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Metacognitive, Critical Thinking, and Concept Understanding of Motion Systems: A Correlational Study

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ABSTRACT

Metacognition skills (MS) is an individual's ability to evaluate and regulate his own thinking. Critical thinking skills (CTS) is the ability to apply the knowledge to solve problems, evaluate information, and make solutions. Conceptual understanding (CU) refers to an integrated and functional understanding of scientific knowledge. This study aims to analyze the correlation between MS and CU on motion system; CTS and CU; and MS and CTS. This research was conducted at Public High School (PHS) 3 Bekasi in February – March 2021 by involving a sample of 110 students of Grade 11 Mathematics and Science Class, who were selected through simple random sampling technique. The instrument used were the essay test, and a multiple-choice test distributed online. The research method is descriptive method with correlational studies. The results show that there is a positive relationship between MS and CU on Motion System with a correlation of 0.967; CTS and CU with a correlation of 0.431; and MS and CTS with a correlation of 0.978.

Keywords: 21st Century Skills, Metacognition, Biology Concepts, Thinking Skills, Human Body Systems

Introduction

The 21st century is characterized by developments information and communication technology has accelerated global competition and has a significant impact on great for education. This development led to students must have skills such as information, media, and technology skills; communication and collaboration skills; as well as critical thinking and problem-solving skills so that can be successful in life and at work (Pheeraphan, 2013). Students who have knowledge and skills in dealing with change will be able to adapt to changing situations where in this case 21st century skills will be able help a person learn and adapt to changes that occur all the time (Ongardwanich et al.,2015). These skills emphasize that students can apply technology through literacy digital, creative, and critical in the thought process, and possess excellent interpersonal and social skills good.

Education is a process of developing the thinking intelligence of students so that they are ready to compete in the era of advanced knowledge. One of skills that must be developed in education is a thinking skill (Putri et al., 2018). Thinking skills not only requires ability remembering but also need other abilities higher levels such as analysis, synthesis, and evaluation (Yuriza et al., 2018). Therefore, skills thinking is associated with the learning process because there is close relationship between thinking and learning skills (Yee et al., 2015).

Education can push students ready to compete by increasing intelligence, the ability to reason, creativity, and critical thinking. Education does not only contribute to shaping knowledge, skills, and attitudes but can also directing students to increase their curiosity, thus helping students in obtaining deeper understanding of knowledge.

Biology is one of the subjects with extensive study and requires detailed delivery appropriate in learning (Hardianti et al., 2014). Students perceive biology as a difficult subject and requires the ability to memorize because of the many foreign terms used and the breadth of material coverage discussed (Nisa et al., 2015). Biology has complex concepts and problems that must be studied so that the solution in biology too requires a good understanding of concepts especially when dealing with materials with high difficulty and complex (Raida, 2018). Biology has concepts concept that is difficult to understand, one of which is due to there are many sequences of processes, mechanisms, or stages that dynamic, as well as foreign vocabulary that makes students have difficulty imagining the material being studied (Tasyari et al., 2021). One of them is like in material about systems in the human body. Understanding human body systems requires correlation structure with function, but in learning between structure and function it is not seen directly and is often explained in a very complex (Mathai & Ramadas, 2009). One of the materials from the human body system is a movement system. Movement system is matter of biology that describes the skeleton, bones, muscles, joints, and disturbances in the human movement system that is taught at the high school level in grade 11 of odd semester.

Based on the results of observations on student learning outcomes of PHS 3 Bekasi in the Final Semester Assessment of the 2020/ 2021 academic year, the percentage of students' incompleteness in biology grade 10 was 47.30% with minimum completeness criteria (KKM) is 70. Low cognitive understanding of students may occur due to lack of role active students in the learning process. Student's curiosities are very low and most of students will not ask if they are not required asked by the teacher. Students only receive explanation from the teacher without trying to dig deeper. So, the question that arises is only a question that have been discussed or questions that have the answer listed in the teaching materials. On the other hand, the teacher too rarely gives a problem to be analyzed or evaluated, so that students feel surprised and have difficulties to solve the higher order thinking problems (Hadi et al., 2018).

Critical thinking skills are one of the higher orders thinking skills that need to be mastered by students to allow students do analysis, evaluation, and solving the problem innovatively (Ichsan et al., 2019). Critical thinking skills defined as a set of abilities or cognitive skills related to logical analysis and evaluation of arguments (Stupnisky et al., 2008). Critical thinking is one of the important competencies on helping students in transferring knowledge and apply problem solving skills (Rini et al al., 2020). Critical thinking is seen as an ability which can critically reflect on personal experience. Critical thinking is not about conclusions achieved by students but concerns how the process that students go through to reach that conclusion. Critical thinking skills are important to have because they are related to with how the student's thinking process solve an existing problem. Critical thinking can easily be done by someone who have a character as a critical thinker.

Ability to use thinking processes critically will allow students to see several different opinions or the similar ones. Students who apply critical thinking skills will be responsible for their own opinions (Pintrich, 2004). In applying of critical thinking skills, students will go through several thinking processes such as: analyze information from observations, experiences, and reasoning to be able to decide, and give accurate and reasonable results or conclusions. Through the critical thinking skills, students will actively form and build knowledge and understanding his own cognitive abilities then apply it to solve a problem.

