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Strategic Factors Skills for Solving Hots Science Questions for Batik Junior High School of Surakarta Grade 8th

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Abstract: This correlational quantitative research aims to examine the relationships among metacognition ability, literacy ability, and High Order Thinking Skills (HOTS) in Science problem-solving among eighth-grade students at Batik Surakarta Middle School in 2023. Utilizing a simple random sampling technique, 168 students were selected as the sample. Data on metacognitive abilities, literacy skills, and HOTS Science problem-solving skills were collected through questionnaires. The analysis employed multiple linear regression with SPSS 25. The findings indicate a positive and significant correlation between metacognition abilities and HOTS Science problem-solving skills (regression coefficient: 1.311, effective contribution: 78.9%, relative contribution: 81.1%). Additionally, there is a positive and significant relationship between literacy skills and HOTS Science problem-solving skills (regression coefficient: 0.192, effective contribution: 18.27%, relative contribution: 18.8%). Collectively, these two independent variables contributed 97% to the variance in HOTS Science problem-solving skills, while the remaining 3% was influenced by unexamined variables. This research emphasizes the importance of metacognition and literacy in enhancing students' HOTS Science problem-solving abilities

Keywords: HOTS; Literacy; Metacognition

Introduction

Learning is the process of acquiring knowledge, skills, and attitudes through interaction with the environment and through personal experience. Learning is an activity that occurs in interaction between individuals and their environment, either directly or indirectly. Apart from that, learning also involves the process of processing information, reflecting, and applying the knowledge gained in everyday life. Someone who carries out learning activities will experience changes in themselves. With these changes, the individual is said to have learned; the level of change is known as learning outcomes (Wahab & Rosnawati, 2021).

Learning outcomes basically reflect the transformation of individual behavior, which includes thinking abilities, emotions, and skills, after following a certain learning process. Learning outcomes show a positive improvement in conditions, which means providing benefits in terms of increasing knowledge, better understanding things that were not previously understood, developing skills, gaining a new perspective on something, and appreciating something more than before (Beddu, 2019).

Learning outcomes are divided into three aspects, namely cognitive, psychomotor, and affective. The cognitive aspect relates to a person's knowledge and understanding. The psychomotor aspect is related to the ability to act and the skills a person has. Meanwhile, the affective aspect is related to a person's character and attitude. Of these three aspects, the cognitive aspect is the main measure in assessing a person's success in the learning process. There are six indicators at the cognitive level developed by Benjamin Bloom and improved by Anderson. These six indicators include the ability to remember, understand, apply, synthesize, evaluate, and create (Magdalena et al., 2020; Febriyanti & Widjajanti, 2023).

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The Ministry of Education and Culture of the Republic of Indonesia encourages learning outcomes that focus on higher-order thinking skills through developing personal potential, literacy skills, and numeracy skills (Jihannita et al., 2023). Research titled "Analysis of Science Teachers' Understanding of High Order Thinking Skills (HOTS) and Their Implementation in Learning" The findings of this study suggest that, overall, the data obtained indicates a lack of understanding among teachers in the schools under investigation regarding Higher Order Thinking Skills (HOTS). Moreover, they are unable to articulate the definition of HOTS (Anggraeni & Sole, 2020; Ulfah et al., 2023).

High-level thinking processes are closely related to Bloom's Taxonomy. Bloom's Taxonomy contains dimensions of knowledge or cognitive processes achieved by students in the learning process. According to Bloom there are six levels of student thinking, namely remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). The thinking levels at C1, C2, and C3 are low-order thinking levels. Meanwhile, the thinking levels at C4, C5, and C6 are higher-order thinking levels (Masitoh, 2020; Wahyudi et al., 2022).

Higher-order thinking skills (HOTS) refer to higher-order thinking skills that go beyond the level of basic knowledge or understanding of information. HOTS involves students' abilities to analyze, evaluate, synthesize, solve problems, apply concepts, and use complex reasoning. HOTS focuses on critical, creative, and reflective thinking skills. Students with HOTS are able to connect, organize, and use the knowledge and information they learn to solve complex problems, formulate structured arguments, and generate new ideas (Masitoh et al., 2020; Hikmawati et al., 2021).

