Professional Competence of Elementary School Teachers in Teaching Mathematics by Utilizing Motor Skills

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Abstract
This study describes the level of professional competence of teachers in teaching mathematics in elementary schools by utilizing motor skills. The main purpose of this study is to explore and describe the stages of building mathematical concepts through motor skills. This type of research is descriptive qualitative which aims to explain in detail the stages of building mathematical concepts in elementary schools through motor skills. Data were collected through field observations, questionnaires, and interviews. The results showed that: 18 out of 20 teachers (90%) do not understand the motor skills of stepping and jumping as an activity to understand mathematical operations; 17 out of 20 teachers (85%) have a wrong understanding that generalizes the motor skills between Numerical and Round numbers are the same; 19 out of 20 teachers (95%) have an understanding of mathematical operations on Round numbers with memorization methods.
Keywords: *Mathematics, motor skills, professional competence*

Abstrak
Penelitian ini mendeskripsikan tingkat kompetensi profesional guru dalam pembelajaran matematika di sekolah dasar dengan memanfaatkan keterampilan motorik. Tujuan utama penelitian ini adalah untuk mengeksplorasi dan mendeskripsikan tahapan membangun konsep matematika melalui keterampilan motorik. Jenis penelitian ini adalah deskriptif kualitatif yang bertujuan untuk menjelaskan secara rinci tahapan pembentukan konsep matematika di sekolah dasar melalui keterampilan motorik. Data dikumpulkan melalui observasi lapangan, angket, dan wawancara. Hasil penelitian menunjukkan bahwa: 18 dari 20 guru (90%) belum memahami keterampilan motorik melangkah dan melompat sebagai kegiatan memahami operasi matematika; 17 dari 20 guru (85%) mempunyai pemahaman yang salah bahwa menggeneralisasi keterampilan motorik antara bilangan Numerik dan Bilangan Bulat adalah sama; 19 dari 20 guru (95%) mempunyai pemahaman tentang operasi matematika bilangan bulat dengan metode hafalan.
Kata kunci: *Matematika, keterampilan motoric, kompetensi profesional*

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INTRODUCTION

Every teacher needs to have competencies to become a professional teacher. The competencies that need to be possessed are pedagogical competence, social competence, personality competence, and professional competence. These competencies have been regulated in Law Number 14 of 2005 concerning Teachers and Lecturers. Of the four competencies, the one related to the subject matter is professional competence. So that every teacher is mandated to teach is expected to be able to master, compile, and present the subject matter they teach according to the characteristics of the students.

Sidjabat (Mortan Sibarani, 2018) states that professional teachers master the science or what they are engaged in (in this case mathematics). To realize this, there are four things that need to be done, namely understanding: teaching material; structure, concepts, and methods of science that are coherent with teaching material; relationships between concepts between subjects; able to apply scientific concepts in everyday life. Meanwhile, Hidayati (2022) explains that teachers who have professional competence are able to step up the results of students and at the same time be able to build the character of students. This is done because teachers have the ability to organize lesson materials according to the characteristics of students.

Mastery of mathematical material needs to be understood by teachers because mathematical material is structured and includes a deductive group of knowledge. The definition of mathematics is explained by Muhammad and Angraini (2023) Mathematics is a cognitive ability that needs to be developed in every student because it is closely related to problem solving involving the relationship between number symbols and students' cognitive activities. Meanwhile, Courant, R (2019) states that mathematics is a science that develops from the investigation of the quantification of relationships between various things involving certain concepts and methods. Based on some of the above opinions, it can be concluded that mathematics is a science that involves logic and deduction to study abstract relationships and patterns in objects and certain procedures. This math learning is able to develop student thinking, namely: logical, critical, thorough, curiosity, unyielding, and others.

The description above emphasizes that mathematical materials are interrelated or partial. While understanding mathematics as deductive knowledge, it is understood by the statement that mathematics as knowledge does not accept generalizations based on observation but based on general proof. This general proof confirms that mathematics is a language of symbols that need to be interpreted in order to have meaning. Through this interpretation, mathematics is formal or abstract.

