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Word count: 5,235
Character count: 29,631
Submission date: 27-Sep-2024 08:34PM (UTC+0700)
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Jurnal Prima Edukasia, 8 (1), 2020, 12-19

Understanding the concept of π numbers for elementary school pre-service teachers on circle materials

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Received: 10 February 2020; Revised: 14 February 2020; Accepted: 13 March 2020

Abstract
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How to Cite: Ekowati, D., & Suwandayani, B. (2020). Understanding the concept of π numbers for elementary school pre-service teachers on circle materials. *Jurnal Prima Edukasia*, 8(1), 12-19. doi:<https://doi.org/10.21831/jpe.v8i1.30103>

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Based on the Ranking data from *Programme for International Student Assessment (PISA)* in 2018, Indonesia is declining in rank again. The value of the indicators of students' reading, mathematics, and science or science skills has dropped. This shows that Indonesia's position is ranked 72nd among 77 countries. The ability of mathematics declining from 386 points to 379 points. Problems in the field of mathematics have an impact on the competitiveness of human resources in the future. Wilkins (Grootenboer & Hemmings, 2007) states, a person's mathematical disposition related to her or his beliefs about and attitude toward mathematics may be as important as content knowledge for making informed decisions in terms of willingness to use this knowledge in everyday life. This means that student learning disposition towards mathematics has the opportunity to be a factor that determines student success in learning mathematics. Disposition is also formed if the other components have developed well previously.

Curriculum change in a short period in Indonesia has caused the unloading of curriculum pairs. 2013 curriculum has been applied in Indonesia since 2013, in practice in the field, there are still many rural areas of Indonesia that still do not practice the education unit level curriculum that is the curriculum before the 2013 curriculum. The emphasis of this curriculum is the balance of soft and hard skills covering aspects of attitude, skills and knowledge (Fadillah, 2014). The concept of the 2013 curriculum is the objective character or competence of graduates who are closed in the form of integration by emphasizing character education, learning character which emphasizes the *scientific* approach with a more detailed assessment character by emphasizing the assessment process.




Integrative thematic learning in the 2013 curriculum is applied to basic education by integrating several lessons that have the same scope. However, the facts at school show many teachers have not yet fully implemented the 2013 National Curriculum which has the principle of integrating many materials (Ruja, 2017) The aim of exploration in thematic learning is so that students are able to do

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Understanding the concept of π numbers for elementary school pre-service teachers on circle materials

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Curriculum change in a short period in Indonesia has caused the unloading of curriculum pairs. 2013 curriculum has been applied in Indonesia since 2013, in practice in the field, there are still many rural areas of Indonesia that still do not practice the education unit level curriculum that is the curriculum before the 2013 curriculum. The emphasis of this curriculum is the balance of soft and hard skills covering aspects of attitude, skills and knowledge (Fadlillah, 2014). The concept of the 2013 curriculum is the objective character or competence of graduates who are classed in the form of integration by emphasizing character education, learning character which emphasizes the *scientific* approach with a more detailed assessment character by emphasizing the assessment process.

Integrative thematic learning in the 2013 curriculum is applied to basic education by integrating several lessons that have the same scope. However, the facts at school show many teachers have not yet fully implemented the 2013 National Curriculum which has the principle of integrating many materials (Ruja, 2017) The aim of exploration in thematic learning is so that students are able to do



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better on the stages in scientific thinking (Sukerti et al., 2013). There are some compulsory subjects in elementary school. One of which is mathematics. Mathematics is a universal science that underlies the development of modern technology today. Why?, Because mathematics has an important role that becomes a mean in solving life problems (Misel & Purwakarta, 2016). The development of reasoning and thinking skills is important from the elementary school level to the tertiary level (Afifah, 2012; Rasyid, 2017; Somawati, 2018).