The results of interviews conducted by researchers with 8th grade Batik Surakarta Middle School students, as well as the results of solving HOTS-based science questions with vibration and wave material, indicate that students' ability to solve HOTS-based questions in science subjects with vibration and wave material independently is still limited. In its implementation, students still need guidance from the teacher to be able to solve this type of problem. Factors of difficulty experienced by students in solving these questions include a lack of in-depth understanding of the material and difficulty parsing sentences in the questions. This shows the need for analysis and research to find out specifically what factors influence high-level thinking processes.

A person's success in achieving learning outcomes in the cognitive aspect Each individual has different thinking abilities, so each student's cognitive learning level is not the same. Therefore, the cognitive learning outcomes achieved by each student as a learning subject will vary.

HOTS science problem-solving skills as part of science learning outcomes are influenced by two main components, namely internal conditions and external conditions. Internal conditions are everything that is inherent in students, such as motivation, interest, talent, intelligence, and so on. Other conditions are external. External conditions, in the context of formal learning, are the conditions of the learning environment and the learning process. The two conditions mentioned interact to form changes in behavior as a result of student learning. From the previous description, HOTS question-solving skills, the final component of learning launched by the Ministry of Education and Culture in the independent curriculum, are greatly influenced by internal and external conditions (Wahab & Rosnawati, 2021).

Slameto classifies the factors that influence the student learning process into two main types, namely internal and external factors. Clark (1981) in Sudjana (2005) explains that the proportion of each factor (internal and external) in learning is 70% influenced by students' abilities (internal) and 30% influenced by the external environment (Jusuf & Waremra, 2017).

It is known that internal factors are more dominant in determining learning outcomes. Several internal factors that influence learning outcomes are metacognition and intelligence abilities. Metacognitive ability is the awareness of thinking about what is known and what is not known. In the learning context, students know how to learn, know their abilities and learning modalities, and know the best learning strategies for effective learning (Reksiana et al., 2020). Flavel (1979) suggests that metacognition plays an important role in the learning process. Research entitled Analysis of the Relationship between Metacognitive Awareness and Mathematics and Science Learning Outcomes for High School Students in the City of Mataram found that metacognitive ability is an ability that contributes quite highly to achieving student learning outcomes. Students who have good metacognitive skills can find a cognitive style that suits their character so that they can complete the learning process well and have implications for optimal learning outcomes (Fitria et al., 2020).

Apart from metacognitive abilities, internal factors that play an important role in learning outcomes are intelligence factors. Intelligence is the ability to solve problems and create products that are useful for life. Intelligence can be classified into eight types. These eight types of intelligence are known in total in the theory of multiple intelligences. Gardner (1983) suggests that humans have at least eight types of intelligence, namely

verbal-linguistic, mathematical-logical, visual-spatial, kinesthetic, musical, intrapersonal, interpersonal, and naturalist intelligence. Of the eight types of intelligence, each individual only has a few that can be optimally developed (Ani Widyawati, 2021).

In relation to integrated science learning in junior high school, students are required to have the ability to study reading. The ability to study reading is often called literacy ability. Literacy skills are a fundamental ability for students who live in a globalized world. All countries in the world are always faced with problems in their lives that require scientific information and scientific thinking in making decisions that concern the interests of many people. The scientific literacy abilities inherent in a child can optimize their ability to reason and explain problems in their lives. The results of research entitled The relationship between scientific literacy abilities and science learning outcomes show that there is a close relationship between scientific literacy abilities and science learning outcomes (Nugraha, 2022; Anshar et al., 2023).

By knowing the types of abilities that are related to the student's learning process, improving the ability to solve HOTS questions as a result of student learning will be easier to achieve, namely by developing these abilities. Based on several references, researchers are interested in examining the relationship between metacognitive abilities, literacy abilities, and numeracy abilities and the ability to solve HOTS science questions in middle school. The verification of these variables was studied by stating the research title, namely Strategic Factors Skills for Solving Hots Science Questions for Batik Junior High School of Surakarta Grade 8.