Metacognitive refers to thinking skills high level involving active control of the process cognition in learning (Kozikoğlu, 2019). Students must be actively involved in the process of learning, such as being able to plan, monitor, regulate, and control cognitive procedures. Metacognition is related to the development of thinking critically and is an important aspect in improving cognitive abilities. Students also need metacognitive to improve thinking skills and problem solving. Therefore, metacognitive related to students' critical thinking and cognitive development, especially in concept understanding. Application of metacognitive and good critical thinking is to use the ability higher order thinking and dealing with cognitive ability in understanding the material studied.

Previous research by Miharja et al. (2019) with the research population is fourth semester students State Universities, information obtained that metacognitive skills and critical thinking positively correlated with cognitive learning outcomes on genetic material. Based on the research, there is an equation from the use of critical thinking variables, metacognitive, and cognitive learning outcomes. While the difference is that in this study the population of the study were students of Grade 11 of public high school, with learning outcomes seen from the understanding of students' concepts, and from the material used. Therefore, researchers try to search about the relationship between metacognitive skills and critical thinking skills with students' understanding of concepts using the subject of the motion system, through literature review.

Methods

Research Design

This research is descriptive research with a correlational study, in which a test aims to measure the degree of relationship between variables (John, 2008). The variables studied consisted of three variables, there are metacognitive skills (X1) and critical thinking (X2) as predictor variables and understanding of motion system concepts as criterion variables (Y). The research design used is designed in Figure 1.

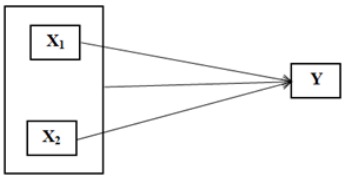

FIGURE 1. Research design relationship of metacognitive skills (X1) and critical thinking (X2) with understanding the concept of motion systems (Y)

Population and Sample

The population and sampling were selected through multi stages of random sampling with the target population being all students of PHS in Kota Bekasi and then using a purposive sampling technique to select PHS in West Bekasi. Furthermore, by cluster random sampling, PHS 3 Kota Bekasi was selected from all public high schools in West Bekasi. Sampling through cluster random sampling technique selected 114 students of Grade 11 Math-Science (MIPA) as respondents and through simple random sampling technique, 110 students of Grade 11 of MIPA were selected as research samples.

Research Instrument

This research uses two instruments: essay test and multiple-choices test. The essay test was used for critical thinking and metacognitive variables integrated with the critical thinking essay test for motion system material where the number of questions on the instrument is 10 questions. Assessment of metacognitive skills was then assessed using the assessment rubric by Corebima (2009) while critical thinking skills were assessed using the assessment rubric of Finken and Ennis (1993). The instrument consists of six dimensions with indicators (Facione, 2011) namely interpretation (Identifying a problem), analysis (Identify and analyze arguments), evaluation (Consider the credibility of statements; Make observations and make judgments), inference (Identify available evidence to draw conclusions), explanation (Define terms and consider definitions; Explain assumptions), and self-regulation (Determine an action to be taken).

The multiple-choice test instrument for the motion system material is used for the variable understanding of the concept from motion system where the number of questions on the instrument is 20 questions. The instrument consists of seven dimensions with indicators (Anderson et al., 2001) namely interpreting (explaining, paraphrasing, or interpreting information according to their own opinion), exemplifying (giving certain examples or illustrations of a concept), classifying (categorizing, classifying, or determine something falls into a certain category), summarize (summarize or generalize a general thing), conclude (draw conclusions from the information presented), compare (integrate two or more things to detect differences or similarities), and explain (describe the meaning of something clearly).

The validity test for metacognitive and critical thinking skills essay tests using Pearson Product Moment at a significance level of = 0.05 and Cronbach's Alpha reliability test at a significance level of = 0.05. While the validity test of multiple-choice questions for understanding concepts in the motion system uses the Biserial Point formula at a significance level of = 0.05 and the reliability test uses Kuder Richadson 20 (KR-20) with a significance level of = 0.05. The validity test for the essay test instrument with SPSS version 25 showed that of the 10 items tested, there were 9 valid questions and 1 invalid item with details in Table 1.

Table 1. Validity Test for Essay Test Question Instruments

No.	Result	No	Result
1	VALID	6	VALID
2	VALID	7	VALID
3	VALID	8	INVALID
4	VALID	9	VALID
5	VALID	10	VALID

While the results of the reliability test of the essay test items showed that the motion system essay test instrument was declared reliable as listed in Table 2.

Table 2. Reliability Test for Essay Test Instruments

Cronbach's Alpha	N of Items
0.584	9

The validity test for the instrument for multiple-choice test questions with SPSS version 25 showed that from the 20 tested items there were 14 valid items and 6 invalid items with details in Table 3.

Table 3. Validity Test for Multiple Choice Test Instruments

No	Validity	No	Validity
1	VALID	11	VALID
2	VALID	12	INVALID
3	VALID	13	VALID
4	INVALID	14	VALID
5	VALID	15	VALID
6	VALID	16	VALID
7	INVALID	17	VALID
8	VALID	18	INVALID
9	VALID	19	INVALID
10	VALID	20	INVALID

While the results of the reliability test of the multiple-choice test items showed that the multiple-choice test items were declared reliable as listed in Table 4.

