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Excretory system learning: What is the relationship between critical thinking skills and biology learning motivation?

Hanifia Rizky[1*], Dalia Sukmawati[2], Rusdi[1]

[1] Biology Education, Faculty of Mathematics and Natural Science, Universitas Negeri Jakarta, Indonesia
[2] Biology, Faculty of Mathematics and Natural Science, Universitas Negeri Jakarta, Indonesia

*Corresponding author: hanifiarizky48@gmail.com

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ABSTRACT

This research aims to find out the relationship between critical thinking skills and students' learning motivation in the excretory system content. The research employs a descriptive method with correlation approach. The research population includes students of Madrasah Tsanawiyah Negeri of a school in Jakarta Timur, Indonesia. Sampling is conducted using multi-stages sampling. Samples used are 95 students of Grade IX. The research instruments consist of critical thinking skill test and learning motivation questionnaire. Data analysis uses regression analysis technique. The regression equation is compiled and tested with variance analysis using ANOVA table with F-test. The multiple regression hypothesis testing carries out by compiling multiple regression equation and testing using variance analysis with t-test. The research results indicate pxy, means that there is a correlation between critical thinking and learning motivation. The research recommendation is that the excretory system learning activity empowers critical thinking so that it improves motivation to learn the excretory system.

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INTRODUCTION

Students' learning motivation is important as it plays a role in creating desire to learn (Azrai, Evriyani, & Prastya, 2016; Ristanto, 2011). Motivation is a success factor for students since it is consequential in configuring information in mind (Darmawan et al., 2019; Ekici, 2010). It is substantial because it influences students in behaving towards knowledge; hence, students must possess learning motivation to utilize their knowledge (Kostiva & Radoynovska, 2010; Shihusa, 2009). It is a basic recipe for academic success (Hadjichambis, Georgiou, Paraskeva-Hadjichambi, Kyza, & Mappouras, 2016; Yildirim, 2020). It involves internal and external factors that stimulate a person's desire and energy to continue to be interested in and committed to work, roles, or subjects or to make an effort in achieving goals (Jan, 2017).

Motivation will activate and direct an individual's behavior to achieve a goal and will affect the individual's behavior intensity (Yunanti, 2016). Students' motivation will facilitate the understanding of a subject in school, especially biology (Afriana, Permanasari, & Fitriani, 2016; Becker, McElvany, & Kortenbruck, 2010). One content that requires an understanding is excretory system (Djamahar, Ristanto, Sartono, & Darmawan, 2020; Ristanto, Djamahar, Heryanti, & Ichsan, 2020). An observation carries out on biology teachers at the research site school with scope of organs involved in the excretory system, process of metabolic waste product formation, and diseases in the human excretory system. The observation results indicate that the sub-content scopes make it difficult for student to understand. The lack of motivation among students affects the biology learning achievement (Hadjichambis et al., 2016; Ristanto, Miarsyah, Luthfi, Kristiani, & Hasanah, 2020). Moreover, an assumption that biology is difficult and boring triggers students' lack of motivation to learn.

Motivation is a force from inside and outside of a person that is started from an effort to consider direction, intensity, and perseverance (Hadjichambis et al., 2016; Colquitt, 2011). It provides direction to someone's behavior to achieve a goal and it will affect his/her behavior intensity (Jan, 2017; Yunanti, 2016). Indicators that a student is motivated include direction of effort and intensity of effort. The direction of effort includes desire to succeed in learning or desire to achieve a goal to perform a task by acting on motivation. The intensity of efforts covers involvement in the learning process and desire to search for new knowledge (Colquitt, 2011). Effort related to someone's interest in a certain situation or intensity of efforts is the effort a person makes in a particular situation. Persistence of effort includes persistence with task and efforts to overcome difficulties in learning (Yildirim, 2020; Colquitt, 2011).

