Correlation Between Thinking Ability and Cognitive Learning Outcomes of 7th-grade Students at SMPN 2 Surakarta

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Abstract. Thinking ability is a basic thing that every student has. Concrete and Abstract thinking abilities are part of the cognitive development stage. This study aimed to identify the correlation between concrete and abstract thinking abilities with cognitive learning outcomes. This study design was a non-experimental correlation in quantitative research. All 7th-grade students of SMPN 2 Surakarta in the 2019/2020 academic year were used as subject in this study. One sample class was selected using Cluster Random Sampling. Data on thinking ability and cognitive learning outcomes were collected using an online test method via a google form. The analysis techniques were correlation product moment on SPSS and scalogram on Rasch Model Analysis. This study found that there is a positive correlation between concrete and abstract thinking abilities with cognitive learning outcomes, students who dominate the abstract thinking abilities have better learning outcomes than the student who dominates the concrete thinking abilities.

1. Preface
Education is an important factor in building a nation and a country that continues to experience development. The goal in education development is to be able to produce superior humans so that they can compete in this era, following Law No. 20 of 2003 Article 3 to be implemented so that students have the skills needed to face work in the 21st century.

A survey conducted by Trend in International Mathematics and Science Study (TIMSS) in 2015 stated that the ranking of Indonesian students on the science test was 45 out of 48 participating countries. The results of the 2015 and 2018 PISA studies found that Indonesia's ranking in scientific ability was ranked 62 out of 69 and ranked 71 out of 79 participating countries. The same thing happened to the results of the Science National Exam for junior high school students, in 2018 and 2019 the average scores for the Science National Exam were 48.5 and 48.79 on a scale of 100 [1,2]. The average score of students of SMPN 2 Surakarta in the previous material was 55.76 and the average report card in the odd semester of the 2010/2020 academic year was 76.9 with a KKM of 75.

Student learning outcomes cannot be separated from the role of supporting factors, in the form of internal and external factors. One of the internal factors supporting the success of student learning is the ability to think. Piaget explained that the development of thinking skills consists of 4 stages, including sensorimotor (0-2 years), pre-operational (2-7 years), concrete operations (7-11 years), as well as formal operations or known as abstract thinking skills (11 - 15 years). The thinking ability of students in junior high school is at an intermediate stage from the level of concrete thinking to the level of abstract thinking. The ability to think concretely is a stage where a person begins to be able to think logically about concrete objects or things. A concrete thinker will focus on objects that are physically close to
him/her. Meanwhile, abstract thinkers will be able to think more logically about broader things, not just fixating on things that are physically real.

So far, teachers have not considered the ability to think in learning activities, including the learning activities of grade VII students at SMPN 2 Surakarta. Besides, this thinking ability will help the learning process succeed. The ability to think will help students to solve problems in learning activities such as finding thoughts or ideas, solving problems, processing information or finding the solution to problems which in turn will determine the success of learning. Each student has different thinking characteristics, for that the teacher should give different treatment because treatment under student abilities will help students achieve the expected results.

Learning is the main thing in the world of education. Learning is the process of gaining knowledge from experience gained by remembering what is seen, mastering the experiences that have been carried out, and processing information from the discovery process [3]. The success of learning can be determined from many aspects, one of which is learning outcomes. Learning outcomes are evidence of success that has been achieved, which can lead to changes in activeness, skills, motivation, and learning achievement. Learning outcomes consist of 3 aspects, that is cognitive, affective, and psychomotor. Cognitive learning outcomes are divided into 6 levels which are packaged in a taxonomy bloom, including remembering, understanding, applying, analyzing, evaluating, and creating. Student learning outcomes are obtained from measurement and assessment activities [4].

The success of learning is determined by many factors, both internal and external. One of the internal factors that support the success of learning is the ability to think. The ability to think is the capacity of a person to use his/her intellect to perform various activities, both visible and invisible. The ability to think consists of 2 categories that is the ability to think concretely and the ability to think abstractly [5].

The thinking ability of students in junior high school is at an intermediate stage from the level of concrete thinking to the level of abstract thinking. The ability to think concretely is a stage where a person begins to be able to think logically about concrete objects or things. A concrete thinker will focus on objects that are physically close to him/her. Whereas someone who can think abstractly will be able to think more logically about broader things, not only being fixated on physically real objects [6]. The current curriculum requires students to find information by being directly involved in the discovery process. Students are required to play an active role so that they experience its first hand. With their experience, students will explore independently to get information by changing abstract things to be more concrete; this will make it easier for students to search and find. Students with concrete thinking skills will find it easier to follow the lesson provided they have to get clear, direct directions.