Based on PISA (Programme for International Student Assessment) initiated by OECD (Organization for Economic Cooperation and Development) in 2015, the performance of Indonesian students was still relatively low. Consecutive average Indonesian students' achievement scores for science, reading and mathematics were ranked 62, 61, and 63 out of 69 countries evaluated. Indonesia's ranking and average score is not much different from the results of previous PISA tests and surveys in 2012 which were also in the low mastery of material group. In addition, on September 24th 2018 Kompas Provides headlines about the achievement of PISA value with the heading "Indonesia Mathematical Emergency"

Mathematics in elementary school consists of several materials. One of them is geometry. In geometry there are numbers pi (π) 3, 14 atau $\frac{22}{7}$. Understanding of concepts in learning mathematics is one of the keys to the provision of mathematical abilities in students. The large number of symbols and formulas used in learning mathematics causes most students to assume that mathematics is a difficult and unpleasant lesson. This happens because students are not given the opportunity to know how the process of the symbols and values that usually accompany the symbol. Students only use symbols in the finished form so they do not understand the meaning of the symbols.

Concepts in mathematics which are arranged in stages and sequentially still require special evidences. So, in learning mathematics, the previous concept must be mastered because it is a prerequisite for continuing the next concept (Misel & Purwakarta, 2016). Teaching mathematics effectively requires an understanding of what students know and need to learn and then provides challenges and support so they can learn mathematics well. Evidencing is often conducted in the field of mathematics. In general, there are still many people who do not know the method used to carry out evidencing in mathematics. Speaking of mathematical evidence, sometimes we meet various groups, generally students and students who tend to think that evidence is not so important in learning mathematics. In the early stages of mathematical evidencing, it was not an easy practice. This problem is the cause that makes one lazy to understand the evidence in mathematics. Among students, evidence is a tool that is only used by mathematicians to explain mathematical statements that are known to be true. In mathematical evidence, there are several simple methods of evidencing using basic logic rules, for example direct evidence, indirect evidence, evidence with contradiction, evidence of singularity, refutation of evidence with counter example, evidence by mathematical induction (Putri, 2011). The evidence used can be in the form of formal evidence and informal evidence.

The ability to understand mathematical concepts is the first ability that is expected to be achieved in the objectives of learning mathematics (Sari, 2017). This is in line with the Decree of Ministry of National Education (Permendiknas) Number 22year 2006 about the standardized contents on the objectives of Mathematics subjects. The core mathematical competence consists of abilities in: (1) understanding mathematical concepts, (2) using reasoning, (3) solving problems, (4) communicating ideas, and (5) having the nature of appreciating usefulness of mathematics. The ability to understand concepts, according to Decree of Ministry of Education and Culture (Permendikbud) (2014), has indicators, namely (a) restating the concepts that have been studied, (b) classifying objects based on whether or not the requirements that form the concept are fulfilled, (c) identifying the characteristics of operations or concepts, (d) applying concepts logically, (e) providing examples or counter examples (not examples) of the concepts being studied, (f) presenting concepts in various forms of mathematical representation (tables, graphs, diagrams, drawings, sketches, mathematical models, or others), (g) linking various concepts in Mathematics and out of Mathematics, (h) developing the important and / or sufficient conditions of a concept (Dirgantoro, 2018).

Indicators of understanding accurate mathematical concepts must also be mastered by elementary school pre-service teachers at the University of Muhammadiyah Malang. This is due to the teacher candidates who will later give the accurate concept to the next generation (Ekowati et al., 2017) (Mizan, 2019). In order to meet these expectations, one of the mathematics learning achievements shows that

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students must be able to apply elementary mathematics learning theories and conceptual knowledge of mathematics in the form of making elementary mathematics learning plans with full responsibility. Every student in Elementary School Education Department (PGSD), Faculty of Teacher Training and Education (FKIP), University of Muhammadiyah Malang as an elementary school pre-service teachers must fulfill the learning achievement.

