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Improving Elementary School Student's Critical Thinking Skills through HOTS-Based Mathematics Question

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ABSTRAK

Kemampuan berpikir kritis siswa di sekolah dasar masih sangat rendah. Telah dilakukan beberapa upaya untuk meningkatkan kemampuan berpikir kritis siswa sekolah dasar melalui berbagai metode pembelajaran. Namun, hanya sedikit penelitian yang menunjukkan adanya peningkatan kemampuan berpikir kritis siswa sekolah dasar melalui soal-soal matematika berbasis HOTS. Penelitian ini bertujuan untuk menganalisis keefektifan metode pembiasaan soal matematika berbasis HOTS dalam meningkatkan kemampuan berpikir kritis siswa sekolah dasar. Penelitian ini menggunakan desain eksperimen semu dengan kelompok kontrol tidak setara yang terdiri dari kelas perlakuan dan kelas kontrol. Partisipan dalam penelitian ini melibatkan dua sekolah dasar dengan tiga puluh dua siswa. Teknik pengumpulan data dalam penelitian ini adalah tes dan dokumentasi. Teknik statistik untuk analisis deskriptif dan inferensial digunakan untuk menguji data terkait tes. Hasil penelitian menunjukkan bahwa rata-rata kemampuan berpikir kritis siswa kelas eksperimen lebih tinggi daripada kelas kontrol dengan selisih rata-rata positif sebesar 2,69. Berdasarkan hasil tersebut, soal Matematika berbasis HOTS efektif dalam meningkatkan kemampuan berpikir kritis siswa sekolah dasar.

ABSTRACT

Students' critical thinking skills in elementary schools are still very low. There have been several attempts to improve the critical thinking skills of elementary school students through various learning methods. However, only a few studies have shown an increase in critical thinking skills of elementary school students through HOTS-based questions in Mathematics. This research aimed to analyses the effectiveness of the habituation method for HOTS-based mathematical questions in improving the critical thinking skills of elementary school students. This study used a quasi-experimental design with a non-equivalent control group made up of treatment and control classes. The participant in this study is involving two elementary schools with thirty-two students. The data collection techniques in this research were tests and documentation. Statistical techniques for descriptive and inferential analysis were used to examine the test-related data. The research demonstrated that the average critical thinking skills of experiment class students were higher than the control class with a positive average difference of 2.69. Based on this result, HOTS-based Mathematics questions are effective in improving the critical thinking skills of elementary school students.

1. INTRODUCTION

The rapid growth of science and technology causes the public to utilize technology and science. PISA (Programme for International Student Assessment) released the latest report data on the literacy of member countries, one of which is Indonesia. Based on this report, the literacy level of Indonesian students was ranked 74 from 79 member countries (Umbara & Suryadi, 2019; Yusupova & Skudareva, 2020). This rank becomes the center of attention for Indonesia because the literacy of a nation affects competitiveness in the global competition era. Mathematical literacy is individual skills to formulate, implement, and interpret mathematics in various contexts (Junika et al., 2020; Kusumadewi et al., 2019). Following the rapid growth of technology and science, mathematical literacy is essential to master by Indonesian generations. It is unfortunate the literacy rate of Indonesian students was low. In literacy, Indonesia was ranked behind Singapore, Malaysia, and Thailand. This issue is penultimate in improving the education quality in Indonesia. Several measures have been carried out, one of which is improving students' critical thinking skills through Mathematics (Hidayah et al., 2021; Pratiwi et al., 2019; Suryawati et al., 2018).

As part of the process of analyzing, evaluating, and providing an appraisal of ideas or facts discovered even with the goal of being able to, higher order thinking skills, or HOTS, lead to a training tool.

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Improving critical thinking skills requires training and habituation (Munawwarah et al., 2020; Yu & Wan Mohammad, 2019; Yusuf, 2018). Critical thinking is the ability to think about an object, content, or problem by the thinker to improve their thinking skills by skillfully taking over the structure and component adhered to the mindset and placing an intellectual standard in themself (Delina et al., 2018; Ikhsan et al., 2017; Risqi & Rini Setianingsih, 2021). Critical thinking uses logical and reflective thoughts by deciding what to do. It is possible to draw the conclusion that critical thinking is a thinking skill that uses a variety of objects and concepts to solve an issue based on both viewpoints (Anisa, 2017; Kivunja, 2014; Sumarno, 2019).