Students perceive biology learning as fun as well as less fun (Ristanto et al., 2020; Astalini, 2018). The presumption triggers lack of motivation to learn biology. Students deem the human excretory system is difficult to understand (Djamahar et al., 2020; Qumillaila, Susanti, & Zulfiani, 2017). The excretory system is one of biology contents that has complex scope (Ristanto, Djamahar, et al., 2020). Similarly, biology consists of complex content related to organ systems and their process (Penazio, 2009). The excretory system content requires students' good comprehension (Kristiani, Ristanto, & Lisanti, 2020). Comprehension should be supported by higher learning motivation by students (Ristanto, 2011). Learning motivation must be improved and supported by biology learning process (Darmawan, Wahono, et al., 2019; Ningsih, Rusdi, & Miarsyah, 2019). It requires a scientific identification to identify factors influencing excretory system learning motivation.

In addition to motivation, critical thinking skills become a focus in current biology learning (Bustami, Riyati, & Julung, 2019; Harahap, Ristanto, & Komala, 2020; Noviyanti, Rusdi, & Ristanto, 2019; Suwono, Pratiwi, Susanto, & Susilo, 2017). Students who have critical thinking skills will process information better and use their reasoning more effectively (Batlolona, Diantoro, Wartono, & Latifah, 2019; Yenice, Ozden, & Evren, 2012). Critical thinking is vital for students in biology learning (Muhlisin, Susilo, Amin, & Rohman, 2016; Noviyanti et al., 2019). It is considered as a skill that has an impact on someone's life. It consists of abilities in

interpretation process, analysis, evaluation, inference, explanation, and self-regulation. Thinking process could lead students to logical way of thinking and interpret learning critically so that curiosity and spirit to learn are expected to grow within the students (Dwyer, Hogan, & Stewart, 2015; Setyorini, Sukiswo, & Subali, 2011).

Biology learning should focus and give emphasize on students (Ristanto, Djamahar, et al., 2020). Biology learning achievement is the main modality for students to think critically (Fitriani, Asy'ari, Zubaidah, & Mahanal, 2019; Styers, Van Zandt, & Hayden, 2018). One way to develop the skill is through quality biology learning process (Bahtiar & Dukomalamo, 2019; Hidayati, Pangestuti, & Prayitno, 2018). It carries out by actively involving students and it could occur if students have better learning motivation (Becker et al., 2010; Loes, An, Saichaie, & Pascarella, 2017).

Critical thinking is required in evaluating and deciding to use information (Noviyanti et al., 2019; Potter, 2010). The benefit of having good critical thinking skills for students is that they could scrutinize a scientific truth and knowledge; thus, they could assess something more carefully (Rahmawati, 2016). Critical thinking is believed as a skill required in 21st century and it accommodates activities that could enhance high order thinking skills, analyzing skill and problem solving skill (Saputri, 2018). It involves various process, namely interpreting, analyzing, evaluating, inferrencing, explanation, and self-control (Potter, 2010).

Student's motivation to learn could be influenced by critical thinking. If critical thinking skill empowerment is not optimal then learning motivation will low. Various studies have been conducted on critical thinking skills and learning motivation on students who learn biology (Bustami et al., 2019; Darmawan, Alamsyah, et al., 2019; Harahap et al., 2020; Kostova & Radoynovska, 2010; Noviyanti et al., 2019; Ristanto, Djamahar, et al., 2020; Suwono et al., 2017; Widiansyah, Indriwati, Munzil, & Fauzi, 2018). There are, however, fewer studies that uncover the relationship between critical thinking skills and learning motivation in the excretory system on students of madrasah tsanawiyah; therefore, the current research aims to analyze the relationship between critical thinking skills and students' learning motivation in the excretory system.

METHODS

Research Design

This research employed descriptive method with correlational approach. Data collection used test instruments in the form of essay test compiled according to critical thinking indicators to identify students' critical thinking. The measurement of students' learning motivation used non-test instrument of questionnaire (Colquitt, 2011). Figure 1 illustrates the research design, namely constellation of correlational studies between variables. Variable X is critical thinking skills that have correlation to or relationship with variable Y of excretory system learning motivation.