Tabel 4. Reliability Test for Multiple Choice Question Instruments

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.780	0.816	14

Data Analysis Technique

Data analysis techniques used in this study using descriptive analysis techniques with SPSS version 25 include the calculation of the minimum score, maximum score, mean, and standard deviation of each variable. The prerequisite test was in the form of normality test using the Kolmogorov-Sminov test (α = 0.05) and homogeneity test using the Bartlett test (α = 0.05). Furthermore, multiple regression correlation test was performed with = 0.05 and correlation test using Pearson Product Moment (α = 0.05) to determine the level of correlation or relationship.

Result and Discussion

Result

The results showed that there were six categories of metacognitive skills in students (Corebima, 2009), namely: criteria Naive as much as 0%, at risk as much as 2%, fair as 17%, satisfied as much as 19%, good as much as 60%, excellent as much as 2 % with details as in Table 5.

Table 5. Interpretation of Metacognitive Skills Score

No	Score Range	Category	Total Student	Percentage (%)
1	0-16	Naive	0	0
2	17-33	At risk	2	2
3	34-50	Fair	19	17
4	51-67	Satisfied	21	19
5	68-84	Good	66	60
6	85-100	Excellent	2	2

The results showed that there were six dimensions of critical thinking skills with the percentage of achievement, namely the interpretation dimension 74%, the analysis dimension 81%, the evaluation dimension 82%, the inference dimension 83%, the explanation dimension 83%, and the self-regulation dimension 78% with details as in Table 6.

Table 6. Interpretation of Critical Thinking Skills Score

No	Dimension	Total Valid Item	Student Score	Max Score	Percentage (%)
1	Interpretation	1	405	550	74
2	Analysis	1	448	550	81
3	Evaluation	2	905	1100	82
4	Inference	1	454	550	83
5	Explanation	2	910	1100	83
6	Self-regulation	2	855	1100	78

The results showed that there were five categories of understanding the concept of movement systems in students (Arikunto, 2010), namely: very poor criteria as much as 1%, poor as much as 1%, fair as much as 21%, good as much as 17%, very good as much as 60 %with details as in Table 7.

Tabel 7. Interpretation of Scores from Understanding the Concept of Movement System

No	Score Range	Category	Total Student	Percentage (%)
1	0-39	Very poor	1	1
2	40-55	Poor	1	1
3	56-65	Fair	23	21
4	66-79	Good	19	17
5	80-100	Very Good	66	60

Analysis Prerequisite Test

The normality test was carried out using the Kolmogorov-Smirnov (KS) test while the homogeneity test was carried out by the Bartlett test at level = 0.05 using SPSS version 25. Based on the results of the KS test and Bartlett test, it was found that the data were normally distributed and had the same or homogeneous variance as shown in Table 8.

Table 8. KS Normality Test and Bartlett Homogeneity Test

Type of Test	α	Significance	Result
Uji KS	0.05	0,200	Normal distribution
Uji Bartlett	0.05	0,000	Have the same variances

Hypothesis Testing

The results of the calculation of the multiple linear regression model of metacognitive skills (X1) and critical thinking (X2) with understanding the concept of the motion system (Y) obtained constant a = 31.741, regression coefficient b = 1.177, and regression coefficient c = 0.348. Thus, the simple linear regression model is = 31.741 + 1.177X1 + 0.348X2. This means that for every addition of one value of metacognitive skills (X1), the level of understanding of the concept of the movement system (Y) of students increases by 1.177 and for every addition of one value of critical thinking skills (X2), the level of understanding of the concept of the movement system (Y) of students increases. of 0.348. Based on calculations using SPSS version 25 obtained a positive relationship between metacognitive skills (X1) and critical thinking with understanding the concept of the motion system (Y) with a correlation coefficient of 0.978 which includes very strong criteria and the contribution value of metacognitive skills (X1) and critical thinking (X2) together on the understanding of the concept of the motion system (Y) of 95.7% where based on the results of the simple correlation regression test of each predictor variable it was found that the contribution of metacognitive skills (X1) to the understanding of the concept of the motion system (Y) was 92.5 % and the contribution of critical thinking skills (X2) and understanding of motion system concepts (Y) is 18.5%.

Discussion

Based on the results of the study, there is a positive relationship between metacognitive skills and understanding motion system concept. This positive relationship shows that the higher the level of metacognitive skills possessed, the understanding of the concept of the movement system of students is also higher. This is in accordance with the results of previous studies which showed that there was a significant relationship with a strong correlation between students' metacognition and conceptual understanding (Saputri et al., 2019).

Students with a high level of metacognitive skills will have cognitive learning outcomes, one of which is indicated by a higher concept understanding when compared to students with a lower level of metacognitive skills. This is in accordance with research by Kristanti (2015) which states that there is a relationship between metacognitive skills and cognitive learning outcomes of students with a strong correlation category. Other research also shows a positive relationship between metacognitive skills and understanding of biological concepts where the increase in metacognitive skills is followed by concept understanding (Basith et al., 2014).

Education in the 21st century requires students to be able to access their understanding accurately (Miller, 2017). Metacognition is one of the important skills for students to have because it is a higher thinking process by involving active control of students' cognitive processes such as planning, predicting, testing, perfecting, checking and evaluating so that metacognition can reflect students' understanding of what is being though (Yusnaeni et al., 2020). The use of metacognitive skills makes students aware of their weaknesses and strengths in learning so they can know what should be done and monitor the actions that have been taken.