In learning Mathematics, various mathematical concepts must be mastered by elementary school pre-service teachers. According to Bell (in Zulkarnaini, 2004), mathematical concepts are divided into 4 branches, namely arithmetic, algebra, geometry, and analysis. As one branch of mathematics, geometry occupies a quite important position to be studied (Cholily, 2017). Geometry is the basic science that is used as an auxiliary science in studying other branches of mathematics. According to Freudental, learning geometry is to understand space, help students to present the feeling of admiring the creation of the universe, learn to know, explore, be able to live, breathe and move better (Gravemeijer & Terwel, 2000). Supporting this opinion, Kennedy & Tipps (1994) states that with learning geometry students are able to develop problem-solving abilities and support many other topics in mathematics. Among the geometry learning materials, π concepts are needed compared to other materials (Cholily, 2017).

Geometry learning related to the π concept was conducted in odd semester 2019/2020, based on observations, it was known that all students used the π value in solving geometry problems, especially circle material. When the students were asked about the origin of the π value, students conveyed it as a valuable provision $\frac{22}{7}$ or 3,14 without knowing the acquisition procedure. On the other hand, the application of the value π is needed in other fields of science.

The research results of Johar, et al (2016) state that learning carries out with a realistic mathematical approach can provide opportunities for students to develop their mindsets. Learning to find value which is usually only given directly by the teacher to students actually comes from phenomena that occur in the real world and can be learned how to find it, so students are able to find real values and are able to understand the true meaning of values (Saefudin, 2012). The right understanding will determine how to apply the correct value. Therefore, this article discusses more deeply related to the understanding of the concept of π numbers for elementary school pre-service teachers in the circle materials.

Method

This research employed a qualitative approach. This model is used because the present study aims to investigate the mathematics teachers and pre service teachers' π numbers. It is understood that π numbers are important factors in calculate the circumference and area of a circle. In this respect, mathematics teachers should have theoretical knowledge about π numbers. In the relevant literature, various quantitative studies have been conducted on the π numbers. In this study, the π numbers of mathematics pre-service teachers are discussed with a qualitative approach. Examining the pre-service teachers' π numbers skills together and making comparisons reveal the important and original dimensions of this study.

This research was conducted on students of the Elementary School Teacher Education Program (PGSD) class of 2018 in the odd semester of 2019/2020 at the Faculty of Teacher Training and Education, University of Muhammadiyah Malang. 45 students were involved as the subjects of this research. In the study participants in the research would describe the pi (π) numbers and how to teach pi (π) numbers for students on elementary school.

In this context, participants were describe the teaching pi numbers on elementary school. The data collection tool of this research was observation, in depth interview, document analysis and test questions. This research used four research instruments, namely: (1) observation, by observing the learning process of the concept of the π number, (2) interviews, to strengthen the data in understanding the concept of the number; (3) test questions, to understand the concept of the number π ; and (4) documentation, in the form of photos or recordings at the time of the research. This observation activity records and records events, behavior in the social settings chosen for research. Field notes are written in detail and non-judgmental, but rather concretely describe what has been observed. The type of interview conducted in this study is in-depth interviews. This interview explores data related to the implementation of learning mathematics pi numbers in elementary schools. And The questionnaire was arranged in a closed manner with a Likert scale. Likert scale is used for measure the attitudes, opinions, and perceptions of a person or group of people about social phenomena. With a Likert scale, the variables to be measured are trans-

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lated into indicator variables. Then the indicator is used as a starting point for arranging instrument items that can be statements or questions. In this research, a Likert scale with a scale of four from gradation from positive will be used until negative. The scale can be in the form of words: The application with the teachers and pre-service teachers was made in the classroom environment.

The practice that participants posed for account pi number were analyzed by descriptive analysis. The data obtained from participants were summarized and interpreted according to the predefined theme and, findings were arranged by a direct citation of the problems (Yıldırım, 2010). Triangulation was carried out to check the validity of the data by checking the acquisition of data from different techniques from the same source (Gunawan, 2013). The practice that participants posed for account pi number were analyzed by descriptive analysis. The data obtained from participants were summarized and interpreted according to the predefined theme and, findings were arranged by a direct citation of the problems (Yıldırım, 2010).

