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Early Grade Teachers' Professional Competence in Applying Sets to Numbers

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Abstract
This study describes the professional competence of early grade teachers in applying set material in learning number material. The main objective of this study is to describe the competence of early grade teachers on set material applied in learning numbers. This type of research is descriptive qualitative with data collection methods through tests and teaching observations. The results showed that: 21 out of 25 teachers (84%) understood the notion of A∪B but were unable to apply it in addition operation; 24 out of 25 teachers (96%) understood about Cardinal numbers but what was spoken was number not lot; 25 out of 25 teachers (100%) understood the notion of A-B but were unable to apply the notion of subtraction operation.
Keywords: *Competency, set, number.*

Abstrak
Penelitian ini mendeskripsikan kompetensi profesional guru kelas awal dalam menerapkan materi himpunan pada materi pembelajaran bilangan. Tujuan utama penelitian ini adalah untuk mendeskripsikan kompetensi guru kelas awal pada materi himpunan yang diterapkan dalam pembelajaran bilangan. Jenis penelitian ini adalah deskriptif kualitatif dengan metode pengumpulan data melalui tes dan observasi pengajaran. Hasil penelitian menunjukkan bahwa: 21 dari 25 guru (84%) memahami pengertian A∪B namun tidak mampu menerapkannya dalam operasi penjumlahan; 24 dari 25 guru (96%) memahami bilangan pokok namun yang dibicarakan adalah bilangan bukan bilangan; 25 dari 25 guru (100%) memahami pengertian A-B namun tidak mampu menerapkan pengertian operasi pengurangan.
Kata kunci: *Kompetensi, himpunan, bilangan.*

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INTRODUCTION

The competence of being a teacher has been regulated in Law Number 14 of 2005 concerning Teachers and Lecturers, Article 10 paragraph (1) states that teachers must have pedagogical competence, personality competence, social competence, and professional competence. The four competencies are holistic so that they become a whole unit that characterizes a professional teacher. Noting the content of the paragraph, one of the competencies that must be possessed is that the teacher has professional competence in his field, in this case mastering mathematics material. This is confirmed by Vlahović and Vujisić-Živković (Zulfakar, 2020) who state that Professionalism is basically the idea of professionalization of teaching which includes comprehensive knowledge of teaching and learning that emerges from scientific research, a rich repertoire of practical teaching procedures, working for the benefit of learners, having a responsibility to society and a code of ethics as a teacher, active participation in pedagogy.

Agus Dudung (2018) states that from various sources that discuss teacher competence, in general, it can be identified and summarized about the scope of professional teacher competence as follows: 1) understand and can apply educational foundations both philosophical, psychological, sociological, and so on; 2) understand and can apply learning theory according to the level of development of students; 3) able to handle and develop the field of study for which he is responsible; 4) understand and can apply various learning methods; 5) able to develop and use various tools, media and relevant learning resources; 6) able to organize and implement learning programs; 7) able to evaluate students' learning outcomes; 8) able to cultivate students' personalities. Teacher competence is an urgent matter for ever-changing learning to occur. This is affirmed by Zamora (2022) that Teachers today have become learning facilitators who focus on developing higher order thinking skills, effective communication, collaboration, and skills needed in the 21st century.

The results of observations and interviews, the weak professional competence of teachers in packaging mathematics lesson materials in accordance with the mindset of students has an effect on learning, namely: teacher-centered learning; mathematics material is based on what is written in the students' handbook; the learning process goes through the stages of providing mathematical formulas, giving example problems, and practicing problems; teachers do not understand the stages of mathematics learning, namely: concrete, semi, and abstract. The results of these observations and interviews confirm that mathematics learning is considered as partial knowledge, resulting in errors in teaching mathematical concepts. This is confirmed by Sfard (Kshetree, et al., 2021) explaining that these misconceptions and errors can occur at any stage during the formation of mathematical concepts through concept interiorization, condensation of newly learned concepts with previous concepts, and concept reification.

Taking into account the description of teachers being able to handle and develop the field of study they are responsible for, teachers need to understand the supporting materials in learning mathematics in the early grades. Mathematics can be called deductive and structured knowledge. As deductive knowledge, mathematics is a language of symbols or a language that is formal or abstract. This confirms that when elementary school students learn mathematics, the teacher should teach from the concrete realm to the abstract or formal. This is confirmed by Piaget that students at the age of 7 to 12 years the stage in mathematics is concrete operational. This means that students learning mathematics must start from the concrete stage.

