

The Effect of Cognitive Ability on Science Literacy Ability in Grade 4 Elementary School Students

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Abstract

This research and development are motivated by the low cognitive ability of learners and followed by low levels of science literacy of science participants. The study's goal was to find out if there was a direct influence on students' cognitive and science literacy abilities. The method in this study is in the form of a test method with an ex-post-facto research design. This research has been done at Sumberagung State Elementary School Yogyakarta with 4th grade A research subjects totaling 32 students. A simple regression technique functioned to analyze the data inferentially. Through a simple regression test, the results of F count = 10,585 and p-value = 0.003 < 0.05 or Ho are rejected. Thus regression Y over X is a significant cognitive ability to affect a student's science literacy. The coefficient of determination obtained the value R Square = 0.274, which means that students' cognitive ability can influence 27.4% variation in the variable science literacy ability. At the same time, 72.6% of science literacy ability was affected by other variables that were not studied. Other factors can affect the science literacy ability of learners. The researcher hopes that further research can improve this research.

Abstrak

Penelitian dan pengembangan ini didorong oleh rendahnya kemampuan kognitif siswa dan rendahnya nilai literasi sains peserta didik. Tujuan dari penelitian ini adalah untuk mengetahui apakah kemampuan kognitif siswa berpengaruh langsung terhadap kemampuan literasi sains siswa. Metode dalam penelitian ini adalah metode tes dengan desain penelitian ex-post-facto. Penelitian ini dilaksanakan di SD Negeri Sumberagung Yogyakarta dengan subyek penelitian kelas 4 A yang berjumlah 32 siswa. Data yang telah dikumpulkan dianalisis inferensial menggunakan teknik regresi sederhana. Melalui uji regresi sederhana didapatkan hasil nilai Fhitung = 10.585 dan p-value = 0.003 < 0.05 atau Ho ditolak. Dengan demikian regresi Y atas X adalah signifikan atau kemampuan kognitif berpengaruh terhadap literasi sains siswa. Koefisien determinasi diperoleh nilai R Square = 0,274, yang berarti 27,4% varians variabel kemampuan literasi sains dipengaruhi oleh kemampuan kognitif siswa. Pada saat yang sama, 72,6% kemampuan literasi sains dipengaruhi oleh variabel lain yang belum diuji. Ada faktor lain yang mempengaruhi kemampuan literasi sains siswa. Hal ini dapat dipelajari untuk melengkapi penelitian ini.

³

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INTRODUCTION

Scientific literacy is one of the primary skills needed in the current digital era (Fakhriyah et al. 2017). We are currently facing the digital era in the 21st century. In the 21st century, science and technology are developing rapidly. In the digital age, various problems arise related to science and technology (De, Pandey, and Pal 2020). When solving the existing problems, it is necessary to empower each individual to decide to participate personally in public policy-making influence on the lives of individuals (Pirajad and Janssen 2019). At the same time, these problems are a challenge for education in the 21st century.

Scientific literacy is a skill used to understand and apply scientific concepts in solving scientific problems and problems that occur in real life (Primasari, Miarsyah, and Rusdi 2020). The importance of scientific literacy skills in the 21st century is because this ability can help individuals utilize the knowledge and skills to solve problems around them (Frydenberg and Andone 2011). Applying the knowledge and skills possessed can help individuals determine the steps to be taken when there is a problem (Darling-Hammond et al. 2020).

Scientific literacy is the ability to use knowledge, identify questions, and draw conclusions based on evidence to understand the surrounding environment (Chusni et al. 2020). This understanding makes natural decisions and changes through human activities (Windyariani and Amalia 2019). Literacy intends to identify its problems scientifically to find out the problem and determine attitudes and steps to be taken (Dragoş and Mih 2015). Individuals with scientific literacy skills generally identify issues and solve them in a scientifically responsible way.