Method

This research aims to evaluate the influence of metacognitive abilities and literacy abilities on HOTS (Higher Order Thinking Skills) problem-solving skills in science subjects. The research design used is correlational research, which will identify the relationship between the variables studied. The dependent variable consists of HOTS science problem-solving skills. The independent variables consist of metacognitive abilities and literacy abilities.

The research instruments used consisted of questionnaires and questions. Questionnaires are used to measure students' metacognitive and literacy abilities, while questions are used to measure HOTS problem-solving skills in science subjects. The validity of the instrument will be evaluated using the validity of the expert team and the validity of the question items. The validity of the expert team involves experts in related fields to assess the validity of the instrument as a whole, while the validity of the items measures the extent to which each item in the questionnaire and questions can measure the concept in question.

The population of this research is class VIII students of SMP Batik Surakarta for the 2023–2024 academic year with intermediate academic characteristics among junior high schools in Surakarta City. The population consists of 168 students, divided into six classes. The research sample was taken using a simple random sampling method using the formula from Surakhmad, with a minimum sample size of 79 students. Research data analysis was carried out using a multiple regression test with the help of the SPSS 25 application. The multiple regression test was used to identify the extent to which metacognition and literacy abilities can predict HOTS problem-solving skills in science subjects in class VIII students at SMP Batik Surakarta (Sutama, 2022).

Result and Discussion

Test Prerequisites

Before proceeding to hypothesis testing, researchers need to carry out prerequisite tests, which include normality tests, heteroscedasticity tests, and multicollinearity tests based on the three hypotheses proposed. The first prerequisite test is the normality test, which is carried out by checking the distribution of residual data. To determine whether the data is normally distributed or not, researchers used the Kolmogorov-Smirnov test. The results of the normality test can be seen from the significance value (sig.) in the Kolmogorov-Smirnov table. Data is considered normally distributed if the sig value is greater than 0.05, indicating that the residual data follows a normal distribution (Janie, 2012).

Researchers conducted a normality test using residual data in the SPSS program to ensure that the data used in the analysis was normally distributed. The results of the Kolmogorov-Smirnov test will provide an idea of whether the data used in this research meets the requirements for a normal distribution or not. In this way, researchers can ensure that the statistical analysis to be carried out is reliable and that the results can be interpreted accurately. Normality test results can be seen in table 1.

Based on the table 1, the first unstandardized residual is data between numeracy literacy and critical thinking abilities; the second unstandardized residual is data between numeracy literacy and creative thinking abilities; and the third unstandardized residual is data between critical thinking abilities and creative thinking abilities. Then, each value is significant on the asymptote. Sig. (2-tailed) is 0.200; 0.200; and 0.200. This

shows that the sig value is > 0.05. Therefore, each residual piece of data is normally distributed.

Table 1. Normality Test with Kolmogorov-Smirnov SPS Test

One-Sample Kolmogorov-Smirnov Test				
		Metakognition	Literacy	HOTS
N		84	84	84
Normal Parameters[a,b]	Mean	129.38	27.62	53.93
	Std. Deviation	13.920	10.196	22.321
Most Extreme Differences	Absolute	.064	.080	.084
	Positive	.061	.080	.084
	Negative	-.064	-.076	-.050
Test Statistic		.064	.080	.084
Asymp. Sig. (2-tailed)		.200[c,d]	.200[c,d]	.200[c,d]

The second prerequisite test is the hetroskedasticity test. The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from the residuals of one observation to another. Heteroskedasticity does not occur if there is no clear pattern in the scatterplot and the points are spread above and below the number 0 on the Y axis (Basuki, 2015). The following are the results of the heteroscedasticity test using SPSS 25.

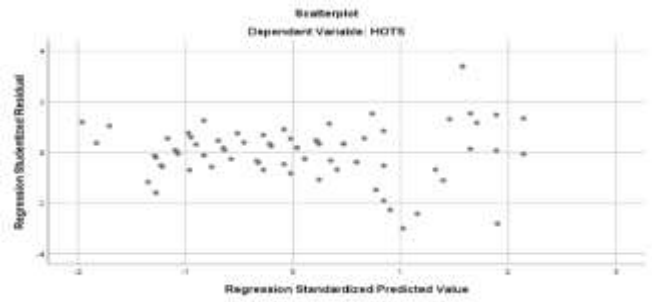

Figure 1. Heteroscedasticity test

From the graph above, it can be seen that the scatterplot does not have a clear pattern; the points are spread above the number 0 and below the number 0. So it can be concluded that there are no symptoms of heteroscedasticity.