Mathematics as structured knowledge means that mathematical materials are interrelated between the initial material and the next material (not partial). The understanding of not partial for teachers actually creates a mindset that in teaching certain mathematics material, there is an assumption that the material is new and has

nothing to do with other material. The mistake of understanding not partial has not been realized by some teachers with indicators that teachers when teaching certain mathematical materials (for example, introducing numbers) have not been able to relate to previous concepts or theories (namely set material) to become prerequisite material. This condition is often a problem that early grade teachers do not realize.

The test results and teaching observations of early grade teachers or teachers who teach in grades I to III obtained the following data:

Tabel 1. Observation of Pre-requisite Materials

Materials taught	Pre-requisite Material Answer	Description
The multiplication operation of Integer numbers, 3 X 5 =...?	Repeated addition: 5+5+5	25 The teacher's answer is correct
Integer multiplication operation, -3 x-5=...?	Repeated addition: ... (teacher cannot write)	23 out of 25 teachers defined it according to the numerals, 2 out of 25 did not give an answer.
The teacher gives 4 fingers of the left hand: pinky, ring finger, middle finger and index finger minus 1 thumb of the right hand. What is the result?	$A = \{a, b, c\}\ dan\ B = \{c, 1\}$ $A - B = \{a, b\}$	All teachers answered 3 because they have the mindset that math problems are abstract.
The teacher gives 3 fingers of the left hand: little finger, ring finger, and middle finger plus 2 fingers of the right hand: thumb and index finger. How many are there?	$\{a, b, c\} \cup \{1, 2\} \rightarrow \{a, b, c, 1, 2\}$	All teachers answered 5, because they have the mindset that the object is abstract.

In the case of the first material, the learning of mathematics is at the abstract stage by building the concept of multiplication on random numbers, so the teacher's explanation can be said to be correct. This means that the prerequisite material given is correct. Whereas in the case of the second material, the teacher's mindset is trying to define with non-numerical numbers. The writing following the integers is not conveyed so that at the multiplication stage of whole numbers the teacher immediately gives the conclusion. The conclusion given is negative multiplied by negative becomes positive and then written =+(5+5+5).

In the third case, consciously or unconsciously, teachers who use hand media are entering the concrete stage. Thus, at that stage the pre-requisite material, namely the subtraction of two sets and cardinal numbers, is not well understood. Whereas in the fourth case material, what the teacher demonstrates is the concrete stage because it uses objects that can be seen. In the pre-requisite material for the operation, the teacher should not say plus and not sum. This is in accordance with the pre-requisite material, the word plus is replaced with the word combined, while the result is not the word how much, but is changed to the word written.

Based on the above observations, the teacher understands math learning in the early grades as a language of symbols or formal language. This understanding has a logical consequence on learning mathematics following the flow of early grade learners who adapt to mathematics as a formal language. Not mathematics as a formal language whose presentation formula is in concrete form and adapts to the vocabulary

that students understand. This is emphasized 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.

The teacher's understanding above cannot be separated from understanding the definition of mathematics. Mathematics, is a field of science, which includes the study of topics such as numbers, formulas and related structures, the buildings and spaces in which they are located, and quantities and their changes. When paying attention to this understanding, it appears that mathematics begins with number material. Thus, this understanding contributes to the teacher that mathematics is abstract knowledge.

The math topic at the beginning of math learning is number. Of the 25 teachers that researchers observed and interviewed, explained that set material had been obtained during the lecture period. However, the material in the set has not been understood when applied to number material. So, some research on how number learning is given with a focus on: computer-assisted media to realize objects and mastery of counting techniques.

The research described above, based on Bruner's theory, is in the semi stage and the selection of words conveyed has led to formal language. Such as: number, amount, add, subtract, multiply, and divide. The choice of words is not in accordance with the pre-requisite material for number material, the pre-requisite material is the set. The definition of set can be defined as a combination of objects that have definitions and can be distinguished. This definition provides an understanding that learning at this time has just entered the concrete stage. So the selection of words needs to be adjusted to the symbols in the set material. For example: combined, reduced, becomes not equal to, many objects are not the number of objects. This confirms that this stage is included in the preconception stage. Dahar (Fuad, et al., 2020) explains that preconceptions are the initial concepts that a person has after construction and before they get formal lessons on certain materials.

Connections between math concepts are poorly understood by early grade teachers. This is because teachers have the perception that in teaching mathematics, the material to be taught has no connection with the previous material. The effect of the teacher's inability to connect between mathematical concepts, the results of teaching observations and interviews, is that the material taught to early grade students tends to lead to formal language (abstract); selection of examples of problems that are the same and similar to those written in the handbook; and less varied in providing problem solving steps. The connection that becomes the teacher's inability is explained by Wagino and Andriani (2021) that mathematical connection skills that meet 4 (four) indicators of mathematical connections, namely recognizing equivalent representations of the same concept, recognizing the relationship of mathematical procedures of a representation to equivalent representation procedures, using and assessing links between topics and other disciplines, using mathematics in everyday life.