Result and Discussion

Mathematics is a tool of linguistic, logic, and statistical thinking. According to Ruseffendi and (Ramadani, 2009), mathematics is deductive, linguistic, and art sciences. It is the core of sciences, the science of organized structure and pattern and relation sciences. Mathematics is called deductive science because it refuses generalization based on observation data, and experiments like other sciences. The general objective of mathematics learning in elementary school is to make the students able to solve mathematic problems. The learning process does not only focus on cognitive aspect, but also developing the students' ability in using mathematics in daily life. Thus, basic mathematics is essential for understanding mathematic materials.

The process of thinking was more emphasized. It is supported by Andiasari (2015) that learning process is built dialogically and simulant question and answer process is made to fix and increase the students' thinking ability. The thinking ability could help them to construct their own knowledge. The teachers' role was not only giving information, but also directing and fascilitating the students in the learning process to create more condusive process. The learning process consisted of three steps that are opening, whilst, and closing activities. The process did not occur instantly, but passed through some certain steps. In the lerning process, the teachers facilitated the students to study well. This interaction created effective teaching and learning process as expected. Teaching and learning process is a concrete form of education process. All elementary and tertiary educational institutions should be interactive, inspiring, enjoy Partable, challenging and motivating the students to be active in developing their skills and interests as well as their physical and psychological states (Suwandayani, 2018)

Elementary schools to higher education would only be effective when they are organized by professional teachers. Good education is the result of teachers' success as the key of education itself (Sari & Valentino, 2017). The effective teaching tends to not only transfer knowledge from teachers to students. The teachers are expected to not only keep the learning process going on and give useful information spontaneously, but also learn more complicated materials and use them to develop the students' skills (Arends, 2004; Rivkin et al, 2000; Wright, Horn & Sanders, 1997; Barnes, 1989). Mathematics is frequently considered to be related to number, space, measurement, calculation procedure, and construction or measuring that are applicable in wider scope. It is not seen as the way of thinking on concept, process and its application, problem exploration and its solution, hypothesis making and examination, and complex ideas about something communicated simply and appropriately (Booker, 2005).

pi (π) is a symbol used by mathematicians to represent the ratio of the circumference of a circle to its diameter. pi (π) is written in the small Greek letter π , spelled as pi (π), and comes from the first letter of the Greek word perimetros, which means circumference. pi (π) is an irrational number, meaning that the number cannot be written as the ratio / comparison of two integers. Fraction like $22/7$. generally used to estimate (approximation) of π , but no ordinary fraction (ratio of integers) can be an exact value. Since the time of the Babylonians, humans have been fascinated by mathematics shape which is considered as a perfect shape, which is a circle. Circles are certainly no stranger as circles occur naturally in the universe, ranging from water ripples to the circumference of moonlight. In nature, a circle often forms when a flat surface is affected by a force that works evenly in all directions. For example, when

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a marble falls into the water and produces waves that spread evenly in all directions as a series of circular ripples.

According to (Verhage & de Lange, 1997) there are five characteristics of a mathematical approach. First, the lesson uses real problem at the beginning of the lesson. Second, students use their own models or symbols to represent real problems. Third, use students' own contributions in solving problems and negotiating their strategies. Fourth, there are interactions between students facilitated by the teacher. Fifth, linking (intertwinment) mathematical topics with other mathematical topics or other lessons. Freudenthal (Gravemeijer & van Eerde, 2009) explains that students were given the opportunity to build and develop their ideas and thoughts when constructing mathematics. Teachers can choose appropriate learning activities as a basis to stimulate students to think and act when constructing these mathematical concepts. The learning steps are developed based on theoretical studies that pay attention to the basic principles and characteristics in learning with a realistic mathematical approach.

