Fourth-grade elementary students critical thinking skills: a preliminary study on magnetic force

A R Ningsih1*, A Suhandi1,2, E Syaodih1,3, B Maftuh1, N Hermita4 and A Samsudin2

1Program Studi Magister Pendidikan Dasar, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229 Bandung 40154, Indonesia
2Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229 Bandung 40154, Indonesia
3Departemen Pendidikan Guru Anak Usia Dini, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229 Bandung 40154, Indonesia
4Prodi Pendidikan Guru Sekolah Dasar, Universitas Riau, Jl. HR. Subrantas Km 12,5 Pekanbaru, Indonesia

*anggunrestu@student.upi.edu

Abstract. This research purposes to define student’s critical thinking skills on magnetic forces toward elementary level through experiential learning. The indicators of critical thinking skills which were utilized in this research were the indicators that were precise to the critical thinking skills on magnetism. A descriptive-qualitative design has already been affected to collect data from fourth grade elementary students in one of Bandung Regency (27 participants: 9-10 years old). The instrument which is utilized formed multiple choices with interview process. The consequence shows that every aspect of critical thinking skills have been developed and defined such as: reasoning, arguments analysis, likelihood and uncertainty analysis and problem-solving and decision-making. To sum up, the experiential learning is able to define the 4th grade elementary student’s critical thinking skills on magnetic forces.

1. Introduction

In demand to get someone ready younger generations with 21st-century skills, emerging students higher order thinking skills have been highlighted for educational purposes throughout the world [1-3]. One of the important skills needed to prepare young people is critical thinking skills. Ideally, an individual must be introduced into rehearses of critical thinking from an early age [4, 5]. Learners (age 6-12) are at critical stages of cognitive expansion, extending from a Preoperational stage, Concrete Operational stage to Formal Operational stage [1, 2]. At this age, teaching critical thinking may be precarious and most rewarding [2]. By teaching critical thinking to students at that age will certainly be able to help them in understanding the lesson materials they learned.

The development of critical thinking (CT) is widely claimed as a primary goal of science education [6, 7]. Critical thinking could be a way to improve natural science which grows in the student’s mind [8]. Though critical thinking can improve student thinking in nature's knowledge, many of the indicators used in critical thinking are general. One difficulty with such conceptualization of CT is that the link between performance on a domain-general CT test and specific subject matter knowledge is not...
One of the natural science materials found in the elementary school curriculum is the magnetic force [9].

Children have been revealed to have commonsensical concepts about magnetism [10, 11]. Several readings show that young children notice the phenomenon of magnetic attraction, but are not capable to deliver suddenly a clear explanation of it [11, 12]. This estimation followed by test result that assumed to fourth-grade students. The student is still demanding to likelihood and uncertainty analysis. One of the inaccuracies made by students in probability and uncertainty of analysis indicator is because students do not know to make artificial magnets by rubbing on a horseshoe magnet. It can be seen in figure 1.

![Horseshoe magnets are rubbing on metal bars.](image)

Many students do not recognize the occasions in figure 1, because many of them have not been familiarized to the critical thinking procedure. In tallying, teachers or soon-to-be teachers do not have a satisfactory understanding of figure 1. In imperative for occasions in figure 1 to be straightforwardly understood, then there are some comprehensions that teachers really requirement: 1) The chattels of metals convened into ferromagnetic, diamagnetic, and paramagnetic while the iron bars themselves fit to a metal that can be magnetically thoughtful by a magnet or frequently known as ferromagnetic; 2) In iron there is a small irregular (domain) magnet so that iron is neutral; 3) Magnetic field. Since magnetic field is a vector, formerly there is a formula for calculating magnetic field magnitude. In the magnetic field formula, magnetic field magnitude is transcribed with symbol B, as follows:

\[ B = \frac{\mu_0 I}{2\pi r} \]  

Based on that background, the authors decided to investigate critical thinking on magnetism force. Fading from the earliest findings, the emphasis of this research aims to find out how the fourth-grade students elementary critical thinking in magnetism force. The result of this research is probably to be a consideration for related research that aims to expand critical thinking in magnetism force.