The choice of words in mathematics learning in the early grades on number material is a concern and a source of inspiration for researchers to conduct research. This is because, number as a mathematical concept that is used in enumeration and measurement is a stage to recognize problem solving involving symbols. The above understanding was found that when entering the initial number material, the language used by the teacher was formal language, such as: the word "amount" instead of "many", less, times, equal to instead of the word to be. This is confirmed by Muhammad, Angraini (2023) who explains that mathematics is a cognitive ability that needs to be developed in every learner because it is closely related to problem solving involving the relationship between number symbols and the cognitive activities of

learners. This emphasizes that to bring early grade learners into the symbol stage, the right word selection needs to be taken.

The description above, provides an understanding that learning mathematics in the early grades there are stages that teachers need to master, namely the application of set material as pre-requisite material on number material. Competence in set material is one of the manifestations that teachers have professional competence. There is a connection between mastery of set material and professional competence, so it is necessary to conduct research on mastery of set material. So the problem formulations in this study are: how is the competence of the teacher's understanding of the set material as a requirement in learning numbers? While the purpose of this study is to describe the competence of teachers' understanding of set material as a requirement in learning numbers.

METHOD

The type of research in this article is qualitative with a descriptive case study research strategy approach. The definition of qualitative research type explained by Sugiyono (2019: 18) is a research method based on the foundation of the Post Positivism philosophy, studied in scientific conditions (experiments), researchers act as instruments, and data is analyzed with qualitative properties that focus on emphasizing meaning. Noting the above understanding, the researcher in this case did not intervene with the research subject.

The research began from March to August 2023, in elementary schools in Karanganyar sub-district, Karanganyar district in 25 elementary schools. The research flow in this article is described as follows:

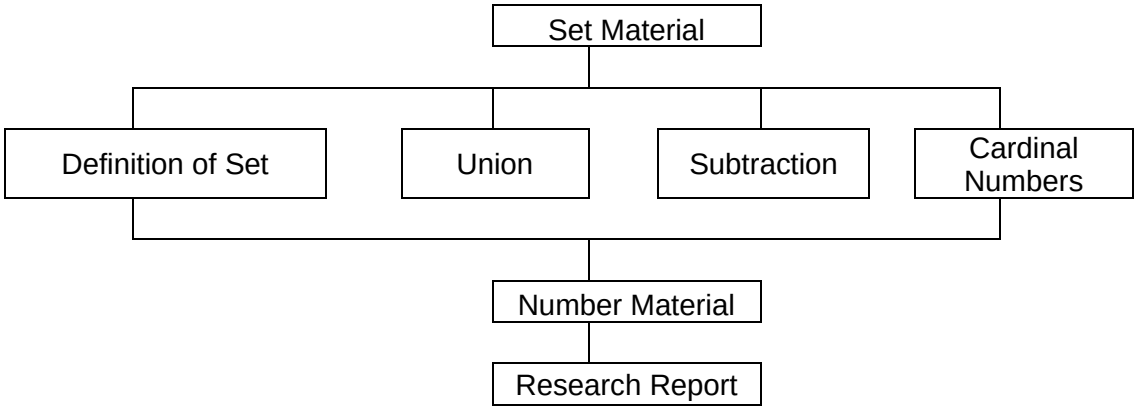

Figure 1. Flow of Research on Professional Competence in Set Materials

The set material for pre-requisites in number material in the early grades is the definition of a set, the combination of two sets, the subtraction of two sets, and cardinal numbers. The material is then given to the teacher to see the competence of understanding the concept and then the form of application in number material. To see the competence of the set material, in this study researchers analyzed and described the teacher's work documents for the set. The competency of applying set material to number material, researchers analyzed and described the teacher's work on set material applied to number material. Analysis and description of answers to this competency is the selection of the right words during the stages of learning mathematics. The work document came from the results of the service of the team of lecturers and students in November 2022. The results of the above analysis are then compiled in the form of a research report.

The research subjects in this case are early grade teachers from 25 elementary schools in Karanganyar sub-district, Karanganyar district. The main data source is the

teacher's work document. Supporting data in this study are texts and informants (in this case the class teacher). Data collection techniques were observation, literature study, and in-depth interviews with informants.