In other words, critical thinking skills are a concept to solve a contextual or non-contextual problem. When a person combines new information with information that is already stored in his memory, associates the two, or reorganizes and develops the information for achieving a goal or solving a problem, HOTS will take place solved (Lu et al., 2021; Septiyani et al., 2020; Susilowati & Suyatno, 2021). Previous study revealed that growth is highly affected by high critical thinking skills (Septiyani et al., 2020). Based on this survey, critical thinking skills can be assessed through various aspects, i.e., analysis skills, evaluation skills, explanation skills, inference skills, interpretation skills, and self-regulation skills (Fitrianawati et al., 2020; Prafitasari et al., 2021; Rubini et al., 2019).

Fundamentally, *High-Order Thinking Skill* (HOTS) is an ability to do things related to facts, then understand, conclude, and connect them with new facts and implement them to solve questions (Astuti et al., 2019; Kurniawati et al., 2021; Risqi & Rini Setianingsih, 2021). HOTS relate to a cognitive part of revised Bloom's Taxonomy, and hence, HOTS are at the level of analyzing, evaluating, and creating new ideas. Therefore, in optimizing students' critical thinking skills in Mathematics, it is necessary to have HOTS-based mathematical questions. This habituation should start early or at the elementary school level (Azizah et al., 2018; Munawwarah et al., 2020; Purawati et al., 2016). This level is the elementary school level where the most basic knowledge, including Mathematics, has begun to be taught.

Based on various research, there have been efforts to improve the critical thinking skills of elementary school students. Although much research has examined the critical thinking skills of elementary school students, previous research revealed that improvement of students' critical thinking skills through HOTS questions in Mathematics is still unsatisfactory (Astuti et al., 2019; Damaianti et al., 2020). Therefore, it requires a deeper study because having critical thinking skills from early childhood will help students in preparing themselves for globalization from the educational aspect. This research aimed to analyses the effectiveness of the habituation method for HOTS-based mathematical questions in improving the critical thinking skills of elementary school students. The research hypothesis was that the habituation method for HOTS-based mathematical questions was effective in improving the critical thinking skills of elementary school students.

2. METHOD

The research is experimental research with the quasi-experiment model, where the researchers compared the level of students' critical thinking skills for mathematical questions on treatment and control classes (Gopalan et al., 2020; Rogers & Revesz, 2019). In the treatment class received treatment in the form of habituation of HOTS-based mathematical questions, while the control class did not receive any treatments. The control class was taught with the speech and direct explanation method. The initial step in this research was providing treatments in the form of a pretest to the treatment and control groups to discover the level of students' in both sample classrooms, critical thinking abilities. Before applying a t-test to examine the balance level in this initial stage, the study used a precondition test.

This research was conducted at two elementary schools in Karanganyar, SDN 01 Selokaton as the Treatment Group with 16 students and SDN 02 Kemiri as the Control Group with 16 students. Both schools were selected for having the same program aiming to implement HOTS-based mathematical questions. The samples were selected randomly since there were no particular characteristics. All 32 students have acquired relevant mathematical materials in the research conducted.

The data collection techniques in this research were *tests* and *documentation*. The test contains mathematical questions covering the properties of number arithmetic operations consisting of five description questions. After testing, the next step was the reliability test. If the result is prominent, it will be continued to the validity test using the Alken coefficient value to allow the result to be used for the pretest and post-test. Documentation aimed to collect information and data required during the research.

The evaluation of students' critical thinking skills was carried out. The assessment was based on a variation in scale with ratings from 1 to 5, where 1 is "very low" and 5 is "very high". The assessment was continued with the level of agreement test using reliability test by Cohen's Kappa. If the agreement level is relatively high, the assessment data from the pretest and post-test can be continued for the subsequent

statistical test. The final step was calculating the average of the pretest and post-test scores and comparing both average scores to conclude.

3. RESULT AND DISCUSSION

Result

The prerequisite tests are conducted before analyzing data in subsequent statistics or normality and homogeneity test. The normality test used a formula from *Shapiro-Wilk* because the samples did nothing more than thirty students. Based on the *Shapiro-Wilk* normality test data processing, data from both classes were normally distributed with each significance value exceeding 0.05. The *Shapiro-Wilk* normality test results acquired significance values of 0.714 for the experiment class and 0.795 for the control class with a rule stating that if the significance < 0.05, the data is normally distributed. This result states that pretest scores from the experiment and control classes were normally distributed, and therefore, data testing could be continued for the homogeneity test.

The homogeneity test employed a formula from Levene because this research examined two data groups. The homogeneity test revealed that the significance value was 0.249 with a rule that a homogeneity significance ≥ 0.05 indicates homogeneous data. It could be concluded that the pretest data examined using Levene's homogeneity was homogeneous. After discovering that the data were homogeneous, the subsequent step was testing the reliability using Cohen's Kappa inter-rater reliability.