2. Method

This research uses the qualitative-descriptive method that purposes to observe students without substantial action to the topics then the results are prevailing in a forthright and truthful way. The subject of research is a fourth-grade elementary student of one Bandung Regency (27 participants: 9-10 years old). They are 16 boys and 15 girls who have prior knowledge about magnetism force.

Instruments used are multiple choice and interview. The multiple-choice question consists of 13 questions each representing the four critical thinking criteria consisting of reasoning, arguments analysis, likelihood and uncertainty analysis, and problem-solving and decision-making. The critical thinking skill indicator used in this research is a modification of Tiruneh. Each question representative each indicator that will be used measuring students critical thinking on magnetism force.
3. Result and discussion

There are four indicators used to measure the critical thinking skills of fourth-grade elementary school students in magnetic force materials. Figure 2 shows the recapitulation of test results from critical thinking skills on magnetic force materials for each indicator or questions, as follows.

![Figure 2](image-url)

**Figure 2.** Recapitulation of average percentage of critical thinking skills of fourth-grade elementary students on magnetic force.

Figure 2 shows that the critical thinking skills of fourth-grade students on magnetic force are dominated by problem-solving and decision-making indicators with a percentage of 41%. The low percentage of each indicator shows that students have not been introduced to critical thinking skills by teachers in elementary schools. Whereas, critical thinking which has routines such as “I see, I think, and I wonder” can be used with very young children to advance the three skills of cautious observation, thoughtful interpretation, and imaginative speculation [13].

3.1. Reasoning

Questions with this indicator will measure interpret the result of an experiment skill students. In this indicator there are 4 questions about the skill. The test results indicate that 34.61% of fourth-grade elementary students already have skills interpret the result of an experiment. The results can be seen in figure 3 below.

![Figure 3](image-url)

**Figure 3.** Test result based on the skill of interprets the result of an experiment.
In some of these questions, many students answered wrongly. In question 1 and 2, there are only 3 students can answer correctly. In question 3, there are 12 students can answer correctly. In question 4, there are 18 students can answer correctly. The results are supported by interview data showing that most students feel that question 1 and 2 is more difficult to answer that question 3 and 4. Hence, it can be said that the interpretation skills of the result of an experiment are comparatively low. Whereas, when the students absorb those concepts fine, it can benefit them in reasoning skills [14, 15].

3.2. Arguments analysis

Questions with this indicator will measure infer a correct statement from a given data set skill students. In this indicator there are 3 questions about the skill. The test results indicate that 50% of fourth-grade elementary students already have the skill of inferring a correct statement from a given data set. The results can be seen in figure 4 below.

![Figure 4](image)

**Figure 4.** Test result based on the skill of inferring a correct statement from a given data set.

In some of these questions, many students answered wrongly. In question 5, there are 7 students can answer correctly. In question 6, there are 13 students can answer correctly. In question 7, there are 19 students can answer correctly. Hence, it can be said that the interpretation skills of the result of an experiment are comparatively low. Most of the students say that they are already learning about this matter and say that question 5, 6, and 7, not a hard question. That can be happened when students not really understanding about magnetic properties. Many studies have discoursed students conceptual difficulties in understanding a magnetic force [16, 17].

3.3. Likelihood and uncertainly analysis

Questions with this indicator will measure predict the probability of event skill students. In this indicator there are 4 questions about the skill. The test results indicate that 18.26% of fourth-grade elementary students already have skills predict the probability of event. The results can be seen in figure 5 below.

![Figure 5](image)

**Figure 5.** Test result based on the skill of predicts the probability of event.
Based on that figure, many students answered wrongly. In question 8, there are 8 students can answer correctly. In question 9 and 10, there are just 2 students can answer correctly. In question 11, there are 7 students can answer correctly. Hence, it can be said that predict the probability of the event is comparatively very low. Based on the result of interview data, most of the students say that in question 8 quite difficult for them. Many students also roughly that in question 9 material have never been taught before. In question 10, most of the student say that the question not really hard to answer. In question 11, most of the students say that they did not know about the concept. So, it can be said that elementary school teachers need advanced behaviour in schools [18, 19].