Untu, et. Al. (2020) explained in the 2012 Australian Curriculum Assessment and Reporting Authority activities that this declarative knowledge is often put aside by teachers because it is considered knowledge that is merely memorizing, not interesting, and not important. This confirms that mathematics as a formal or abstract language makes some teachers in elementary schools in the early grades do not understand correctly about compiling and presenting mathematical material. This condition is in accordance with the results of data from the service of lecturers and students on Saturday, April 15, 2023 in activities to improve the competence of basic mathematics concepts in early grade teachers in Tawangmangu sub-district, Karanganyar district. The data from the service was then analyzed, synthesized, and interpreted by the researchers. One of the data that can be interpreted is that building the concept of mathematical operations for Numerical and Round numbers, all teachers state the same and are rote.

Theoretically, mathematical operations, namely addition (+), subtraction (-), multiplication (x), and division (:) are included in the abstract stage. While early grade students, according to Piaget's learning theory, enter the concrete operational stage. Chopra (2018) explains the characteristics of the cognitive development of Piaget's

theory aged 7-12 years, namely: logical thinking, meaning that students begin to develop the ability to perform mental operations, and can solve problems logically and use deductive reasoning; and concrete understanding, meaning that students are able to understand more complex concepts and can measure and compare objects accurately. Thus, every teacher has an obligation in learning mathematics, namely bringing students to learn mathematics concretely (inductive) to the abstract (deductive) stage. As a consequence of this statement, teachers need to design and present mathematics material into material that is easily understood by students using all five senses.

Data from the community service results show that in understanding math operations for Whole numbers, some teachers use inferences and continue by equating math operations with Numeric numbers. For example:

1. What is the result: 5--3=⋯?

   Answer: 5- -3=5-(-3)

   5+3 =8

   Step one: the teacher emphasizes that if there is an equal sign, then it is given in parentheses

   Second step: The teacher emphasizes change to a mathematical operation sign +

   Step three: The teacher emphasizes work as in the operation of numeric numbers.

2. What is the result of: 5+-3=⋯?

   Answer: 5+-3=5+(-3)

   5-3=2

   Step one: the teacher emphasizes that if there is a different sign, it is given in brackets

   Second step: The teacher emphasizes replace to be the sign of mathematical operation -

   Step three: The teacher emphasizes working as usual on the operation of non-numerical numbers.

The two examples above show that the learning of mathematics that occurs leads to memorization methods and students are placed as objects of learning.

Mathematics learning at this time needs to look at the condition of learners and the creativity of teachers in teaching. Li, J., & Xue, E. (2023) explained that dynamic learners are characterized by being active, energetic, and always moving. They not only receive knowledge from the teacher, but also participate in the learning process. They are always active in asking questions, finding out, and discussing the topics being studied. Dynamic learners tend to have high interest and motivation towards learning, so they often try various ways and strategies in order to master the subject matter. They are not afraid to try new things and are happy to take the risks involved in the learning process. In addition, dynamic learners also often have many activities outside of school, such as extracurricular activities, sports, or organizations that show their activeness and desire to be involved in various activities.

Research from Kang (2023) with the title the relationship between fine motor skills and mathematical ability in children: A meta-analysis. The results of his research state that this study has verified that fine motor skills are closely related to mathematical ability, supporting the ideas of embodied cognition theory and cognitive load theory, and initially clarifying the academic debate about the relationship between fine motor skills and mathematical ability. Practically, this study suggests that educators pay attention to the development of basic motor skills in early childhood and adopt effective fine motor skills training approaches to improve children's fine motor level so as to improve math ability.

Research from Cinar, et al, (2023) with the title: Motor Skills are More Strongly Associated to Academic Performance for Girls Than Boys. The results stated that fine motor skills significantly predicted receptive vocabulary, number knowledge, and attentional skills. The relationship between fine motor skills and receptive vocabulary and attention is stronger for female learners than male learners. Better locomotor performance significantly predicted higher levels of receptive vocabulary, while object control was positively associated with attention skills among female learners only. Learners with better motor skills, especially fine motor skills, are more likely to succeed in areas requiring language, numeracy and attention skills. Therefore, motor skills should be the focus of attention to improve academic and attentional skills at school entry, especially among female learners.