Metacognitive skills are skills that are considered valuable for students to have (Bae & Kwon, 2019). The use of metacognitive skills is not limited during the learning process but can also be used in everyday life which makes students become independent individuals, for example, such as making personal summaries, trying suitable learning strategies, being more flexible in accepting and processing an idea. Activities that lead to metacognition will improve student learning outcomes (Fouché, 2011).

The correlation coefficient obtained based on the tests carried out was 0.962 ($\alpha = 0.05$) with a correlation interpretation, which means that the relationship between metacognitive skills and understanding of the movement system concepts of students is categorized as very strong. This very strong relationship shows that high metacognitive skills are associated with high cognitive learning outcomes of students. These results agree with Yusnaeni et al. (2020) revealed that metacognitive skills play an important role in improving student learning outcomes.

Based on Table 5, the results of the study show that of the 110 research samples, 2% are included in the at-risk category, which means that students do not have awareness as a process, while 17% are in the not really category, namely students are unable to separate what can be thought and how. he thought. The low level of metacognitive skills is caused by the lack of students training themselves in solving a problem because the more often they are trained, the higher their metacognitive skills will be. Metacognitive skills that are used well will make students able to solve problems well, on the contrary if they are not used properly they will be less able to solve problems properly (Nurhayati et al., 2017).

There are 19% of students in the developing category, which means that if there is encouragement and support, students can go to their own thinking awareness. Then the other 60% are categorized as ok, which means that students are aware of their own thinking and can distinguish the stages of input, elaboration, and output of their thoughts. Students also often use models to organize their own thinking and learning. Meanwhile, only 2% of students are included in the super category, which means that students have used metacognitive skills regularly to

regulate their own thinking and learning processes. Students are aware of and can also use well the various possibilities of thinking and reflecting on their thinking processes. Differences in the level of metacognitive skills in students can be caused by several factors such as learning strategies, learning environment, and motivation. In addition, age and experience are considered to have a strong contribution to differences in the level of students' metacognitive skills (Anderson, 2002).

Metacognitive skills contributed 92.5% to students' understanding of the movement system concept while 7.5% was caused by other factors. Based on previous research, one of the other factors that might contribute to learning outcomes is self-concept which has a contribution value of 30.5% (Rodiah et al., 2020). These results are supported by previous research which states that the contribution of metacognitive skills to learning outcomes is 54.9% (Kristiani, 2015) and research by Basith et al (2014) which states that metacognitive skills contribute 54.2% to understanding biological concepts.

Based on the results of the study, there is a positive relationship between critical thinking skills and understanding the concept of the motion system. Previous research stated that there is a positive correlation between critical thinking and student learning outcomes (Annisa et al., 2020). This positive relationship shows that the higher the level of metacognitive skills possessed, the understanding of the concept of the movement system of students is also higher. It further means that increasing critical thinking skills will improve student learning outcomes (Shobirin et al., 2019). Critical thinking skills can be used by students to understand and apply concepts so that conceptual understanding can be achieved (Wulandari, 2018).

Critical thinking skills are the process of using cognitive abilities or strategies that can increase the acquisition of the goals to be achieved. It also includes the process of solving problems, formulating influencing factors, calculating various possibilities, and drawing a decision (Halpern, 2013). The use of critical thinking is one of the skills that globally is the goal of education in the learning process, so it is important for teachers and students to have.

The use of critical thinking skills is an effective way for students to improve their understanding of concepts (Chukwuyenum, 2013). Learners can gain knowledge through the discovery process from a variety of existing information so that it involves students in understanding the material and concepts more clearly. From the knowledge gained and then applied in new contexts related to daily live, it can strengthen the understanding of the concepts of the material that has been studied (Çepni et al., 2017).

The correlation coefficient obtained based on the test is 0.431 ($\alpha = 0.05$) with the interpretation of correlation which means the relationship between critical thinking skills and understanding of the movement system concept of students is categorized as fair, while the contribution value of critical thinking skills to understanding the concept of the movement system is 18.5%. This result is far enough when compared with the research of Shobirin et al. (2019) which shows that critical thinking skills are correlated with student learning outcomes with a value of 0.753 or categorized as strong with a contribution value of 56.8%. Other research also states that critical thinking skills contribute to learning outcomes by 73.9% with a correlation value of 0.860 or categorized as very strong. (Mite & Corebima, 2017).

The contribution of critical thinking skills to understanding concepts is quite low when compared to this other research. One of them is caused by students who are not accustomed to using their thinking skills because they rarely face questions in a description format that require higher order thinking skills in solving them (Lestari et al., 2019). Teachers who taught biology in this research more often gave multiple choice questions when carrying out daily tests with a fairly low level of difficulty. As a result, students feel surprised when faced with questions that are

analyzing or evaluating a problem (Fauzi, 2019). Other research also shows that Indonesian students have difficulty in solving higher order thinking questions (Hadi et al., 2018). This condition is caused by the lack of opportunities for students to be able to answer these questions in the learning process (Netri et al., 2018) (Netri et al., 2018).

Based on Table 6, the achievement of the lowest interpretation dimension compared to other dimensions, which is 74%, implies that students are still less than optimal in understanding and interpreting the meaning of the problem in the given question. Previous research stated that students have not been able to understand the questions well because they are not familiar with the problems given (Piatek-Jimenez, 2010). Students are accustomed to working on questions with a fairly low level of difficulty so that when faced with questions that require high thinking skills, they have difficulty understanding the meaning of the questions given. Interpretation is the ability to understand and identify problems which can also be interpreted as conveying understanding (Nolan, 2005). This means that students are also not able to convey and explain their understanding well.