Individuals with scientific literacy skills can solve problems using scientific concepts obtained in education based on their level (Adnan et al. 2021). Individuals will be able to recognize knowledge from the surrounding technology and its positive impact and use the knowledge they have. Creativity in creating useful new technologies is in this knowledge (Fakhriyah et al. 2017). The Program Internationale for Student Assessment evaluates abilities and expertise in several developed and developing countries, given the importance of scientific literacy.

The PISA assessment every three years began in 2000. The areas of research and research evaluation include reading literacy, mathematics literacy and scientific literacy (OECD 2019). The results of the PISA study from 2000 to 2015 show that Indonesia's ranking continues to increase. In 2015, the scientific literacy of Indonesian students ranked 69th among 76 countries with a score of 403 (OECD 2017). Although it has improved, it is still far below the international average score set by PISA.

The results of the annual survey in 2015, a test conducted on 15-year-old students in scientific literacy, Indonesia, obtained a score of 403. This score is low because it is still lower than the average score of 493 for all participating countries of the Organization for Economic Cooperation and Development. (OECD 2017). This score is because the questions used in PISA cover six cognitive aspects of cognitive processes (Farida 2016). Therefore, we know that the cognitive abilities of Indonesian students are still lower than the average level of other OECD countries.

The average score of Indonesia is still relatively low, reflecting that most students in Indonesia have not been able to analyze and apply knowledge concepts to solve problems. Several factors cause low scientific literacy in Indonesia, namely gender, economy and society, and immigration (Windyariani and Amalia 2019). Other factors that contribute to the standard scientific literacy of Indonesian students include an inappropriate selection of textbooks, wrong understanding, non-contextual learning, low reading skills, cognitive abilities, and an environment that is not conducive to learning (Fuadi et al. 2020).

Cognitive ability is one factor that influences an individual's level of scientific literacy (Howell and Brossard 2021). Cognitive ability is related to the mastery of science (Kruit et al. 2018). Cognitive abilities emphasize students' abilities in science in the form of facts, concepts, principles, and procedures. Students' cognitive abilities can be analyzed using tests containing cognitive questions. What learning steps will the teacher do next after analyzing students' cognitive abilities to find out students' thinking process abilities (Nabilah, Sitompul, and Hamdani 2020).

The thinking process of students is not directly observed based on their behavior. Still, their cognitive abilities can show from the type and quality of the response given when facing a problem or question (Pitriani, Widiyowati, and Usman 2019). Cognitive skills, according to Piaget, a person's cognitive abilities will continue to change along with interactions with other people and problem-solving efforts. When someone has succeeded in solving one problem, their success will use that success to solve different issues that are similar or at a more complicated level (Hanafi and Sumitro 2020).

Thus, the more often children interact with the surrounding environment, the more they encounter problems. Solving one issue will be used as a reference for solving other problems. In this case, cognitive development occurs according to the problem at hand. This cognitive development follows scientific literacy, that is, as a way of thinking, investigating, knowledge systems and interacting with technology and society. (Rosa et al. 2021).

Based on research conducted by Hanafi, cognitive development in children shows the result of the way children think. A measuring tool for children's cognitive development is the ability of a child to relate various ways of thinking in the context of solving a problem can (Hanafi and Sumitro 2020). Problem-solving as a measuring tool for cognitive abilities can act as if the use of cognitive abilities to solve problems scientifically or can be called scientific literacy.

Jufrida's research results explain that in science learning, which only relies on material memory, students have not been able to understand and master the concepts of science learning. This disability makes students' cognitive abilities decrease. This research states that the low cognitive ability affects students' scientific literacy, which also reduces (Jufrida et al. 2019).

Researchers suspect that students' cognitive abilities have a relationship or influence on scientific literacy skills, applying their knowledge to identify and solve problems in the surrounding environment. The purpose of this research is to determine whether students' cognitive abilities have a direct impact on students' scientific literacy skills.

METHODS

The method in this research is a test method with a post-mortem research design, because this research involves variables that have occurred and has nothing to do with the variables studied. The research was conducted at Sumberagung elementary school Yogyakarta. The research subjects were all fourth-grade students for 2021/2022, and the research sample was grade 4A students. This study uses the Windows program SPSS 24 for statistical analysis to use simple regression analysis to test the hypothesis.