Research from Chagas, Leporace, and Batista (2016) with the title: Relationships Between Motor Coordination and Academic Achievement in Middle School Children. The results of the study explain that although it is recognized that children with obvious impairments in motor coordination development may show difficulties in obtaining academic achievement. Writing, reading, and math performance were used to relate academic achievement. Pearson correlation and partial correlation were used to analyze the relationship between gross motor coordination and academic achievement, controlling for physical activity. Bivariate correlations showed no significant relationship between gross motor coordination and academic performance in male and female learners. On the other hand, gross motor coordination scores were significantly correlated with writing performance when controlled for physical activity. This study focuses on gross motor skills with learning achievement in reading, writing, math. There is a relationship between gross motor skills and writing but it must be in the form of activity.

The dynamism of today's students, teachers need to utilize to build mathematical concepts. Stages to build the concept of mathematical operations need to use motor skills. Hanafiah, Mokodenseho, Dewi, Zahruddin, and Palayukan (2023) explain that gross motor is the ability to move the body using large muscles, most or all of the gross motor limbs are needed so that children can sit, kick, run, up and down stairs and so on. Motor skills, namely: forward, backward, jumping forward, jumping backward, and verbal affirmation by the teacher, are a series of stages of combination between motion and logic of students in building the concept of mathematical operations.

Based on the results of the description above, the researcher focuses on building the concept of mathematical operations on Round numbers by optimizing the motor skills of students. For this reason, the problem can be formulated: How to build the concept of mathematical operations on Round numbers in the early grades by using motor skills? While the purpose of this study is to describe the stages of building the concept of mathematical operations on Round numbers in the early grades by using motor skills.

METHOD

The type of research in this article is descriptive qualitative because the initial data is in the form of numbers that need to be described first. Sugiyono (2019: 18) explains that the research method is based on the foundation of the Post Positivism philosophy, the research is in scientific conditions (experiments), the researcher acts as an instrument, and the data is analyzed with qualitative properties that focus on emphasizing meaning. Based on the description above, the researcher in this case did not intervene with the research subject.

The research began from April to July 2023, in elementary schools in the Tawangmangu sub-district of Karanganyar district. The research flow in this article is described as follows:

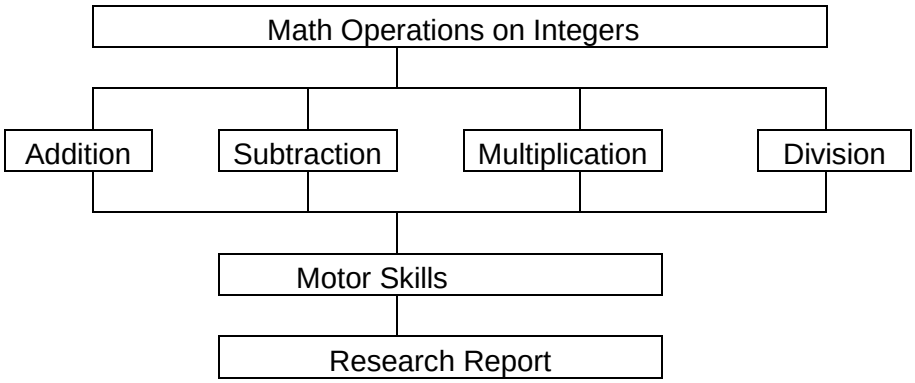

Figure 1: Research Flow of Building Math Operations

Integers which are a combination of negative integers and numerals, their mathematical operations need to emphasize the existence of two symbols that have different meanings. The symbol (-) can be read subtraction to show the symbol as a mathematical operation. If it is read negative then this is to show it as a region of numbers, namely the region of negative Integers. Building mathematical operations in this study by optimizing the dynamism of learners, namely through motor skills. Stepping forward to represent the Addition symbol. Stepping backward to represent the Subtraction math operation. Jumping forward to represent a positive scale, while jumping backward to represent a negative scale. The results of the above analysis were then compiled into a research report.