The degree of trust is an activity to describe the results of research on the actual object description. Moleong (2019: 48) states that techniques to test the degree of trust 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. Data from teacher work documents were validated by matching techniques with informants. Meanwhile, data derived from interviews was carried out with re-interview techniques.

The data that has been validated is then analyzed. The definition of data analysis explained by Afrizal (2015) states that data analysis is 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 analyzing data using Miles and Huberman (Afrizal, 2015) explain that the stages of analyzing qualitative research data are data reduction, data presentation, and drawing a conclusion.

RESULTS AND DISCUSSION

The results of the study obtained data that early grade teachers in understanding the meaning of the set as a collection of clearly defined objects from 25 teachers there are still 4 teachers who do not fully understand. Lumbantoruan, J. H., & Nadeak, B. (2022) explained 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. This makes students' understanding less understanding. This can be seen from the answers to the material presented, namely:

Set A = {goat, buffalo, fish, beautiful girl}

Answer: Correct there are 4 teachers, Incorrect there are 10 teachers without giving reasons, Incorrect there are 11 teachers by giving arguments there is a word that is relative, namely "beautiful".

The answers of 11 teachers with arguments are correct, because the answer key is not a set because there is a relative word.

The combined material in the set defined by {a,b}∪{1}={a,b,1} is well understood for all teachers. but in the problem material presented below:

{a, b, c,1,2} ∪ {1, 2, e} = ...?

The answers given by the teachers were:

4 teachers answered {a, b, c, 1, 2, 1, 2, e}

21 teachers answered {a, b, c,1, 2, e} and gave arguments, the same member was written only once.

The answers of 21 teachers are correct and the arguments given are also correct. This shows that 21 out of 25 teachers can be interpreted that 21 teachers understand the notion of combination in the set.

A combined application to number learning for a given early grade is as follows:

Which of the following statements is true:

Statement 1: {* ,*,*}∪{*,*,*,*}→{*}

Statement 2: {*, *, *}∪{*,*,*,*}={*,*,*,*,*,*,*}

Statement 3: {*,*,*}∪{*,*,*,*}→{*,*,*,*,*,*}

25 teachers gave the correct answer for statement 2, with the argument "the number" of objects is 7. For statement one, the argument is "the number" of objects must be 7. For statement 3, all teachers could not give an answer.

Understanding of cardinal numbers symbolized by n(A) to express the "number" of members of A not the "sum", for example: n ({a, b,1,2}) =4. At this stage all teachers

understand the meaning of cardinal numbers. But when applied in number learning to determine the correct statement, all teachers still use the word "number". for example the following:

Statement 1: The instructor shows the little finger, ring finger, middle finger, and index finger.

index finger, then the teacher says: how many fingers are there?

Statement 2: {*,*,*}+{*,*}={*,*,*,*,*}

Answer:

25 teachers said it was the correct question

Pronunciation: the number of objects Three plus the number of objects Two equals Five.

Statement 1 uttered by the teacher is wrong, because the objects displayed are still in the form of concrete objects. As for statement 2, the answer spoken by the teacher is wrong because the material presented is still in the form of pictures, so the statement spoken is the number of pictures of objects.

The understanding of the material for subtracting two sets (A-B) has been understood by 25 teachers, the material presented is as follows: {a,b,c}-{c,1}={a,b}. But when applied in learning Numbers, the statement given by the teacher is not correct. The material, namely:

Statement 1: The instructor raises the fingers of the left hand: Kelilking, Sweet, Middle,

and Index minus the right hand fingers: Thumb, equals

how many?

The answer given by the teacher is 3.

The answer given by the teacher is wrong because the left hand does not show the Thumb finger. So the correct answer is 4.

Based on the results of the above research, the ability to understand set material can be said to be good. This is because the understanding of the concept of combination, cardinal numbers, and subtraction of two sets can be understood. Mastery of set material to be pre-requisite material confirms that the teacher has understood Piaget's learning theory. Korompis (2023) explains that the stage of learners at the age of 7 to 12 or 13 years is concrete operational. When paying attention to this understanding, it can be interpreted that the teacher has understood that set material as a support for number learning. A good understanding of set material is the basic capital for learning numbers. Chopra (2018) explains the characteristics of Piaget's cognitive development 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.

Catani, Leifer. (2023) stated that in solving math problems in the form of story problems in which there are many numbers and number operations, making the level of difficulty of students even higher. This is due to the lack of understanding of the concept from the beginning in students. This statement emphasizes that set material is important material to be able to explain number material, because number material will be needed to solve math story problems.