The self-regulation dimension obtained a result of 78%. Students with good self-regulation will be able to solve problems appropriately and determine an action to be taken when receiving information (Nuri et al., 2019). This dimension has the second lowest achievement after the interpretation dimension. Based on the results of the study, students have difficulty in analyzing problems because they have not been able to connect biological concepts that are relevant to their daily lives. Students tend to be less concerned about observing events around them, even though knowledge will be easier to understand when students feel involved in it either in the form of personal experience or other people known (Utami et al., 2018). The achievement of the self-regulation dimension which is lower than other dimensions indicates that students have not been able to apply the skills of analyzing and evaluating results well, so that the ability to control themselves in dealing with problems becomes less. (Rizky et al., 2020).

The next dimension is the analysis dimension, which is the ability of students to analyze problems, information or events obtained (ŽivkoviĿ, 2016). The results showed that the dimension of the analysis obtained a high percentage of achievement, which was 81%. Analysis is the skill of students in reviewing assumptions, ideas, classifying, distinguishing, and detecting and analyzing an argument (Omar et al., 2012). In addition, students must be able to make arguments based on theories that are relevant to their problem-solving abilities (Alfonso, 2015). This percentage of achievement shows that students have been able to use reasoning or evidence to convey their arguments and opinions supported by general concepts, although not in detail. Students can identify the meaning of the question and then express their opinion in the form of a reasonable argument.

The evaluation dimension achieved 1% higher than the analysis dimension, which was 82%. Evaluation is the ability to assess statements or information obtained (ŽivkoviĿ, 2016). Evaluation is to assess the credibility of a statement which is an explanation of someone's opinion and to assess the logical strength of a statement or argument. Evaluation means providing an evaluator using certain criteria and making comparisons of statements or opinions (Omar et al., 2012). The results show that students have been able to assess the credibility of well-presented statements and evaluate the opinions that have been submitted. Students can use the information they have to make judgments about the statements given and provide conclusions on the answers produced.

The percentage of achievement of the highest dimensions of critical thinking skills in this study, which was 83%, was found in the inference and explanation dimensions. Inference means identifying and gathering the data and evidence needed to draw reasonable conclusions. While

explanation refers to the ability to explain assumptions or opinions convincingly about the results of one's reasoning that leads to the conclusions reached (Facione, 2011). The results of the research indicate that students are skilled in processing the information that has been obtained, which is then used to draw reasonable conclusions based on the evidence provided. Students are also very good at defining terms from something and even providing additional explanations in the form of analogies that are relevant to their daily lives.

Critical thinking skills contribute 18.5% to students' understanding of the movement system concept while 81.5% relates to other factors. This means that understanding the concept of the motion system is not only related to critical thinking skills but there are other variables that also contribute to cognitive learning outcomes. Where in this study is shown by understanding the concept of the movement system of students. Several factors can relate to the cognitive learning outcomes of students such as health, interests, motivation, talents, intelligence, and so on (Shabani & Mohammadian, 2014). This is supported by previous research which showed that there was a positive and significant relationship between motivation and learning outcomes (Piliang et al., 2019). Thus, other variables that were not examined may have a higher contribution to the understanding of students' movement system concepts. Based on the results of the study, there is a positive relationship between metacognitive skills and critical thinking with understanding the concept of the movement system (Siswati et al., 2020).

Activities in the learning process such as predicting, planning, monitoring understanding, and evaluating cognitive development are metacognitive skills that occur every day (Stanton et al., 2011). The thinking ability of students will develop with the help of metacognitive skills which will then contribute to cognitive learning outcomes shown by understanding concepts. This is because the ability to think will affect the level of understanding of students. In addition, in the learning process, students are required to solve various problems which will stimulate students' thinking skills. In the process, critical thinking skills can provide direction in thinking and help determine the problems faced more accurately (Malahayati et al., 2015). Therefore, critical thinking skills are needed in solving problems because students' understanding of concepts can be obtained by constructing the knowledge they already have.

Good metacognitive skills will help students in conditioning the learning process carried out such as determining suitable learning strategies, managing study time, with whom to study, and monitoring the success of their learning. Meanwhile, critical thinking skills enable students to train their thinking skills and gain an understanding of concepts that can improve their cognitive abilities. This process indirectly improves students' cognitive learning outcomes so that both contribute to understanding concepts in different aspects. These results are supported by previous research which shows that there is a strong relationship between metacognitive skills and critical thinking with cognitive learning outcomes (Wicaksono, 2014).

Metacognitive skills are used by students to find out how to organize and understand thinking processes (Yusnaeni et al., 2020). Students who can control their thinking activities well, then other thinking skills will also run, including one of them is critical thinking skills. The use of metacognitive skills by students can also overcome difficulties in the learning process, while critical thinking skills are useful as reflective feedback from the learning cycle to improve students' thinking processes (Stanton et al., 2011). So that both metacognitive skills and critical thinking contribute to improving cognitive learning outcomes, which in this study were demonstrated by understanding the concept, although from a different point of view.