The research subjects were first grade or early grade teachers from 20 elementary schools in Tawangmangu sub-district, Karanganyar district. The main data source is the teacher's work document during community service, while the supporting data is text and informants. Data collection techniques were carried out by observation, literature study, documentation study, and in-depth interviews with informants.

Validating is an activity to describe the results of research about the actual object description. Moleong (2019: 48) states that techniques to test the degree of trust or validation can be through: extension of participation, persistence of observation, triangulation, peer checking, adequacy of reference, negative case analysis, member checking. The technique used to test the degree of trust in this study is triangulation. Community service work documents are validated by interview techniques with informants. Meanwhile, the interview data is validated by repeated interview techniques but at different times.

The data that has been validated is then analysed and interpreted to find its meaning. The definition of data analysis is explained by Afrizal (2015), namely data analysis as a basic data processing activity that is still in the form of actions, narrations, field notes, and written materials that support research, so that it can be interpreted. The stages of analysing data in this study used Miles and Huberman (Afrizal, 2015) who explained that the stages of analysing qualitative research data are data reduction, data presentation, and drawing a conclusion.

RESULTS AND DISCUSSION

Result

The results of data analysis from the teacher's work documents at the time of community service obtained data that the research subject in providing learning for Round numbers is oriented to the teacher's personal conclusions and based on the mathematical operations of small numbers. The learning that teachers carry out contradicts Piaget's theory. Korompis (2023) explains that the stage of students at the age of 7 to 12 or 13 years is concrete operational. This means that building

mathematical concepts needs to be done by process not by giving conclusions. Giving conclusions is evident when math materials are given as follows:

How to teach that 5--3=5+3

The answers from the 20 teachers who participated in the service were:

5 - - 3 = 5 - (- 3)

5 - (- 3) = 5 + 3

In the second step, the teacher emphasized: "if the symbol is the same then it turns into a + symbol, otherwise if the sign is different then it turns into -.

The results of the interview with the research subject:

Researcher: at this stage, have students been given the multiplication operation? multiplication operation?

Subject: Already ... namely in the learning of numerical numbers.

Researcher: Is there already a symbol to emphasize the negative area? as a negative area?

Subject: No.... Yes, but so what...it's a formula I've always been I'm familiar with it.

Subject : like I used to do..that is by stepping forward and backwards for addition and subtraction..but the the steps ..forgot.

The data results for the multiplication operation obtained the following data:

How to explain the operation: -3 x-5=⋯?

The answers from 20 teachers are as follows:

-3 x-5=(-)x(-)(3 x 5)

(-)x(-)(3 x 5)=+(3 x 5)

+(3 x 5)=+(5+5+5)

In the second step, the teacher also emphasized: "if the symbol is the same then it turns into a + symbol, otherwise if the sign is different then it turns into -.

The results of the interview with the research subject for the multiplication operation of whole numbers, obtained the following data:

Researcher : can the area symbol be multiplied in the first step?

Subject : it can...but how?

Researcher : If it can be multiplied...what is the difference with the operation symbol of subtraction operation symbol?

Subject : I don't know.....but I remember.....if the multiplication operation is with jump...forgot how...

The data results for the division operation are as follows:

How to explain the operation: (-6)/2=⋯?

The answers from 20 teachers are as follows:

(-6)/2 = (-)6/2.....(sign-ignored first)

(-)6/2 = (-)3.....(work like an Integer)

The results of the interview with the research subject for the multiplication operation of whole numbers, obtained the following data:

Researcher : Why is the negative symbol ignored first?

Subject : to make it easier to count.

Researcher : Is there such a thing in math learning?..the stage of stage of ignoring...

Subject : like no...if you use the jumping method like in numbers Numbers...the positive and negative results are taken into account first...do it first and then the number is the same as operating with counting numbers.