The ability to think affects the achievement of student learning outcomes because this thinking ability will help students improve performance in learning activities. Their research shows that there is a close relationship between thinking skills and student learning outcomes. Based on these problems, a problem will be studied, that is how the correlation between students' thinking abilities and students' science cognitive learning outcomes is?

2. Methodology

2.1. Research Design
The research approach in this study is quantitative research. The research method is a non-experimental correlation study. There is one predictor variable in the form of thinking ability and one response variable in the form of science learning outcomes. This research was conducted at SMP Negeri 2 Surakarta in the second semester of May-June 2019/2020. Grade VII population consisting of eight classes with each class consisting of 32 students with a sample of one crew selected through random cluster sampling.

2.2. Data Collection and Analysis
The data collection technique uses a test method which is carried out online via a google form. There are two tests, that is a learning outcome test to measure students' cognitive learning outcomes and a
thinking ability test to determine students' thinking abilities. The thinking ability test is in the form of multiple-choice questions with four answer choices and is divided into 15 questions of concrete thinking skills and 15 questions of abstract thinking skills. The learning outcomes test in the form of multiple-choice 25 questions consisting of four choices.

The data analysis technique includes the prerequisite analysis test and hypothesis test. The prerequisite test in this study includes the normality test, linearity test, and homogeneity test. The normality test is used to determine whether the distribution of sample data is consistent with or deviates from the normal distribution [8], in this study using the Shapiro Wilk test with the help of SPSS. The linearity test aims to determine whether the variables have a significant linear relationship or not [8]. Linearity test is done through the Test of Linearity test using SPSS. The last precondition test is the homogeneity test which aims to determine whether the variance of several groups is homogeneous or not [9], carried out through the Test of Homogeneity of Variance.

The analysis carried out is a univariate analysis to determine the description and frequency distribution of the variable level of thinking ability and student learning outcomes. Data on thinking skills and learning outcomes are then calculated using the following formula:

\[ X = \frac{X_i}{n} \times 100\% \] (1)

Explanation:
\( X \) = Average score of students
\( X_i \) = The total score obtained by students
\( n \) = Total maximum score

Hypothesis test to answer the relationship between thinking skills and cognitive learning outcomes is a simple correlation analysis through the Moment Product Correlation with the help of SPSS and a scalogram test through the Rasch Model Analysis.

3. Result and Discussion

The test instrument that has been tested is then used to collect research data. The prerequisite analysis test then carried out the data on thinking skills and learning outcomes. The results of the normality test on the research variables can be seen in the Table 1.

| Table 1. Normality Test Results |
|---------------------------------|
| Variable                        | N  | Significance |
| Concrete Thinking Abilities     | 32 | 0.424        |
| Abstract Thinking Abilities     | 32 | 0.406        |
| Cognitive Learning Outcomes     | 32 | 0.208        |

The table above explains that each variable has a significance value > 0.05, so it can be concluded that the variables used are normal. The results of the linearity test showed that the significance of the score for the concrete thinking abilities with cognitive learning outcomes was 0.423. The significance between the abstract thinking abilities score and learning outcomes is 0.549 and the significance between the two groups is > 0.05, so the decision on the linearity test results is linear both between the concrete thinking abilities with learning outcomes and the abstract thinking abilities with learning outcomes. The significance obtained in the homogeneity test is 0.932. This indicates that the significance value is > 0.05 so it is decided that the two groups are homogenous.

The results showed that the significance value between the concrete thinking ability score and cognitive learning outcomes was 0.423, while the significance between the abstract thinking ability score and learning outcomes was 0.549. The significance between the two groups is > 0.05 so that the decision on the linearity test results is linear both between the ability to think concretely with learning outcomes and the ability to think abstractly with learning outcomes. The significance produced in the
The homogeneity test is 0.932. The results show that the significance value > 0.05, then Ho is accepted. The decision on the homogeneity test of the two groups was homogeneous.

**Figure 1. Students’ Cognitive Learning Outcomes**

The percentage of students’ cognitive learning outcomes is presented in figure 1. It shows that students with high cognitive learning outcomes contains of 4 students or 12.5%, students with medium cognitive learning outcomes contains of 78.1% of the students, and students that categorized in low cognitive learning outcomes is 9.4%.