Before testing the hypothesis, data were tested for reliability using the inter-rater reliability test Cohen's Kappa. Based on the test results, the data have a value of 0.820, meaning that the data has a high agreement level. A high agreement level indicates that the data can continue to the average level of similarity test obtained from the pretest data. This test utilized the independent sample *t*-test formula. This test aimed to discover H_0, i.e., there is a significant difference between students' critical thinking skills through HOTS questions in control and experiment classes. Independent sample *t*-tests for pre-test data are presented in Table 1.

Table 1. Independent Sample *T*-Test for Pre-Test Data

Condition	t	Df	Sig. (*2-Tailed*)	Mean Difference	Std. Error Difference
Equal Variances Assumed	0.731	30	0.470	0.563	0.769
Equal Variances Not Assumed	0.731	28.366	0.470	0.563	0.769

Based on Table 1, there was an insignificant difference on students' critical thinking skills through habituation of HOTS questions in experiment and control classes with (Sig, (2-tailed) ≥0.05). According to a test using SPSS version 26, the significance value was 0.470 or Sig. (2-tailed)≥ 0.05. A significant difference between average students' critical thinking skills on HOTS Mathematics questions. This result was analyzed for the effectiveness of both classes. After both classes were declared balanced, the research continued to post-test data using the *Shapiro-Wilk* normality test. The assessment of both assessors was tested for normality using the *Shapiro-Wilk* test. The test revealed a significance value of 0.168, indicating that post-test data were normally distributed. Besides the *Shapiro-Wilk* normality test, The homogeneity test obtained a significance value of 0.156, categorized as homogeneous data.

The independent sample *t*-test was used to observe differences in students' critical thinking skills after being administered HOTS Mathematics questions between the control and experiment classes. The research hypothesis remained the same as when analyzing the pretest scores, where H_0 is the condition when there is a significant difference between the students' critical thinking skills on Mathematics questions of the experiment and control classes (Sig. (2-tailed) < 0.005), and H_1 is the condition where there is no significant difference between the experiment and control classes (Sig. (2-tailed) 0.05). Based on the test, the sig. (2-tailed) value of the *t*-test was under 0.05; hence, H_0 was rejected. Therefore, there were similar differences between the experiment and control classes. To discover which class has the greater influence, a descriptive test was conducted to compare the two classes.

Based on the descriptive test, the average critical thinking skills in the experiment class was 22.44, and 19.75 in the control class. These results indicate an increased average in the experiment class. Then showing an increase in critical thinking skills in every aspect. The data shows that the experiment class more significant than the control class. It can be concluded that the method of habituating HOTS-based mathematical questions for elementary school students can improve critical thinking skills. More detailed data are presented in Table 2.

Base on Table 2, the results and point comparisons on each aspect of students' critical thinking skills through the pretest and post-test are clarifying. The experiment and control classes experienced a significant increase. However, when observed further, the experiment class with the habituating of HOTS-based questions had the most significant improvement compared to the control class.

Table 2. Independent Sample T-Test for Post-Test Data

Aspect	Experimental Class		The Differences of Each Test	Control Class		The Differences of Each Test
	Pre-Test	Post-Test		Pre-Test	Post-Test	
Analytical skill	3.00	4.45	1.45	3.44	3.87	0.43
Evaluating skill	3.15	4.43	1.28	3.20	3.80	0.60
Explanation skill	3.25	4.89	1.64	2.12	3.75	1.63
Interpretation skill	4.15	5.10	0.95	3.93	4.06	0.13
Self-regulation skill	4.10	4.90	0.80	3.15	4.26	1.11

Discussion

The globalization era requires all people to start preparing in all fields to increase their competitiveness. Several fields must be improved the education and science fields. Mastering science can create a technology to help and facilitate the life of the nation. In basic education, basic materials have been taught, one of which is Mathematics (Dockendorff & Solar, 2018; Pramitasari et al., 2019). Solving the problem takes the ability to think critically to solve existing questions. Likewise in facing globalization, critical thinking skills are the fundamental weapon that can lead to making decisions or solving existing questions. Due to the questions of critical thinking skills in Mathematics, efforts are required for improvements, particularly in elementary school education. One of which is habituating students to solve HOTS-based math questions. Students' skills of critical thinking through the habituation of questions based on *Higher Order Thinking Skills* (HOTS) are obtained through an assessment based on questions previously taught (Azizah et al., 2018; Purawati et al., 2016). Before administering HOTS-based mathematical questions, students were provided with material and practice questions (Hidayah et al., 2021; Pratama & Retnawati, 2018). Hence, in the process, students were not confused about working on or mastering critical thinking aspects.