Discussion

In learning mathematics for Integers, the teacher is seen to have the mindset of continuing what has been learned. This can be seen from the teacher's stages in explaining, namely: focusing on mathematical symbols but not paying attention to the symbols as symbols of mathematical operations or symbols of number regions; and number operations following operations on Integers. This contradicts Piaget's learning theory. Agustyaningrum, Pradanti, and Yuliana (2022) explained that Piaget's cognitive development theory, the thinking stage of students in elementary school is generally at the concrete operational stage. Furthermore, the recommended mathematics learning is student-centered and active learning, such as discovery and contextual learning methods. The statement confirms that ignoring and focusing on the symbols - and + can be interpreted that the method of learning mathematics on whole numbers is rote.

The application of the rote method, from the results of the analysis of teacher work documents, obtained data 18 out of 20 teachers (90%) do not understand the motor skills of stepping and jumping as an activity to understand mathematical operations; 17 out of 20 teachers (85%) have a wrong understanding that generalizes the motor skills between Numeric and Round numbers are the same; 19 out of 20 teachers (95%) have an understanding of mathematical operations on Round numbers with the rote method. This condition in the current era has an effect, schools will experience a decrease in trust from the community due to less than optimal school performance in building cognitive competence and student character. This is emphasized by Lumbantoruan, J. H., & Nadeak, B. (2022) who stated that the difficulties of teachers with pedagogical competence with minimal learning tools and professional competence, unable to explain concepts in the media and not assisted by self-made modules.

Early grade learners basically have excess energy so they are dynamic. Stepping and jumping movements require muscle movement, so these movements are often called gross motor skills. Hasninda (2014: 52), states that gross motor is a body movement that uses most or all of the limbs that are influenced by the maturity of the child himself. The excess energy in students can be utilized to build concepts by learning and playing. Piaget (Novitasari, Nasirun, and Delrefi, 2019) explains that play is an activity that is carried out repeatedly and causes pleasure or satisfaction for students.

The benefits of motor skills can also be used to build math concepts. This is explained by Operto (2023), namely, improving brain coordination, increasing brain development, increasing creativity, increasing independence, and helping in academic learning. This is also emphasized by Sulistiyowati (2023) who states that the benefits of motor skills include training memory and fine motor skills, increasing concentration and patience, and increasing intellectual capacity. This concept is used to explain math operations on whole numbers. For example in the material:

How to teach that 5-3=5+3

The math operation used is subtraction, this can be explained as follows:

Make an agreement that the right of the model represents the positive region, the left of the model represents the negative region, and 0 represents the neutral region.

The face of the model shows the view to the positive or negative region depending on the problem.

Step forward movement for + math operations and Step backward movement for - math operations.

Step 1: the model is in the neutral position, not facing the positive or negative region.

Step 2: the model faces right and occupies the number 5 position.

Step 3: the model reverses direction because the second one is negative.
Step 4: the model moves 3 steps backwards.
Step 5: ask the question: "which position? Not "equals how much?"
Step 6: repeat the demonstration until the movement is correct learners are correct.
Step 7: The affirmation step, when facing the negative region and the movement steps backwards the teacher says "move to which area?", the learner will answer "to the positive area". positive".
Write a positive word with + to give the conclusion.

Multiplication operations on whole numbers through motor skills for materials:
How to explain the operation: -3 x-5=⋯?

The math operation used is multiplication, this can be explained as follows:
Make an agreement that the right of the model represents the positive region, the left of the model represents the negative region, and 0 represents the neutral region.
The face of the model shows the view to the positive or negative region depending on the problem.
Jump forward for + math operations and jump backward for - math operations.
Step 1: the model is in the neutral position, not facing the positive or negative region.
Step 2: the model faces left because the repeated number is -5.
Step 3: the model jumps backwards because the multiplier number is -3.
Step 4: the model jumps backward 3 times with a single jump 5.
Step 5: ask the question: "which position? Not "equal to how much?"
Step 6: repeat the demonstration until the movement is correct. learners are correct.
Step 7: The affirmation step, when facing the negative area and the movement jumps backwards the teacher says "move to which area?", the learner answers to the "positive" area.
Write positive words with + to give a conclusion.