The correlation coefficient obtained based on the test is 0.978 ($\alpha = 0.05$) with the interpretation of the correlation which means the relationship between metacognitive skills and critical thinking with understanding the concept of the movement system of students is categorized as very

strong, while the contribution value of metacognitive and critical thinking skills is 95.7%. on the understanding of the concept of the movement system of students with the contribution of metacognitive skills of 74.2% and critical thinking skills of 21.5%. This result is in accordance with the simple correlation regression test conducted on each variable where metacognitive skills make a bigger contribution than critical thinking skills. The results of the contribution of predictor variables in this study are also in accordance with previous research which states that metacognitive skills and critical thinking together make a very large effective contribution, namely 75.02% of student learning outcomes (Malahayati et al., 2015). If students apply metacognitive skills in the learning process, critical thinking skills will be involved in it because both belong to the higher order thinking skills needed in 21st century learning and contribute very strongly to cognitive learning outcomes which in this study are shown by student's understanding concept

Conclusion

Based on the results of the study, it can be concluded that there is a positive or directly proportional relationship between; metacognitive skills with understanding the concept of the motion system, critical thinking skills with understanding the concept of the motion system, and metacognitive and critical thinking skills with understanding the concept of the motion system. Other researchers are advised to link with the contributions of various learning models, expand the scope of the research area, increase the number of questions, and increase the research sample.

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References

Alfonso, D. V. (2015). Evidence of Critical Thinking in High School Humanities Classrooms. *GiST Education and Learning Research Journal*, *11*, 26–44. https://doi.org/10.26817/16925777.281

Anderson, L. W., Krathwohl Peter W Airasian, D. R., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (2001). *A Taxonomy for Learning, Teaching, and Assessing: a Revision of Bloom's Taxonomy of Educational Objectives*. https://www.uky.edu/~rsand1/china2018/texts/Anderson-Krathwohl - A taxonomy for learning teaching and assessing.pdf

Anderson, N. J. (2002). *The Role of Metacognition in Second Language Teaching and Learning*.

Annisa, L., Oktaviana, C., & Habibi, A. A. (2020). Hubungan Keterampilan Berpikir Kritis Dengan Hasil Belajar Peserta Didik. *Edubiologica Jurnal Penelitian Ilmu Dan Pendidikan Biologi*, *8*(1), 35–37. https://doi.org/10.25134/edubiologica.v8i1.2337

Bae, H., & Kwon, K. (2019). Developing metacognitive skills through class activities: what makes students use metacognitive skills? *Educational Studies*, 1–16. https://doi.org/10.1080/03055698.2019.1707068

Basith, A., Corebima, A. D., & Zubaidah, S. (2014). Hubungan antara Keterampilan Metakognitif dan Pemahaman Konsep Biologi Siswa Kelas X pada Penerapan Strategi Problem-Based

Learning dan Reciprocal Teaching di SMAN 9 Malang. *Prosiding Seminar Nasional XI Pendidikan Biologi FKIP UNS*, 423–428.

Çepni, S., Ülger, B. B., & Ormanci, Ü. (2017). Pre-Service Science Teachers' Views towards the Process of Associating Science Concepts with Everyday Life. *Journal of Turkish Science Education*, *14*(4), 1–15. https://doi.org/10.12973/tused.10208

Chukwuyenum, A. N. (2013). Impact of Critical thinking on Performance in Mathematics among Senior Secondary School Students in Lagos State. *IOSR Journal of Research & Method in Education (IOSRJRME)*, *3*(5), 18–25. https://doi.org/10.9790/7388-0351825

Facione, P. A. (2011). Critical Thinking : What It Is and Why It Counts. In *Insight assessment*. Insight Assessment. https://www.insightassessment.com/CT-Resources/Teaching-For-and-About-Critical-Thinking/Critical-Thinking-What-It-Is-and-Why-It-Counts/Critical-Thinking-What-It-Is-and-Why-It-Counts-PDF

Fauzi, A. (2019). Profile of Junior High School Students' Critical Thinking Skills in Answering Questions Related to Biological Concepts. *Scientiae Educatia: Jurnal Pendidikan Sains*, *8*(1), 51–63. https://doi.org/10.24235/sc.educatia.v8i1.4081

Fouché, J. (2011). Do Metacognitive Strategies Improve Student Achievement in Secondary Science Classrooms? *Christian Perspectives in Education*, *4*(2), 1–25.

Hadi, S., Retnawati, H., Munadi, S., Apino, E., & Wulandari, N. F. (2018). The Difficulties of High School Students in Solving Higher-Order Thinking Skills Problems. *Problems of Education in the 21st Century*, *76*(4), 520–532. https://doi.org/10.33225/pec/18.76.520

Halpern, D. F. (2013). Critical Thinking Workshop for Helping our Students Become Better Thinkers. In *Ideas to Action*. http://louisville.edu/ideastoaction/-/files/featured/halpern/critical-thinking.pdf

Hardianti, Y., Sartono, N., & Dewahrani, Y. R. (2014). Pengaruh Penggunaan Lembar Kerja Siswa (LKS) Bilingual terhadap Hasil Belajar Siswa pada Materi Sistem Reproduksi Manusia. *Biosfer*, *7*(1), 30–36. https://hsgm.saglik.gov.tr/depo/birimler/saglikli-beslenme-hareketli-hayat-db/Yayinlar/kitaplar/diger-kitaplar/TBSA-Beslenme-Yayini.pdf

Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research*, *8*(4), 935–942. https://doi.org/10.12973/eu-jer.8.4.935

Kozikoğlu, İ. (2019). Investigating critical thinking in prospective teachers: Metacognitive skills, problem solving skills and academic self-efficacy. *Journal of Social Studies Education Research*, *10*(2), 111–130.