**Figure 2. Students’ Thinking Abilities Categorizations**

Based on the thinking group that shown in figure 2, as many as 10 students were included in the concrete thinking group, 15 students were in the abstract thinking group, and 7 students had the same score in both categories, so they were not used in the second hypothesis test. The percentage of students based on the results of categorization based on the score of concrete thinking skills included 18.8% low, 65.6% moderate, and 15.6% high groups. Categorization based on abstract thinking group includes 21.9% low category, 65.6% moderate, and 12.5% high category.

The results of the correlation test for the ability to think concretely with cognitive learning outcomes indicate that the significance level is 0.000, which means that there is a correlation between the two variables. The value of the correlation coefficient is positive, with a number of 0.638 which states that the level of correlation is strong with a relative contribution of 63.8%. The correlation test conducted to determine the effect of the ability to think abstractly on cognitive science learning outcomes using SPSS through the product-moment correlation test resulted in a significance of 0.000 and a correlation coefficient of 0.645, means that there was a correlation between the ability to think concretely with the results of learning cognitive science. Guttman Matrix in figure 3 shows students’ mapping in answering the questions.
Figure 3. Gutmann Matrix Results

The effect of thinking ability on cognitive learning outcomes is different, although the scores between students with the dominance of concrete and abstract thinking dominance are not different, the ability of students in the two groups is different in answering questions. The Gutmann matrix shows the ranking of students’ abilities based on the level of students’ abilities, where students with high ability at the top are students in the dominant group of abstract thinking, while students with the lowest order are students in the concrete thinking dominance group. This is following the opinion where students who can dominate abstract thinking are easier to find something without presenting it in real terms [11]. This is because they can think logically to help them make hypotheses and formulate perceptions so that they can make and evaluate plans for their future.

Students with codes 2L, 5L, 6L, 7L, 9L, 7K, and 0O are students at a neutral difficulty level, students with codes 0L, 1L, 3L, 4L, 0P, 2P, 3P, 4P, 7P, 9P, 0K, 3K, 6K, 8K, 9K, and 1O are the dominant group in abstract thinking, while the other 10 students are the dominant group in concrete thinking. Students with code 3L are students in the dominant ability group to think abstractly. Students can answer all questions with an easy level and can answer questions at a difficult level. For these students, it can be predicted that there is an indication of a wrong answer when question number 8, the student is wrong in answering even though the student can answer question number 2 with a higher level of difficulty, so it can be predicted that the student should be able to answer the question correctly.

Students with code 3P are students who belong to the dominant group of abstract thinking. These students have high abilities based on the results of this analysis. There is an indication of a misfit or not following the answer pattern. Students are not able to answer questions with an easier difficulty level.
However, the student can answer 3 questions with a higher difficulty level, so it can be predicted that the student can answer the questions. Following the theory presented by Piaget, where the dominance ability to think abstractly is a development process of the dominant ability to think concretely because it has gone through the dominant ability to think concretely, students will find it easier to deal with concrete situations and problems oriented to concrete conditions well, students with this high abstract thinking ability can solve analytical problems and a high level of difficulty well because of his ability to use logic. Following the opinion [12] stated that students answered more questions on the difficulty level of analysis correctly because students with the dominant ability to think abstractly dared to take higher risks.

4L students have high abilities with order 4; this student is included in the dominant group of abstract thinking. Students can work on questions with an easy level well and can answer questions with a higher difficulty level. Students with code 0P are students in the order of 5 who have high abilities are students who can dominate abstract thinking. The 6P students from the dominance group think concretely even though they have the same score as the 0P students, but their abilities are still below it. This is because the consistency of 6P students is better in answering questions from low to high categories than 6P students.

Student consistency in answering the easiest questions and higher difficulty level develops along with the development of their thinking abilities. In accordance with the opinion [13] as cognitive development increases, the better at using logic and being able to relate different things with the easiest difficulty level to a higher difficulty level. The results of the same research were also conveyed which stated that the higher the students' thinking skills, the higher their reasoning abilities so that the students would find it easier to solve problems [14].

1P students are students from the concrete thinking dominance group, with the same score, 4P students from the abstract thinking dominance group have lower abilities, this student can answer the first 6 questions with an easy difficulty level, but is unable to answer questions with a higher difficulty level well. It can be seen that there is an indication of a misfit by 4P students in point 3 where students with the above abilities are unable to answer the item so that there is an indication of a guess on that item, so it can be predicted that the student has a lower score. When compared with 9P students from the dominant group of abstract thinking at the same score, 4P students have a higher ability.