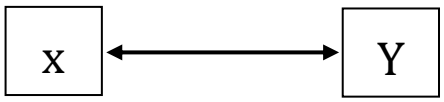

Figure 1. Constellation of correlational study

Note:
X: Critical Thinking, Y: Learning motivation (excretory system)

Population and Samples

Sampling carried out using multi-stage sampling. The samples were selected by means of purposive sampling. Of all MTs Negeri in Jakarta, MTs Negeri in East Jakarta was selected and one of the them was taken as sample using random sampling. The research respondents were

students of Grade IX that consisted of 4 (four) classes amounted 134 students. The sampling technique employed McClave's formula where standard deviation divided by the root of the number of sample used. The standard deviation was (11.6) and divided by the sample root (95) resulted in 0.11, which was <1 indicating the data were representative; thus, 95 students were chosen with age ranged between 14 to 15 years.

Instrument

Instruments to measure learning motivation used non-test instrument of questionnaire (Colquitt, 2011). The learning motivation indicators included hard work, attention, and persistence in learning. The validity test of the instruments of the biology learning motivation used a statistical technique of product-moment correlation. The processing of the instrument trial results employed SPSS 23 program with significance level of 0.05. The testing criteria is if the resulted r > r table then the question items are valid. The number of instrument items before the trial was 30 question items. The trial and analysis results indicated that 7 (seven) question items were invalid, whereas the remaining 23 items were valid. The reliability test on the question items of the biology learning motivation instruments carried out using Cronbach's Alpha with SPSS. The reliability test generated 0.894, thus it had high criteria. The grid of the biology learning motivation instruments is presented in Table 1.

Table 1
Grid of Biology Learning Motivation Instruments

Component	Indicator	Question Item		Total
		Positive	Negative	
Direction of Effort	Desire to succeed in learning Biology.	1, 3*, 20*	5*, 6, 18	6
Intensity of Effort	Involvement in the biology learning process.	4*, 8, 11	12, 21, 25	6
	Desire to search for new knowledge of Biology.	2, 10, 22	26*, 28*, 30	6
Persistence of Effort	Diligence in working on biology assignments.	7, 15,16*	9, 17, 27	6
	Efforts to face difficulties in learning biology.	14, 23, 24	13, 19, 29	6

Note: * invalid question items

The critical thinking skills used test instruments of essay with answer score criteria available in the assessment rubric. The critical thinking skills measured students' higher order thinking skills in the excretory system topic. The critical thinking indicator measured included interpretation, analysis, evaluation, inference, explanation, and self-regulation. Validity test for the critical thinking skills instruments employed a statistic technique of product-moment correlation. The testing criteria is if the resulted r > r table then the question items are valid. The number of instrument items prior to the trial was 12 question items and 7 (seven) of them were valid. The instruments had been tested their reliability using Cronbach's Alpha formula and yielded 0.607 with high category. The grid of the critical thinking skills in the excretory system is presented in Table 2.

Procedure

The research carried out after the students learn about the human excretory system. The research variables of critical thinking skills and motivation were determined based on preliminary test of observation and literature study. The research main aspects consisted of critical thinking skills test and biology learning motivation questionnaire. The instruments had been tested for the validity and reliability to biology education experts and students from other

schools that had academic equality with the research population. Data collection conducted without disturbing the students' learning activity and the results were then analyzed. The research stages are illustrated in Figure 2.

Table 2
The Grid of the critical thinking skills in the excretory system

No.	Critical thinking skills indicator	Sub-critical thinking skills	Question indicator	Question No.
1	Interpretation	Categorization Coding Clarify the meaning	Students could categorize, perform coding, and clarify the meaning of the excretory system	1*, 2
2	Analysis	Examine ideas Identify arguments Analyze arguments	Students could examine ideas, identify arguments, and analyze arguments from laboratory test results related to diseases in the excretory organs	3*, 4
3	Evaluation	Assess claims Assess arguments	Students could assess claims and arguments for diseases that attack the human excretory system	5, 6*
4	Inference	Question the evidence Presume alternatives Draw conclusion	Students could question the evidence, presume alternatives, and draw conclusion of symptoms occur from the human excretory organs	7, 8
5	Explanation	Present the results Justify procedures Present arguments	Students could present results, justify procedures, and present arguments related to the excretory organ mechanism.	9*, 10
6	Self-regulation	Self-assessment Self-correction	Students could perform self-assessment and self-correction to maintain the health of the excretory system	11*, 12
Total				12