The data analysis technique is the method used to prove the hypothesis. In this study, the data analysis technique used is inference analysis. The reasoning analysis used a simple regression technique. Research hypotheses about the relationship between variables X and Y using inferential statistics. Inferential statistics is a statistical technique used to analyze sample data. The results of the analysis will be generalized to the population.

Researchers also want to know how much cognitive ability affects students' scientific literacy. To determine the size of this effect, the researcher used SPSS 24 for Window to perform a simple regression test and analyze the size of R Square. the measurement test gives the results of the value of R square. Then match the number of R squares with the percentage of the effect of cognitive ability on scientific literacy.

FINDINGS AND DISCUSSION

Data Description

In the cognitive ability variable, data is obtained from the distribution of the frequency distribution and then statistically processed into frequency distribution data starting from the data on the number of classes, mean, median, and mode. The formula used is the Sturges formula ($K = 1 + 3.3 \log n$) thus obtained six classes with the lowest score of 60 and the highest score of 95, the mode value for the scientific approach variable is 80, while the median value is 75 and the mean value is 73.16. The standard deviation or standard deviation obtained is 9.14.

Meanwhile, for the scientific literacy variable, data is obtained from the distribution of the frequency distribution and then statistically processed into frequency distribution data starting from the data on the number of classes, mean, median, and mode. The formula used is the Sturges formula ($K = 1 + 3.3 \log n$) thus obtained six classes with the lowest score of 65 and the highest score of 95, the mode value for the scientific approach variable is 80, while the median value is 80 and the mean value is 79.34. The standard deviation or standard deviation obtained is 6.39.

Inferential Statistical Analysis Results

In the normality test of this study using the Kolmogorov-Smirnov, sig. Normality showed the result of cognitive ability 0.143, and scientific literacy showed the result of 0.020. cognitive ability and scientific literacy have a significance > 0.05 . All data proved normal so that the analysis could be proceeded. The significance value obtained by the linearity test is 0.304. If the linear value is greater than 0.05, it can be concluded that there is a significant linear relationship between cognitive ability variables and scientific literacy variables.

The regression test results can be presented in table 1 as follows.

Table 1. Simple regression test

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	325.529	1	325.529	10.585	.003b
Residual	861.138	28	30.755		
Total	1186.667	29			

a. Dependent Variable: scientific literacy

b. Predictors: (Constant), scientific literacy

Statistical hypothesis:

H₀: = 0 (meaningless regression)

H₁: ≠ 0 (regression means)

The simple regression test was obtained from the value of Fcount = 10.585 and p-value = 0.003 < 0.05 or H₀ was rejected. Thus the regression Y over X is significant or cognitive ability affects students' scientific literacy.

The test results prove that cognitive ability significantly influences students' scientific literacy. It can conclude that good cognitive abilities will most likely affect students with good scientific literacy. Students active in learning activities have a better experience and ability to utilize knowledge to develop cognitive abilities. Students actively respond and research many things to help master the problem or material when the learning process occurs. Students use their cognitive abilities to analyze and make decisions about using their knowledge in responding and utilizing this knowledge.

Table 2. Test of determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.524a	.274	.248	5.54571

a. Predictors: (Constant), scientific literacy

The judgment test results in Table 2 show that the judgment coefficient is R-squared = 0.274, which means that students' cognitive ability can affect the 27.4% variation of the variables of scientific literacy ability. At the same time, 72.6% of scientific literacy ability is affected by other untested variables.

Cognitive ability is the ability of students to master the cognitive domain. The cognitive domain based on Bloom's revised taxonomy includes behaviors that emphasize intelligence, such as knowledge and thinking skills, including memory, understanding, application, analysis, evaluation, and creation (Nabilah, Sitompul, and Hamdani 2020).