The two examples above were given during community service. The results of the observation obtained data, namely the teacher feels that current learning does not need to be memorized and builds mathematical concepts can be from the utilization of motor skills. This is in line with Rochanda Wiradintana (2018) who explains that the development of process-oriented learning is very important as done by Bruner, because going through the process stages can improve learning outcomes that have an impact on student behavior. The motor skills above are one form of building mathematical concepts through the process.

Based on the motor skills above, this emphasizes that learning mathematics for early grade students should be done through play. If this is done by the teacher, then in terms of professional competence the teacher can be said to be able to structure mathematical material. This is in line with Sundari's statement, Fauziati (2021) explains that knowledge can be transformed by paying attention to four educational themes that are in accordance with the development of students, namely; knowledge structure, readiness, intuition and motivation. The teacher's mistake that is often made is to give conclusions without students doing inductive proof. This is also emphasized by Agus Dudung (2018) who states that the professional competence of teachers can be considered from understanding and being able to apply learning theory according to the level of development of students and being able to handle and develop the field of study that is their responsibility.

The teacher's ability to build the concept of mathematical operations in the early grades is one of the characteristics of a professional teacher. Pham (2023) A professional teacher is a teacher who has a teaching qualification that is in accordance with the subject he teaches. In addition, he has the ability and expertise in the field of education and is able to understand the needs and peculiarities of students. Professional teachers also have a sense of responsibility to continue to develop themselves through appropriate training and courses in order to provide the best teaching to their students. In addition, a professional teacher must have a good work ethic and be able to interact well with everyone involved in the education process, including students, parents and colleagues.

Motor skills in addition to improving agility of movement and aesthetics, can also provide activities to build mathematical concepts. This is in line with the results of Kang's research (2023) that basic motor skills through an effective motor skills training approach can improve the motor level of learners so that it can improve mathematics ability. This emphasizes that motor skills designed with mathematical packaging can build mathematical concepts through interpreting motor movements. This statement is also reinforced by the results of research from Chagas, Leporace, and Batista (2016) that through controlling physical activity (gross motor skills) can build knowledge about word concepts, writing skills, and build mathematical concepts.

The teacher's ability to build the concept of mathematical operations in the early grades is one of the characteristics of a professional teacher. Pham (2023) A professional teacher is a teacher who has a teaching qualification that is in accordance with the subject he teaches. In addition, he has the ability and expertise in the field of education and is able to understand the needs and peculiarities of students. Professional teachers also have a sense of responsibility to continue to develop themselves through appropriate training and courses in order to provide the best teaching to their students. In addition, professional teachers must have a good work ethic and be able to interact well with everyone involved in the education process, including students, parents and colleagues. This is in accordance with the results of research by Cinar, et al. (2023) which explains that through motor skills and packaging of the material to be taught (in this case math material) can improve writing, vocabulary, and counting skills.

Inference, memorization, and ignorance are forms that are often found in schools for early grades. This is confirmed by Netson and Ain (2020) who state that learning difficulties in mathematics occur due to internal factors (inside) and external factors (outside). Difficulties in math subjects are the use of arithmetic operations, understanding the language of the questions, and working on problems with many formulas.

CONCLUSION

The result of the research is that motor skills can improve the understanding of mathematical concepts in the material of addition and subtraction operations of whole numbers. Stepping forward or stepping back followed by the direction of the view of the positive area or negative area is a combination that needs to be interpreted by students. The interpretation is the stage of giving meaning to the addition or subtraction operation Stepping forward and looking at the negative area is a form of operation a+ -b=⋯, where a,b ϵ A which can be changed to a-b=⋯, where a,b ϵ A. Thus, with motor skills-based learners can build their knowledge correctly and teachers are not focused on learning that focuses on conclusions to be memorized.

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