Kristiani, N. (2015). Hubungan Keterampilan Metakognitif dan Hasil Belajar Kognitif Siswa pada Pembelajaran Saintifik dalam Mata Pelajaran Biologi SMA Kurikulum 2013. *Jurnal Biologi, Sains, Lingkungan, Dan Pembelajarannya*, *10*(6), 513–518.

Lestari, P., Ristanto, R. H., & Miarsyah, M. (2019). Metacognitive and Conceptual Understanding of Pteridophytes: Development and Validity Testing of an integrated Assessment Tool. *Indonesian Journal of Biology Education*, *2*(1), 15–24. https://doi.org/10.31002/ijobe.v2i1.1225

Malahayati, E. N., Duran Corebima, A., & Zubaidah, S. (2015). Hubungan Keterampilan Metakognitif dan Kemampuan Berpikir Kritis dengan Hasil Belajar Biologi Siswa SMA dalam Pembelajaran Problem Based Learning (PBL). *Jurnal Pendidikan Sains*, *3*(4), 178–185.

Mathai, S., & Ramadas, J. (2009). Visuals and Visualisation of Human Body Systems. *International Journal of Science Education*, *31*(3), 439–458. https://doi.org/10.1080/09500690802595821

Miller, T. M. (2017). Measurement, Theory, and Current Issues in Metacognition: An Overview Tyler. In *ACS Symposium Series* (pp. 1–15). https://doi.org/10.1021/bk-2017-1269.ch001

Mite, Y., & Corebima, D. A. (2017). The Correlation Between Critical Thinking and The Learning Results of The Senior High School Students in Biology Learning Implementing Group Investigation (GI) Learning in Malang, Indonesia. *Journal of Applied and Advanced Research*, *2*(2), 56–62. https://doi.org/10.21839/jaar.2017.v2i2.57

Netri, N., Holiwarni, B., & Abdullah, A. (2018). Development of test instruments based higher order thinking skill (HOTS) on chemical equilibrium at second grade in senior high school.

Jom, *5*(2), 1–11. https://jom.unri.ac.id/index.php/JOMFKIP/article/download/20515/19843

Nisa, A., Djamahar, R., & Evriyani, D. (2015). Pengaruh Penggunaan Media Permainan Ular Tangga Terhadap Hasil Belajar Kognitif pada Materi Sistem Reproduksi Manusia. *Jurnal Biosfer*, *8*(2), 20–26.

Nolan, J. (2005). Interpretation: techniques and exercises. In *Multilingual Matters*. https://doi.org/10.1080/1750399x.2014.972030

Nurhayati, N., Hartoyo, A., & Hamdani, H. (2017). Kemampuan Metakognisi Siswa dalam Pemecahan Masalah pada Materi Bangun Datar Di Kelas VII SMP. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, *6*(1), 1–13.

Nuri, A. R. U., Sajidan, S., Oetomo, D., Prasetyanti, N. M., & Parmin, P. (2019). Improving Indonesian Senior High School Students' Critical Thinking Skill through Science Integrated Learning (SIL) Model. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *4*(2), 145–158. https://doi.org/10.24042/tadris.v4i2.3144

Omar, N., Haris, S. S., Hassan, R., Arshad, H., Rahmat, M., Zainal, N. F. A., & Zulkifli, R. (2012). Automated Analysis of Exam Questions According to Bloom's Taxonomy. *Procedia - Social and Behavioral Sciences*, *59*, 297–303. https://doi.org/10.1016/j.sbspro.2012.09.278

Ongardwanich, N., Kanjanawasee, S., & Tuipae, C. (2015). Development of 21st Century Skill Scales as Perceived by Students. *Procedia - Social and Behavioral Sciences*, *191*(1), 737–741. https://doi.org/10.1016/j.sbspro.2015.04.716

Pheeraphan, N. (2013). Enhancement of the 21st Century Skills for Thai Higher Education by Integration of ICT in Classroom. *Procedia - Social and Behavioral Sciences*, *103*(1), 365–373. https://doi.org/10.1016/j.sbspro.2013.10.346

Piatek-Jimenez, K. (2010). Students' interpretations of mathematical statements involving quantification. *Mathematics Education Research Journal*, *22*(3), 41–56. https://doi.org/10.1007/BF03219777

Piliang, I. W., Rusdi, R., & Miarsyah, M. (2019). Correlation between Learning Motivation and Learning Outcomes in Circulation System Learning Materials in Grade XI. *Indonesian Journal of Science and Education*, *3*(1), 15–20. https://doi.org/10.31002/ijose.v3i1.861

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review*, *16*(4), 385–407. https://doi.org/10.1007/s10648-004-0006-x

Putri, N. R., Miarsyah, M., & Vivanti, D. (2018). Hubungan kecerdasan naturalis dan motivasi belajar dengan kemampuan berpikir kritis peserta didik pada materi pencemaran lingkungan. *Florea : Jurnal Biologi Dan Pembelajarannya*, *5*(2), 100–109. https://doi.org/10.25273/florea.v5i2.3124

Raida, S. A. (2018). Identifikasi Materi Biologi SMA Sulit Menurut Pandangan Siswa dan Guru SMA se-Kota Salatiga. *Journal of Biology Education*, *1*(2), 209–222. http://journal.stainkudus.ac.id/index.php/jbe%0AIdentifikasi