Note: * invalid question item

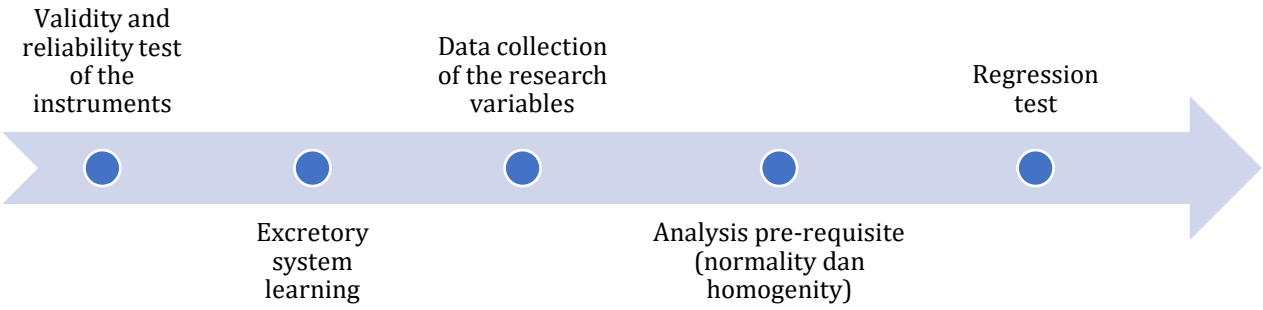

Figure 2. Research Procedure

Data Analysis Techniques

The analysis technique started with performing pre-requisite tests, namely normality and homogeneity tests. The normality test aims to find out whether or not the data is normally distributed. The normality test employed Kolmogorov Smirnov test. The normality test obtained D = 0,046 < D_{tabel} = 0.13; hence, the learning motivation data on critical thinking skills

were normally distributed. The homogeneity test is intended to find out whether or not the research sample has the same homogeneity level. The test used Levene's test in a significance level of 0.05. The test results indicated that the resulted X2 = 5.47 was less than X2 table = 118.75; therefore, the hypothesis stating that the variance was homogeneous was accepted at a significance level of (0.05). The hypothesis testing utilized regression analysis. The regression equation tested using variance analysis with ANOVA table. Next, the simple correlation hypothesis testing carried out to find out the correlation or relationship between critical thinking and learning motivation.

RESULTS AND DISCUSSION

The highest students' learning motivation indicator was found in desire to succeed in learning, whereas the lowest was in the desire to search for new knowledge. It suggested that students' desire to learn was very high; the desire to search for new knowledge, however, must be improved. The result of biology learning motivation measurement based on the indicators is illustrated in Figure 3.

