, this sample worksheet makes students more familiar with various theories and strategies for learning mathematics in elementary school. In addition, students also have an idea of how to develop worksheets and carry out learning using certain methods or strategies. This is in accordance with the opinion of Mamlok-Naaman, et al which states that an in-depth understanding of the characteristics and syntax of a learning model/method/strategy to be developed is very important in supporting the success of learning (Mamlok-Naaman, Hofstein, & Taitelbaum, 2012). The syntaxes in the theory and student worksheets in the developed book also serve as a guide for students. Other research also shows that by accompanying and guiding pre-service teacher students, they can improve pedagogical content knowledge, and pedagogical knowledge is one aspect of pedagogical content knowledge (Nopriyeni, at al. 2019).

CONCLUSIONS

The findings of this study show that learning using learning strategy books in elementary school is more effective than PCK

pre-service elementary school teachers. This is due to the fact that the book contains complete materials and examples. This study is restricted to a small group of Ahmad Dahlan University students. More extensive research can be carried out.

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