Rini, D. S., Adisyahputra, A., & Sigit, D. V. (2020). Boosting student critical thinking ability through project based learning, motivation and visual, auditory, kinesthetic learning style: A study on Ecosystem Topic. *Universal Journal of Educational Research*, *8*(4A), 37–44. https://doi.org/10.13189/ujer.2020.081806

Rizky, H., Sukmawati, D., & Rusdi, R. (2020). Excretory system learning: What is the relationship between critical thinking skills and biology learning motivation? *Biosfer*, *13*(2), 320–332. https://doi.org/10.21009/biosferjpb.v13n2.320-332

Rodiah, S., Komala, R., & Rusdi, R. (2020). The Correlation Between Biology Learning Outcomes and Senior High School Students' Self Concept. *Jurnal Penelitian Dan Pembelajaran IPA*, *6*(1), 141–151. https://doi.org/10.30870/jppi.v6i1.4594

Saputri, Y. D., Indrowati, M., & Ariyanto, J. (2019). Hubungan Keterampilan Metakognisi Dengan Pemahaman Konsep Biologi Melalui Model Pembelajaran SSCS. *Proceeding Biology Education Conference*, *16*(1), 133–138.

Shabani, M. B., & Mohammadian, M. (2014). Relationship Between Goal Orientation, Critical

Thinking, Meta-Cognitive Awareness and Self-Regulated Learning of Iranian Students. *International Journal of Language Learning and Applied Linguistics World (IJLLALW)*, *5*(1), 403–418.

Shobirin, M., Corebima, A. D., & Lukiati, B. (2019). Critical Thinking Skills and Students' Achievement on Biology Lesson Using Genetic Instructional Material Based on Learning Cycle 5E: A Correlation Study. *Jurnal Pendidikan Sains*, *7*(1), 15–19.

Siswati, B. H., Hariyadi, S., & Corebima, A. D. (2020). Hubungan Antara Berpikir Kritis Dan Metakognitif Terhadap Hasil Belajar Mahasiswa Biologi Dengan Penerapan Model Pembelajaran Rwrs. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *10*(2), 74–82. https://doi.org/10.24929/lensa.v10i2.110

Stanton, N. A., Wong, W., Gore, J., Sevdalis, N., & Strub, M. (2011). Critical Thinking, Theoretical Issues in Ergonomics Science. *Theoretical Issues in Ergonomics Science*, *12*(3), 204–209. https://doi.org/http://dx.doi.org/10.1080/1464536X.2011.564479

Stupnisky, R. H., Renaud, R. D., Daniels, L. M., Haynes, T. L., & Perry, R. P. (2008). The interrelation of first-year college students' critical thinking disposition, perceived academic control, and academic achievement. *Research in Higher Education*, *49*(1), 513–530. https://doi.org/10.1007/s11162-008-9093-8

Tasyari, S., Putri, F. N., Aurora, A. A., Nabilah, S., Syahrani, Y., & Suryanda, A. (2021). Identifikasi Media Pembelajaran Pada Materi Biologi Dalam Meningkatkan Pemahaman Konsep Peserta Didik di Masa Pandemi Covid-19. *BIO-EDU: Jurnal Pendidikan Biologi*, *6*(1), 1–8.

Utami, B., Probosari, R. M., Saputro, S., Ashadi, A., Masykuri, M., & Sutanto, A. (2018). Students' critical thinking skills profile: constructing best strategy in teaching chemistry. *IJPTE : International Journal of Pedagogy and Teacher Education*, *2*, 63. https://doi.org/10.20961/ijpte.v2i0.19768

Wicaksono, A. G. C. (2014). Hubungan Keterampilan Metakognitif dan Berpikir Kritis terhadap Hasil Belajar Kognitif Siswa SMA pada Pembelajaran Biologi dengan Strategi Reciprocal Teaching. *Jurnal Pendidikan Sains*, *2*(2), 85–92. http://journal.um.ac.id/index.php/jps/

Wulandari, A. Y. R. (2018). Correlation Between Critical Thinking and Conceptual Understanding of Student's Learning Outcome in Mechanics Concept. *AIP Conference Proceedings*, 1–8. https://doi.org/10.1063/1.5054432

Yee, M. H., Yunos, J. M., Othman, W., Hassan, R., Tee, T. K., & Mohamad, M. M. (2015). Disparity of Learning Styles and Higher Order Thinking Skills among Technical Students. *Procedia - Social and Behavioral Sciences*, *204*(November 2014), 143–152. https://doi.org/10.1016/j.sbspro.2015.08.127

Yuriza, P. E., Adisyahputra, A., & Sigit, D. V. (2018). Hubungan antara Kemampuan Berpikir Tingkat Tinggi dan Tingkat Kecerdasan dengan Kemampuan Literasi Sains pada Siswa SMP. *BIOSFER Jurnal Pendidikan Biologi*, *11*(1), 13–20.

Yusnaeni, Corebima, A. D., Susilo, H., & Zubaidah, S. (2020). The Contribution of Metacognitive Skills and Creative Thinking Skills in 21st Century Learning. *Universal Journal of Educational Research*, *8*(4A), 31–36. https://doi.org/10.13189/ujer.2020.081805

ŽivkoviĿ, S. (2016). A Model of Critical Thinking as an Important Attribute for Success in the 21st Century. *Procedia - Social and Behavioral Sciences*, *232*(April), 102–108. https://doi.org/10.1016/j.sbspro.2016.10.034