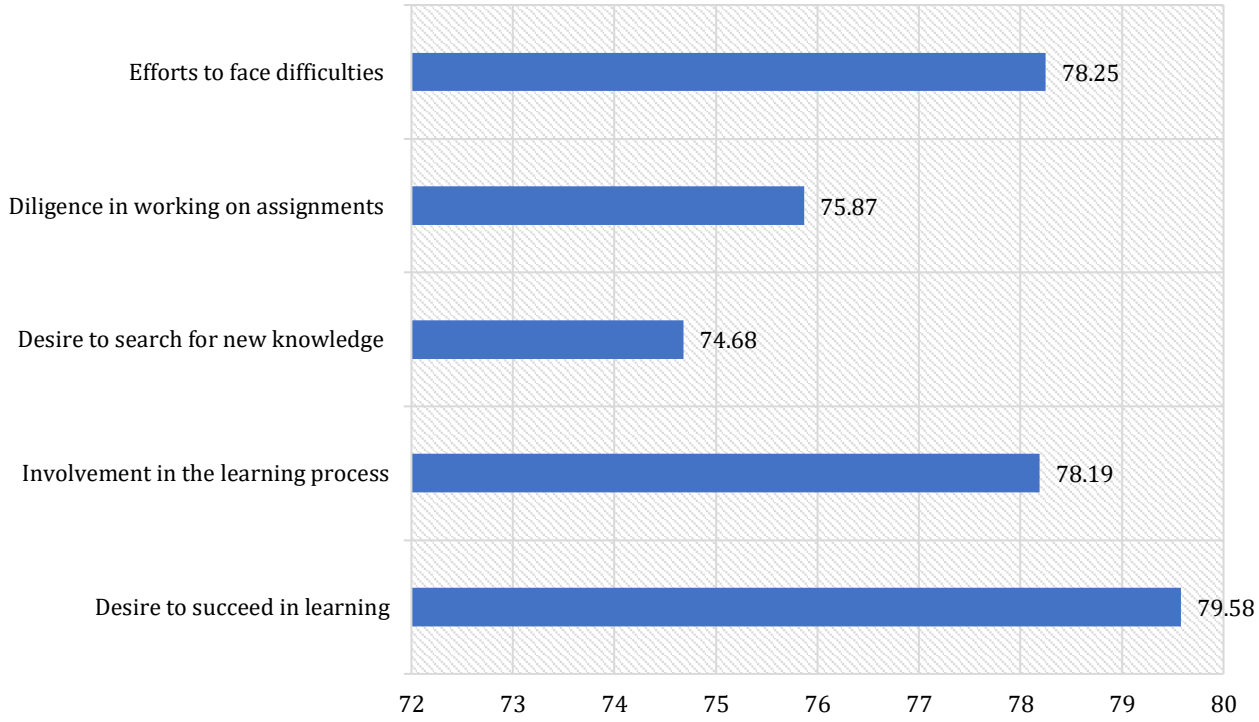

Figure 3. Average students' biology learning motivation

In the average score of biology learning motivation indicator, the highest score was in desire to succeed in learning. A person who conceptualizes a goal will be able to develop strategies to achieve the goal, bring motivation, and maintain the motivation. On the other hand, the lowest average in the indicator of desire to search for new knowledge was due to the activity that requires process and motivation from the students. Each student has different intrinsic motivation level. It is in this aspect that the teacher provides extrinsic motivation to improve the students' intrinsic motivation (Ningsih et al., 2019).

The data provides knowledge that students had a high spirit in the aspect of desire to succeed. This information is essential for teacher in optimizing the learning process since most students had high desire to succeed yet they still required teacher's guidance to be willing to search for and find knowledge. The highest students' critical thinking indicator was in the interpretation indicator, whereas the lowest was in the self-regulation indicator. It implied that

good interpretation provided information that students were able to understand and describe a meaning. The self-regulation indicator, on the other hand, must be improved since it is an illustration of students' abilities in self-evaluation. The measurement result of the critical thinking skills in the excretory system is depicted in Figure 4.