Application in number learning, some of the errors obtained are errors in understanding closed sentences with command sentences. The closed sentence symbol is 4 + 2 = 6, while the command sentence is symbolized by {*,*,*}∪{*,*,*,*}→{*,*,*,*,*,*,*}. If you look closely, a closed sentence is a statement that already has a truth value. This means it is in an abstract position. Meanwhile, the command sentence is realized in the form of combined symbols and arrows, which means that it is asked to write back according to the number of objects presented.

Domingo (2023) explains that mastery of pre-requisite material is often not understood for the mathematics material being taught. This is because teachers see math material as partial material.

The choice of the words "many" and "number" is often confused during math learning in the early grades. During hand demonstrations or media positions using pictures, teachers often choose the word number to ask about the quantity of objects presented. It can be said that the teacher does not realize the position when explaining number learning, namely in a concrete or semi-concrete position. If the position is concrete or semi-concrete, the teacher chooses the word "many" to express objects or images. Sundari, Fauziati (2021) explained that knowledge can be transformed by paying attention to four educational themes in accordance with student development, namely; knowledge structure, readiness, intuition and motivation. Teacher errors that often confuse the choice of the word "many" with "number" show that the teacher does not understand the notion of the knowledge structure of mathematics.

The material of subtraction of two sets has been mastered well, but in its application the teacher does not understand, why in mathematics material that is taken is the same object or picture between the reduced group and the reducing group. It can be interpreted that early grade teachers tend to be results-oriented, not process-oriented. This statement contradicts Rochanda Wiradintana (2018) who explains that the development of process-oriented learning is very important as done by Bruner, because by going through the process stages can improve learning outcomes that have an impact on the behavior of students.

Lack of understanding of the application of the set leads students to be slow in solving story problems. Sukoco (2023) states that students' ability to solve problems in operational number material is still lacking. This can be seen from the presence of students who have not been able to understand well the mathematical sentence modeling in the problem. Students cannot make a solution plan in advance in solving problems and the answers given by students are less precise, this statement confirms that set material needs to be mastered well because it is the basis for solving math story problem material.

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. It can be understood that mastery of set material in principle is understood by early grade teachers, but in its application teachers still direct mathematics learning that is formal (abstract). For example, the teacher demonstrates a picture of two chairs added up with a picture of one chair. This material is math learning that contradicts Piaget's theory. This is because there is an error in the choice of words between "many" and "number".

Karuru, Tandiseru, and Lumele (2016) explained that set material becomes pre-requisite material for relation and function material. If the set material is not well mastered, the mastery of the material of relations and functions of students has difficulty. Simangunson, Panggabean, and Irvan (2023) explain that there is a connectivity between learning mathematical sets and abstract algebra studies. Taufik (2013) explains that set material is the basis for realistic math material. This is because the selection of words used follows the vocabulary derived from the environment of students. From the results of the description it appears that the set material becomes the basis for learning numbers and also becomes a medium for utilizing vocabulary that comes from the environment of the students themselves.

Courant, R (2019) states that mathematics is a science that develops from the investigation of the quantification of relationships between things involving certain concepts and methods. This statement emphasizes that set material as pre-requisite

material in number learning is often not the concern of early grade teachers. So that students will experience difficulties for the next material. This is because mathematics is a science that involves logic and deduction to study abstract relationships and patterns in objects and certain procedures. The learning of mathematics is able to develop students' thinking, namely: logical, critical, thorough, curiosity, and unyielding.

Sidjabat (Mortan Sibarani, 2018) states that professional teachers master the science or what they are engaged in. 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; being able to apply scientific concepts in everyday life. Hidayati (2022) explained that teachers' professional competence affects the character of students. This description directs researchers that professional competence needs to be continuously improved because the material taught has a relationship with the material before and the next material. This certainly affects the character building of students.

Based on the description above, professional competence on mastery of mathematics materials for early grade teachers needs to improve the ability to structure mathematics materials. Pham, K. T., Thi Do, L. H., Dinh, H. V. T., Nguyen, Q. A. T., Phan, Q. N., & Ha, X. Van. (2023) explained that 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.

CONCLUSION

The competence of early grade elementary school teachers in mastering set material is quickly understood, but still has a mindset that mathematical material is partial. The results showed that: 21 out of 25 teachers (84%) understand the notion of A∪B but are unable to apply it in building the notion of addition operations; 24 out of 25 teachers (96%) understand Cardinal numbers but when applying the spoken statement is the amount (abstract), so that the process of building number symbols is not optimal; 25 out of 25 teachers (100%) understand the notion of A-B but teachers are unable to apply the notion of subtraction operations.

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