In this research, the results of the analysis of the understanding of the concept of π numbers were presented in the learning material of 45 students in the PGSD, University of Muhammadiyah Malang. The results of the analysis on the understanding test of the concept of π numbers from elementary school pre-service teachers in accordance with the aforementioned indicators of understanding. First, restating the concepts that have been learned (Juliastuti et al., 2019). In this indicator, students were asked to explain the steps in how to obtain the π number in circle material. In addition to explaining the steps, students were also asked to write down the calculation results for the acquisition of the π number. Of the 45 students, 26 of them were able to restate the concept of the π number in precise and calculate the acquisition of the π number accurately. According to Johar, (2016) the steps to find the value of π are as follows; (1) Students draw circle; (2) Students measure the diameter with a ruler; (3) Students measure the circumference of a circle with wool yarn or fabric meter; and (4) After all is known, students calculate the value of π by calculating the ratio of the circumference of a circle and diameter of a circle.

While 14 of them were incorrect in re-stating the concept of π number and there was no answer to the acquisition of π number. In addition, 5 other students, only counted the π number without explaining the steps in how to obtain the number. So that a total of 19 students who had difficulty repeating the concept of the π number was due to starting elementary school, had never gotten a learning that directed students in obtaining the number π . These students were accustomed to directly get the doctrine of the formula regarding the π number of $\frac{22}{7}$ or 3,14 (Cholily, 2017). Understanding and mastery of a material or concept is a prerequisite for mastering the next material or concept (Sari, 2017). In Mathematics, every concept is related to other concepts, and a concept is a prerequisite for other concepts (Heruman, 2008). Therefore, understanding the concept is fundamental in learning mathematics to make the learning more meaningful (Effendi, 2012).

Secondly, classifying the objects depending on whether or not the requirements to form the concept are fulfilled. In this indicator, students were asked to mention components in identifying π number (Mizan, 2019). The components used in identifying the π number are circumference, diameter, and radius (Cholily, 2017) (Mizan, 2019).

All research subjects, 45 students, were able to mention the components in identifying the π number correctly despite their different ways. 39 students mentioned that the components were circumference and diameter. 6 students mentioned circumference and radius. It is noted that students mainly focused on circumference and diameter when they were asked to identify π number. Few students tend to mention radius as to get radius, they should pass one more step that is counting radius = $\frac{1}{2}$ diameter (Cholily, 2017). The students of PGSD do not get used to comprehend the way how to construct π number directly. Thus, when these elementary school pre-service teachers study to identify π number by themselves, each step would be meaningful for them. (Saefudin, 2012) (Ekowati, 2017). This is called as meaningful learning for the students (Ekowati et al., 2017).

Thirdly, identifying operation or concept characteristics in π number. The characteristics have three components in identifying π number that are circumference, diameter or radius (Cholily, 2017) (Mizan, 2019). All 45 students are able to identify the characteristics of π number by mentioning 2 or 3 components.

Fourthly, applying the concept logically. In this indicator, the students were asked to give essay questions or formula covering π number. The students' answers in comprehension test in the form of essay test showed that 20 students are able to apply π concept logically and appropriately. The students

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wrote the area and circumference of the circle that need π number completely. Besides, 25 students wrote the answer incompletely and there are wrong answers, too. Nevertheless, they could explain clearly when they were interviewed despite these wrong answers. It could be well understood after doing meaningful learning. Therefore, a learning process requiring the students to get used to communicate in written or unwritten form need to do (Pebriana et al., 2017).

Fifthly, giving examples from the learnt and unlearnt concepts. In this indicator, comprehension through the exposure of learnt and unlearnt concepts is one indicator to comprehend the concepts. In essay questions, the students only answered “yes” or “no” whether the component is needed in π concept and its reasons. Besides, 21 students are able to give examples and not examples of π concept as well as its reasons. 24 students did not get used to communicate orally or in a written form in Mathematics subject so that they did not give reasons. Starting from elementary school to senior high school, the most dominant activity in Mathematics is counting (Yayuk et al., 2017). It makes the students’ ability in mathematic communication low and the learning activity not enjoyable (Ekowati et al., 2017).