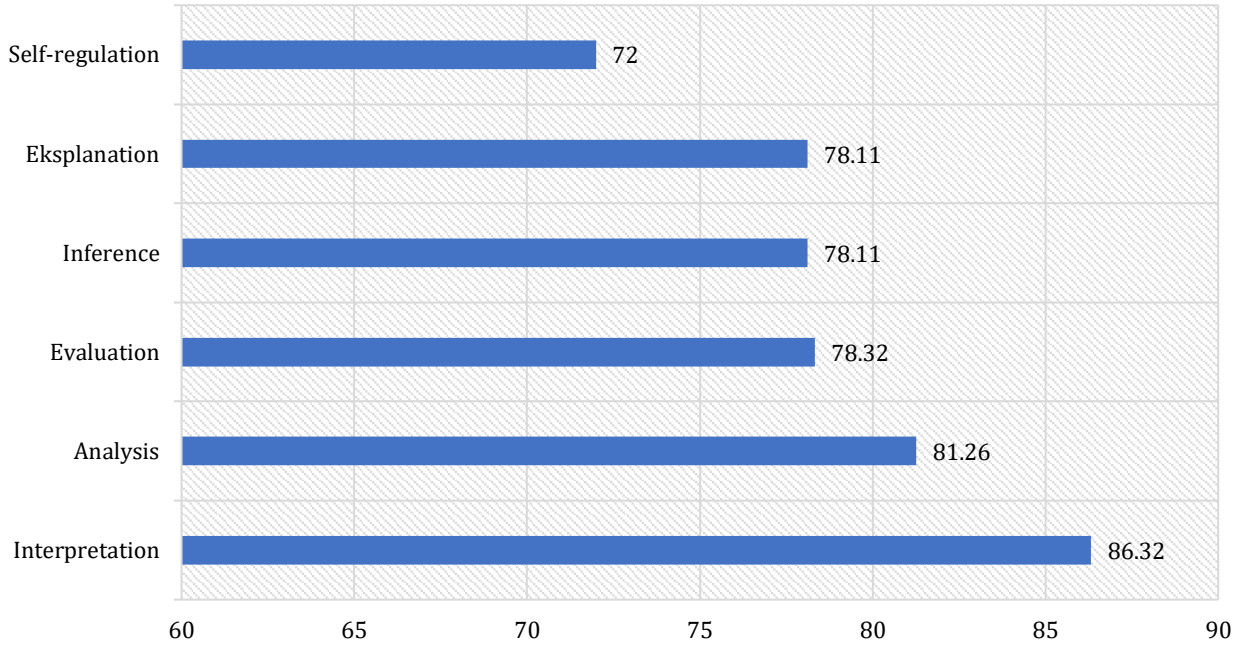

Figure 4. Average critical thinking skills of excretory system

In terms of the average score of critical thinking, the highest average was found in interpretation indicator, which is explaining a meaning on interpreting the structure of organs in the excretory system. Many students already had understanding in the stage of explaining a meaning. It can be stated that interpretation was in a good category and related to students' abilities in interpreting an object observed. Interpretation trains students in re-explaining and understanding a meaning of an event, data, procedure, or regulation (Agnafia, 2019).

The lowest indicator was self-regulation with average score of 72. It would render difficulties for students in learning the excretory system. This finding was an evidence of low self-control towards efforts in maintaining the health of the excretory system. Self-regulation is no better than the interpretation indicator where students control themselves in encountering problems by applying expertise in analyzing and evaluating the developed results. Critical thinking affects students' biology learning motivation. Lack of motivation will be an obstacle for critical thinking development. Belief and motivation are the main factors that play a role in critical thinking (Dehgani, 2011). The simple linear regression equation for the critical thinking regression model calculation with learning motivation was $\bar{Y} = 68.351 + 0.112X_{2.}$ The calculation resulted $F = 1.033 < F_{tabel} = 1.086$. It suggested that the correlation form between critical thinking and learning motivation was linear at a significance level of 0.3. The significance test and model linearity was $\bar{Y} = 68.351 + 0.112X_2$. It can be inferred that the equation was significant and linear. It meant that if critical thinking increased one point, then learning motivation tended to increase by 0.112 point in a constant of 68.351. The data suggested that the learning process should activate students' critical thinking so as motivate them in participating in the learning. Hence, teachers are demanded to be creative for their students' progress. The correlation between critical thinking and learning motivation is illustrated in Figure 5 and the model correlation coefficient of $\bar{Y} = 68{,}351 + 0{,}112X_2$ in Table 3.

Table 3
Model Correlation Coefficient of $\bar{Y} = 68{,}351 + 0{,}112X_2$

		Biology Learning Motivation	Critical Thinking
Correlation	Learning motivation	1,000	.128
	Critical thinking	.128	1.000
Significant	Biology learning motivation	.	,108
	Critical thinking	.108	.