2P students are the dominant group in abstract thinking. This student can answer the first 5 questions with an easy difficulty level well, but there is an indication of the guess in point 6 with the highest difficulty level. Based on their ability according to the matrix, 2P students should not be able to answer correctly on the question because questions with a lower difficulty level cannot be answered correctly, besides that other students are also unable to answer the question so that 2P students should have a score of 5. 4K students with the same score have lower abilities than 2P students, this is because there is an indication of guesses in item 2. After all, students with the above abilities are not able to answer these items, and because the consistency of 2P students is higher, the 2P students' abilities are better than students 4K. This is because the ability of students in the concrete thinking dominance group has not been able to achieve what abstract thinkers can do so that these concrete thinkers have difficulty answering questions with a higher level of difficulty. Almost the same pattern occurs in 1L who are students in the dominant group of abstract thinking.

8L students are students in the concrete thinking dominance group, with the same score this student has a higher ability than 5P students in the concrete thinking dominance group and 7P from the abstract thinking dominance group. This student was able to answer more correctly at a higher level of difficulty than the other 2 students. 7P students from the dominant group of abstract thinking can answer correctly on questions with easy difficulty levels well. However, there is a misfit in item 2 with a high level of difficulty, where the student can answer correctly predicted as a result of guesses so that the student should get a lower score.

8P students are students in the concrete thinking dominance group, while 0K students from the abstract thinking dominance group. The ability of 8P students is higher than 0K students because 8P students are more successful in working on questions with a higher level of difficulty. However, with
the same score, they have the ability below it but can answer questions with an easy difficulty level well without any indication of misfit even though this student has not been able to solve questions with a higher difficulty level. This is following the opinion [15] which states that students with the dominant ability to think concretely can process information, think about the information precisely according to what they feel or experience they have experienced. Through this experience, students will find it easier to capture information and process it according to what is obtained. Students with the dominant ability to think concretely will be better able to complete work in a predetermined time. They will try their best to organize a series of tasks systematically through coherent stages.

The inability of students in this concrete group to work on problems with a higher level of difficulty is due to the difficulty in determining the correct answer to analysis questions and is abstract. In accordance with the opinion [16] that students with the ability to dominate concrete thinking will find it easier to remember and memorize facts, formulas, and information with easy rules, but they will experience difficulties when faced with questions with a higher difficulty level and abstract conditions.

Thinking skills have a high correlation with learning outcomes [17]. The analysis above shows that students with the dominant ability to think abstractly have higher learning outcomes than students in the concrete thinking dominance group based on the Guttman matrix. It can be seen that students with high abilities are occupied by students in the dominant group of abstract thinking, while students with low abilities consist of students in the concrete thinking dominance group. [7] The dominance ability of abstract thinking is part of high-level skills, while the dominant ability to think concretely is classified as a low-level ability so that students with the ability to dominate abstract thinking have higher learning outcomes than students in the dominant concrete thinking group.

The analysis above shows that students with the dominant ability to think abstractly answer questions with an easy difficulty level well and can solve questions with a higher difficulty level. In contrast, students in the concrete thinking dominance group are only able to solve questions with a low difficulty level. This is because students with the dominant ability to think abstractly will use their logic to help determine problem-solving.

The ability of abstract thinkers in dealing with something even though it is not tangibly tangible will help students to understand and absorb the meaning of the question and begin to analyze to solve the problem. They have high reasoning so that most students with the dominant ability to think abstractly do not need the help of real problems in solving problems. In accordance with the statement that the dominant ability to think abstractly is a person’s ability to carry out logical and rational analysis [14]. Following the cognitive development theory presented by Piaget that at the dominant stage of concrete thinking, a person has limited thinking in visualizing something so that a concrete picture is needed to overcome these limitations [18].

A similar opinion [19] through the research which states that a person at a concrete thinking development stage needs a real object to help them understand something. Meanwhile, students in the abstract thinking stage can overcome these limitations without the need for concrete pictures because of their imaginative abilities. [10] A person with a dominant style of concrete thinking needs a real object to help them understand something, whereas someone with a dominant style of abstract thinking can understand something without presenting its tangible form because they will carry out an analysis based on the information that has been they get.

[15] Students with the ability to dominate concrete thinking when applied to learning situations that can support their thinking abilities will get better results, where the higher the students’ thinking skills, the student's understanding will increase so that learning outcomes will increase. Students can solve something effectively because they have a good understanding so that their consistency level can increase their cognitive learning outcomes [20].

4. Conclusion
The results of this study conclude that there is a positive correlation between thinking skills and learning outcomes. The ability to think concretely has a positive correlation with cognitive learning outcomes, and the ability to think abstractly has a positive correlation with cognitive learning outcomes, students
with the ability to think abstractly have academic abilities in the form of higher learning outcomes than students in the concrete thinking group.

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