Table 2. Multicollinearity Test Results

Coefficients[a]						
					Collinearity Statistics	
Model		B			Tolerance	VIF
1	(Constant)	-127.087	-14.094	.000		
	Metakognition	1.311	14.254	.000	.105	9.564
	Literacy	.395	3.420	.001	.105	9.564

a. Dependent Variable: HOTS

The third prerequisite test is the multicollinearity test. The multicollinearity test is a linear relationship between independent variables in multiple regression. The multicollinearity test is intended to show the relationship or correlation between each variable. Multicollinearity does not occur if the VIF value is < 10 or the tolerance value is > 0.1 (Suyono, 2018). The following are the results of the multicollinearity test using SPSS 25.

Based on the table 2, it is known that the VIF value < 10 is 9.564 and the tolerance value > 0.1 is 0.105, so it can be concluded that the data does not experience multicollinearity.

Hypothesis Testing

Hypothesis testing through multiple linear regression testing using SPSS obtained the following data:

Table 3. Regression Test Results

Model		Unstandardized Coefficients B	Std. Error	Beta	t	Sig.
1	(Constant)	-127.087	9.017		-14.094	.000
	Literacy	.395	.116	.192	3.420	.001
	Metacognition	1.311	.092	.802	14.254	.000

a. Dependent Variable: HOTS

Based on the results of the first hypothesis test, the price of B is a regression coefficient of 1.311 with a ρ value of 0.000 (< 0.05) from the regression equation Y= -127.08+1.31X1+0.39X2. A positive regression coefficient indicates a positive correlation between abilities. metacognition with HOTS science problem-solving skills; from the ρ value, it can be seen that the correlation is significant. This means that there is a real difference between increasing or decreasing metacognitive abilities and increasing or decreasing HOTS Science problem-solving skills by 1,311. This can be interpreted as meaning that the higher the metacognitive abilities possessed by students, the higher the students' skills in solving HOTS science questions. Vice versa, the lower the students' metacognitive abilities, the lower the students' skills in solving HOTS science questions. These results are in line with the results of research entitled Analysis of the Relationship between Metacognitive Awareness and Mathematics and Science Learning Outcomes for High School Students in the City of Mataram, which found that metacognitive ability is an ability that contributes quite highly to achieving student learning outcomes. Students who have good metacognitive skills can find a cognitive style that suits their character so that they can complete the learning process well and have implications for optimal learning outcomes (Fitria et al., 2020).

Based on the results of the analysis, metacognitive abilities have a positive and significant relationship with

the HOTS science problem-solving skills of Batik Surakarta Middle School students in 2023–2024. The relationship between metacognitive abilities and HOTS problem-solving skills is a direct one. This relationship shows that metacognitive abilities have an important role in optimizing HOTS Science problem-solving skills, where metacognitive abilities enable students to overcome problems effectively through careful planning, in-depth understanding of the problem, and careful assessment of the solutions taken. This process involves the ability to formulate problems in a structured manner, set clear goals, and choose appropriate methods to achieve them, allowing students to hone holistic problem-solving skills. By integrating these steps of metacognition, students can develop critical skills that are essential to learning (Khairinaa et al., 2023). In the research, it is known that the relative contribution among other independent variables is 81% and the effective contribution among all variables that influence learning outcomes is 78%.

Based on the results of the second hypothesis test, the value of B is a regression coefficient of 0.395 with a ρ value of 0.001 (< 0.05) from the regression equation $\hat{Y}$= -127.087 + 1.311X1 + 0.395X2. A positive regression coefficient indicates a positive correlation between abilities. literacy with HOTS science problem-solving skills; from the ρ value, it can be seen that the correlation is significant. This means that there is a real difference between increasing or decreasing literacy skills and increasing or decreasing HOTS science question-solving skills by 1,311. This can be interpreted as meaning that the higher the metacognitive abilities possessed by students, the higher the students' skills in solving HOTS science questions. Vice versa, the lower the literacy skills possessed by students, the lower the students' skills in solving HOTS science questions. These results are in line with the results of research entitled The relationship between scientific literacy abilities and science learning outcomes, showing that there is a close relationship between scientific literacy abilities and science learning outcomes (Nugraha, 2022).