These cognitive abilities become the initial foundation for students to master other abilities (Susilowati P. J. 2018). Cognitive ability is a cumulative development. Cumulative development means

that mastered developments first will be the basis for further developments. Therefore, it will inhibit students' development of other abilities, hamper if cognitive development.

According to Piaget, a person with cognition behavior, namely the act of recognizing or thinking about the conditions. Therefore, the child's personality will be formed indirectly through the learning process, including a very complex thought process is a psychological event that encourages attitudes and behavior. Learning science can stimulate cognitive structures to develop reasoning abilities (Juwantara 2019). Therefore, the level of readiness of cognitive structures and developing reasoning abilities in learning science.

Cognitive development can affect scientific literacy is one of development. Scientific literacy is the ability to use science to solve problems in daily life to understand scientific concepts and processes (Sutrisna 2021). According to PISA (International Student Assessment Program), scientific literacy is the ability to apply scientific knowledge, discover problems, and draw conclusions based on scientific evidence to understand the changes caused by natural and human activities and make decisions (OECD 2017).

Various internal and external factors influence scientific literacy. Factors that influence scientific literacy include the selection of teaching materials, cognitive misconceptions, low reading skills, non-contextual learning, and the learning environment (Fuadi et al. 2020). Of these various factors, misconceptions have an important influence on students' scientific literacy skills. The misconception is an error or incompatibility of the concept with the scientific understanding accepted by experts (Yuliati 2017).

The reasons for the misunderstandings experienced by students can be from the students themselves. The stage of development of inconsistent perceptions of learning, students' reasoning limitations and errors, the ability of students to capture and understand concepts, apply what they have learned, students' interest in learning the concepts being taught (Nugroho, Utomo, and Hastuti 2019). Thus, students' low cognitive abilities can be one of the effects of misconceptions.

Students' cognitive abilities affect students' conceptual understanding abilities (Novitasari and Pujiastuti 2020). Good cognitive abilities will make it easier for students to understand their learning concepts. On the other hand, the low cognitive ability of students fails in understanding scientific concepts from the learning. Thus, understanding the concept of science as the initial basis for scientific literacy is influenced by students' cognitive abilities.

Scientific literacy is the ability to use knowledge to solve science-related problems (Kristyowati and Purwanto 2019). Adequate knowledge must exist in the process of utilizing knowledge. Sufficient knowledge comes from cognitive abilities that can accommodate knowledge cumulatively. Thus, students' cognitive abilities affect students' scientific literacy skills.

Therefore, to improve students' scientific literacy, it is necessary to increase student's cognitive abilities. Improving cognitive abilities can improve students' understanding of concepts (Kurino 2019). Improving cognitive abilities will be the basis for growing students' scientific literacy. To improve students' cognitive abilities, teachers need to analyze students' cognitive abilities.

Analyzing students' cognitive abilities is very helpful to understand the realization of learning outcomes and the level of realization of students' cognitive abilities (Nasution and Casmini 2020). Analyzing cognitive abilities is expected to help teachers understand the degree of cognitive ability and understanding of how high student achievement is. This analysis activity also makes it easier for teachers to improve students' cognitive abilities in finding solutions to achieve maximum student cognitive abilities.

To improve the quality of students, teachers can design learning in the classroom to improve cognitive abilities. Scientific learning must be balanced by asking assessment questions, encouraging students to develop thinking skills, and growing students' reasoning skills in certain situations (Gunawan, Suraya, and Tryanasari 2014). In addition, mastery of scientific material lies in thinking and thinking as a guide scientific assessment

CONCLUSION

Students' cognitive abilities affect students' scientific literacy skill. The cognitive ability affects the ability to understand the concept of the material they are studying. Scientific literacy is the ability to use knowledge in solving problems faced by students who require an understanding of the correct initial concepts. Using the correct concept of knowledge will result in good scientific literacy of students.

Author

In 21st-century life, scientific literacy skills will be necessary, and student learning activities should improve cognitive abilities and scientific. Teachers as facilitators in learning need to know ways to develop cognitive abilities to improve students' scientific literacy.

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