3.4. Problem-solving and decision-making

Questions with this indicator will measure identify the best among a number of alternatives in solving problem skill students. In this indicator, there are 2 questions about the skill. The test results indicate that 71.15% of fourth-grade elementary students already have skills identify the best among a number of alternatives in solving problem skill students. The results can be seen in figure 6.

![Figure 6](image_url)

**Figure 6.** Test results based on the skill of identify the best among a number of alternatives in solving problems.

Based on that figure, many students answered wrongly. In question 12, all of students can answer correctly. Whereas in question 13, there are 11 students can answer correctly. Based on the result of interview data, most of the students say that question 12 is the easiest question to answer. Whereas, in question 13, they say “pretty hard to answer because they never had experience with it” or they never read the book which correlates with this topic. Hence, it can be said that identify the best among a number of alternatives in solving problems are good enough. Whereas, when the students absorb those concepts well, it can help them in problem solving skills [14, 20].

4. Conclusion

Many fourth-graders of elementary school still have critical thinking skills that can be said to be low, especially in magnetic force. It can be seen from the results of tests presenting that many students answer questions with wrong answers. If elementary school students have been introduced to the skills of critical thinking earlier, then the results achieved are supposed to be more optimal. Thus, it would be better if research on critical thinking at the elementary school level could be further developed by researchers.
Acknowledgments
Researchers acknowledged that throughout the process of this research inaugurate many difficulties. These difficulties will not be resolute without the support and reinforcement of some people. The researchers would like thank KEMENRISTEK DIKTI for a part of financial support through the HIBAH PUPT and also to everyone who has supposed a positive essence and reinforcement. These difficulties will not be resolute without the support and reinforcement of some people.

References
[1] Greiff S, Niepel C and Wustenberg S 2015 Thinking Skills and Creativity 18 1
[2] Zhao G, Wang D, Chen Q, Shen Y, Han W, Xiong Y and Jiang S 2017 Creative Education 8 9 1452
[3] Kettler T 2014 Gifted Child Quarterly 58 2 127
[4] Lourenço O M 2016 New Ideas in Psychology 40 123
[5] Seaman R L, Cannella M I, Brock M E and Dueker S A 2017 Critical Studies in Education 41 2 68
[6] Tiruneh D T, Cock M D, Weldeslassie A G, Elen J and Janssen R 2017 International Journal of Science Mathematics Education 15 4 663-682
[7] Tiruneh D T, Weldeslassie A G, Kassa A, Tefera Z, Cock M D and Elen J 2015 Educational Technology Research and Development 64 3 481
[8] Wijayanti M D, Raharjo S B, Saputro S and Mulyani S 2017 Journal of Physics: Conference Series 895 012036
[9] Preston C 2015 Research in Science Education 46 6 857
[10] Bradamante F and Viennot L 2007 International Journal of Science Education 29 3 349
[11] Skjoldager N D and Skjoldager N K 2017 Nordic Theatre Studies 29 2 137
[12] Baker B M and Saari A 2018 Discourse: Studies in the Cultural Politics of Education 39 2
[13] Aizikovitsh U E and Cheng D 2015 Creative Education 6 4 455
[14] Li J and Singh C 2016 European Journal of Physics 38 025702
[15] Ding L, Wei X and Liu X 2016 Research in Science Education 46 5 613
[16] Onorato P and Ambrosio A D 2013 Physics Education 48 766
[17] Kelly Y L K, Irene T H, Kit-Tai H and Eva C M L 2014 Instructional Science 42 2 251
[18] Thurlings M, Evers A T and Vermeulen M 2015 Review of Educational Research 85 3 430
[19] López V and Pintó R 2017 International Journal of Science Education 39 10 1353
[20] Özyurt Ö 2015 Eurasia Journal of Mathematics Science and Technology Education 11 2 353