Based on the results of the analysis, literacy skills have a positive and significant relationship with the HOTS science problem-solving skills of Batik Surakarta Middle School students in 2023–2024. The relationship between literacy skills and HOTS problem-solving skills is a direct one. This relationship shows that literacy skills have an important role in optimizing HOTS science problem-solving skills. Through scientific literacy, children can develop their critical abilities to analyze information, understand natural phenomena, and formulate deep questions. Scientific literacy equips them with critical thinking tools that enable them to solve complex problems, make informed decisions, and identify possible solutions. By having a strong understanding of science, children can apply their knowledge in everyday life, solve problems, and plan actions based on scientific evidence. Therefore, scientific literacy skills are not just academic skills but are also an important foundation for the development of children's analytical and critical thinking abilities, which are very relevant to the context of their lives (Seprianto & Hasby, 2023).

In the research, it is known that the relative contribution among other independent variables is 18.8%, and the effective contribution among all variables that influence learning outcomes is 18.27%.

The multiple regression test was jointly declared significant with a ρ value of 0.000 <0.05 and obtained a coefficient of determination of 0.97. This shows that metacognition and literacy abilities contribute 97% to teacher satisfaction, while the remaining 3% is influenced by factors other than those not included in the study. The relative contribution for each variable is 80% for metacognition abilities and 18.8% for literacy abilities. This shows that metacognitive abilities have the greatest contribution to HOTS science problem-solving skills compared to the contribution of the literacy ability variable. This means that metacognition skills have an important role in optimizing HOTS Science problem-solving skills. With good metacognition skills, students are able to understand how to learn and optimize their abilities.

Based on previous research, there is a profound understanding of the factors influencing students' skills in solving Higher Order Thinking Skills (HOTS) science problems. This study indicates that metacognitive ability has a significant contribution to the achievement of HOTS science skills, greater than other independent variables. The findings of Yuriza et al. (2018) affirm a positive relationship between high-order thinking skills and science literacy skills in junior high school students. Similarly, Puji Astuti (2018) research highlights the close connection between mathematical literacy and high-order thinking skills.

Another study by Limbach emphasizes the crucial role of teachers in enhancing students' high-order thinking skills, particularly through stimulating questioning techniques to develop HOTS about the environment (Nisa et al., 2018). In the context of literacy and numeracy skills, Syahputra (2019) research reveals that students face difficulties in responding to HOTS questions due to a lack of memory/understanding of facts, comprehension of concepts, and understanding of principles.

Regarding metacognition, Ismayati et al. (2020) found that students with high Self-Regulated Learning (SRL) levels demonstrate effective metacognitive use in

formulating strategies and monitoring actions, while students with low SRL are still unable to optimize the application of metacognition.

The results of Faiziyah et al. (2022) research provide an understanding that students' metacognitive levels can influence their ability to apply critical thinking, especially in solving HOTS tasks that demand high-level analysis and problem-solving. Additionally, Dwi Ningsih (2023) study shows that students' metacognitive levels can affect their ability to answer comparison HOTS questions.

Conclusion

The study concludes that a positive and significant relationship exists between metacognitive abilities and HOTS Science problem-solving skills, as evidenced by a regression coefficient of 1.311, an effective contribution of 78.9%, and a relative contribution of 81.1%. Similarly, there is a positive and significant relationship between literacy skills and HOTS science problem-solving skills, indicated by a regression coefficient of 0.192, an effective contribution of 18.27%, and a relative contribution of 18.8%. Collectively, the two independent variables contribute 97% to the variation in HOTS Science problem-solving skills, while the remaining 3% is influenced by unexamined variables not included in the research.

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Author Contributions
The authors provide an equal contribution to this work. Conceptualization, I, B, S.; methodology, I, B, S.; validation, B, S..; formal analysis,I, B, S.; investigation, A, S; writing—original draft preparation, I.; writing—review and editing, B, S. All authors have read and agreed to the published version of the manuscript.

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