The data collection step began with administering pretest HOTS-based mathematical questions to experiment and control class students. The pretest results were then processed using the statistical prerequisite test, i.e., the normality and homogeneity tests. After performing the prerequisite test, data were tested for normality using the *Shapiro-Wilk* test. The test revealed that data from the experiment and control classes were normally distributed. The subsequent step was the homogeneity test using the Levene formula. It was discovered that the data from both classes were homogeneous. Since the two prerequisite tests have been fulfilled, the test was continued with the *t*-test to discover a balanced of students' critical thinking abilities in the experiment and control classes. It also reveal that the skills of critical thinking in Mathematics were similar. The data collection process was carried out for two weeks, during which the researchers collaborated with teachers at two elementary schools in Karanganyar: SDN 01 Selokaton and SDN 02 Kemiri. The habituation of HOTS-based questions was carried out directly during the learning process. The researchers divided the learning period, where the first week focused on grade 4 SDN 01 Selokaton as the experiment class, and the second week focused on grade 4 SDN 02 Kemiri as the control class. At the last meeting at each public elementary school, the researchers administered a post-test to grade 4 students in the form of HOTS-based mathematical questions.

The post-test data assessment was tested for normality and homogeneity before testing the hypothesis using the *t*-test. Based on series of tests, the values in both classes were normally distributed. We can see data from both classes were homogeneous. Since the post-test data were normally distributed and homogeneous, the researcher continued with hypothesis testing using the *t*-test formula. There are significant differences in the results for both classes. The mean value in the experiment class was 2.69-fold higher than the mean value in the control class. Based on the significant differences in each data test, it can be concluded that the habituation method of providing HOTS-based mathematical questions is effective in improving and optimizing the critical thinking skills of elementary school students.

This research result is in line with previous study that showing that HOTS-based questions could improve critical thinking skills and affect analysis skills to help students categorize problems and information needed as provisions in solving problems (Damaianti et al., 2020). This statement follows by other study that demonstrating good analytical skills can be identified through students' ability to answer the questions correctly and be able to explain the steps for solving the problem, and being able to manage

information based on existing problems to get the right and correct answers (Budiman & Jailani, 2014). The ability to think critically accompanies students in solving their problems from the process of analyzing, evaluating, and finding solutions. This opinion is supported by previous research that state the ability to think critically is a process of managing concepts, applying, classifying, and evaluating the information obtained and generated (Azizah et al., 2018). Not only being able to improve students' analytical skills, and critical thinking can improve students' abilities in concluding the information obtained.

In understanding knowledge, critical thinking skills are essential and beneficial for students. Not only in education but critical thinking is also closely related to solving problems in daily life. Although it has been considered that the students' responses to the questionnaire were reasonable, it appears that they tended to relate to what they anticipate rather than according to their reality. Students are taught to comprehend difficulties in questions that apply to everyday life, and all learning materials are connected to learners' actual experiences. Students in this learning are better at comprehending the questions, more engaged in asking questions, and more excited about the learning process, which makes learning more meaningful (Maolidah et al., 2017; Priyambodo & Maryati, 2019).

Based on the results and discussion on the data outcomes that have been tested above, it can be concluded that the skills of critical thinking of elementary school student's can be increased through the habituation method of practicing HOTS-based math questions. It has been proven during the research on fourth grade at SDN 01 Selokaton and SDN 02 Kemiri, Karanganyar Regency, Indonesia. Mastery of critical thinking skills can provide benefits, especially in the context of problem-solving. It is highly required since critical thinking skills are 21st-century skills that will be useful for students in competing at the international level (Hussin et al., 2018; Sadaf & Johnson, 2017). Improved instruction is required if students are to have high HOTS. In this study, it was discovered that the curriculum had undergone a fundamental transformation and that technological improvements were crucial to HOTS. Students in the current era of technology Although it is simple to acquire a variety of information online, users must filter and only use reliable sources. They will become more open-minded as a result.

Therefore, the implication of this research is expected to be a reference for educators in dealing with and developing students' critical thinking skills through HOTS-based mathematical questions, not only as a reference for educators but also as initial capital for a nation in improving welfare in the life of the nation and state. The research limitation was that it did not consider other indicators or factors. This research still requires further in-depth research due to several time limitations and subjects and objects involved.

4. CONCLUSION

Based on the research objectives, the results demonstrate that the method of habituating HOTS-based mathematics questions is effective and optimal in improving the critical thinking skills of elementary school students. The success of this method is evaluated from the Sig. value (2-tailed), indicating an average difference in the students' skills of critical thinking in experiment and control classes with a significant difference in the average scores of experiment and control classes. The research results are expected to provide an overview and benefits for educators and education practitioners in elementary schools to improve critical thinking skills using the HOTS-based mathematics habituation.

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