Sixthly, presenting concepts in various mathematic representation (tables, graphs, diagrams, figures, sketches, mathematical model, and others). In this indicator, the students were asked to draw 2 circles with free diameter. Having drawn the circle, each student was asked to count the circle circumference and diameter. All students were asked to write the result of table count available on board. The table consists of columns containing circle circumference, formed diameter, and the ratio of circumference and diameter that result π number.

15 students were able to draw circle correctly. Nevertheless, when they were asked to present the calculation result of circle circumference and diameter, 30 students or 75% students did not answer appropriately. The incorrectness of circle circumference causes the incorrectness of π number (Cholily, 2017). It is because π number is taken from the comparison of circle circumference and diameter (Mizan, 2019). The students did not get used to count circle circumference that made 75% students round off the number. It makes π number inconsistent. This learning experience becomes one meaningful learning process for each student (Laurens et al., 2018).

Seventhly, linking various concepts in Mathematics and out of Mathematics. In this indicator, the students were asked to give examples of the circle application in daily life and identify the circle circumference (Sari, 2017). 20 students had linked the π concept in Mathematics or out of Mathematics by providing examples of circle application and identified the circumference correctly. 24 students gave examples of the circle application, but it was not correct to identify the circle circumference as they counted by rounding off the calculation. Besides, there was 1 student who used wrong formula in identifying the circle circumference. When the students were interviewed, they were able to explain well despite the inaccurate answers in the written test. It is contradictory in terms of students’ mathematical educational abilities. It means that mathematical communication, written and non-written, needs to be sharpened well through a student-oriented learning process (Effendi, 2012) (Juliastuti et al., 2019).

Table 1. The Result of Comprehension Test of π Number Concept

The Indicators of Concept Comprehension	The Students Number		
	Good	Fair	Poor
Restating the concepts that had been learnt.	26	19	-
Classifying objects based on whether or not the requirements forming the concept are fulfilled.	45	-	-
Identifying the characteristics of operations or concept.	45	-	-
Implementing the concepts logically.	20	-	25
Giving examples or counter examples (not examples) of the concepts learnt.	21	24	-
Presenting concepts in various forms of mathematical representation (table, graphs, diagrams, figures, sketches, mathematical models, and others).	15	30	-
Linking various concepts in Mathematics and out of Mathematics.	20	24	1
Developing the important and sufficient requirements of a concept.	45	-	-

Eighthly, developing important and sufficient requirements for the concept. In this indicator, the students have to be able to identify developing the important and sufficient requirements. In π concept, the important requirements to know the π value are circle circumference, diameter, and radius (Mizan, 2019). Of the 45 students examined, the students were able to develop the important and sufficient requirements in π concept correctly. The interview result also strengthened the students’ answers that is

appropriate to the way of getting π number. Generally, the eight indicators of the understanding concept of π number by elementary school pre-service teachers are in line with the Table 1.

CONCLUSION

Based on the research result of concept comprehension of π number, the elementary school pre-service teachers had strengths in some indicators that are classifying objects based on whether or not the requirements forming the concept are fulfilled, identifying the characteristics of operations or concept, and developing the important and sufficient requirements of a concept. Contrarily, their comprehension is low in terms of implementing the concepts logically, giving examples or counter examples (not examples) of the concepts learnt, presenting concepts in various forms of mathematical representation (table, graphs, diagrams, figures, sketches, mathematical models, and others), and linking various concepts in Mathematics and out of Mathematics. Thus, a good Mathematics learning is needed (Sari, 2017), especially in π number concept. Furthermore, the correct comprehension on π number concept would be beneficial for the use of π number concept in other fields (Ekowati et al., 2017).

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