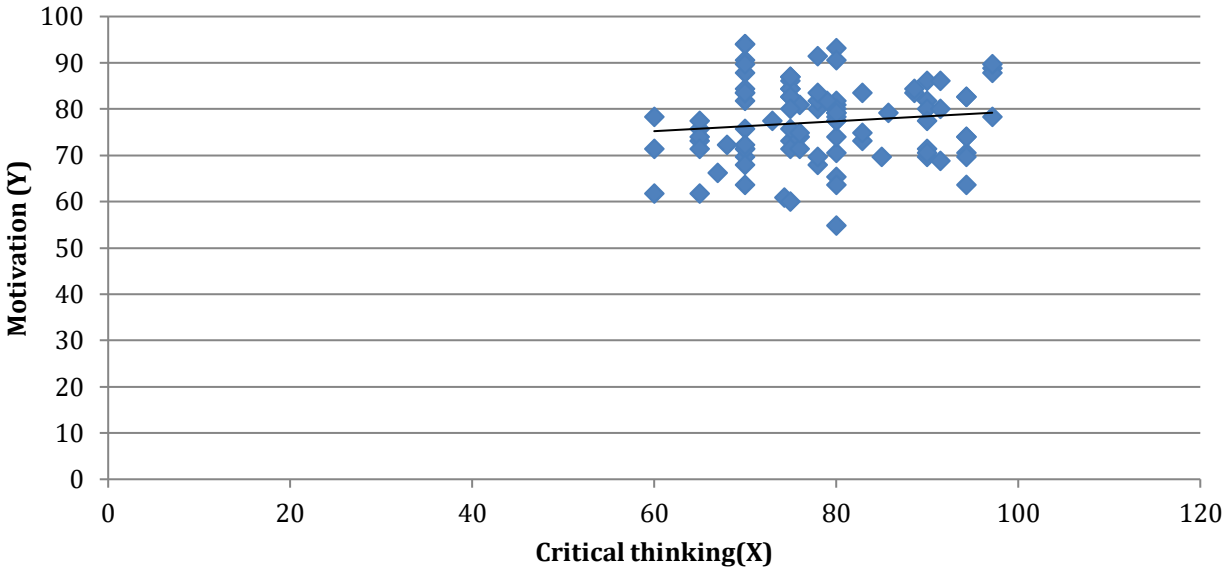

Figure 5. Correlation regression model of $\bar{Y} = 68{,}351 + 0{,}112X_2$

The strength of the relationship between critical thinking and learning motivation was indicated as a correlation coefficient (rx_2y) of 0.128. The significance test of the correlation coefficient resulted t = 1.245 and the t table = 0.667; thus $t > t_{table}$ at an alpha of 0.5. It implied that the correlation coefficient was significant or there was a positive relationship between critical thinking and learning motivation. Therefore, the better the critical thinking, the better the biology learning motivation (Table 4).

Table 4
Partial correlation coefficient of regression X to $\bar{Y}$

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	68,351	7,149		9,561		,000	
	X2	,112	,090	,128	1,245	,216	,128	,128

The strength of the relationship between critical thinking and biology learning motivation was calculated using partial correlation coefficient test. The calculation yielded (rxy) of 0.128. The coefficient of determination $(Rxy)^2 = (0.128)^2$ meant that 1.6% of variation in the critical thinking gave contribution to learning motivation; hence, there was closeness or strength of relationship between critical thinking and biology learning motivation.

The critical thinking is created to establish students' critical thinking skills and prepare students in a global scope, namely a complex social life (Ristanto et al., 2020; Zivkovic, 2016). There is a relationship between critical thinking and learning motivation. The critical thinking

affects by several factors, among others, learning motivation (Muhammad, 2014; Duncan, 2015). Critical thinking skills, creative thinking, and metacognition often intersect in terms of their attention on problems faced, problem solving learning, and emphasize on reflection (Bustami et al., 2019; Astalini, 2018). Moreover, they provide an opportunity for students to explore ideas, monitoring, evaluation, information management, and emphasize on motivation and open minded (Darmawan et al., 2019; Asy'ari, 2016).

Motivation is a mechanism that ultimately influences a person to act in the desired way (Hadjichambis et al., 2016; Muhammad, 2014; Colquitt, 2011). Students who have intrinsic motivation possess superiority since they have self-confidence (Ningsih et al., 2019; Solmaz, 2016). Similarly, motivation is crucial to succeed in educational matters and, success in the learning process will not be achieved without spirit since it is a long-life process. Motivation is a strength that encourages students to face all difficulties and challenging situation (Valarmathie, 2017; Duncan, 2015).

Motivation is defined as a cognitive strength that directs involvement at school. It could be seen from cognitive and affective desire to start and maintain participation in learning activities (Yildirim, 2020; Colquitt, 2011; Wood, 2019). Similarly, motivation covers responsibility, courage to take a risk, sincerity to complete assignments, and have realistic goals. A teacher must gradually retreat from a center of attention and encourage students to be more responsible for their own learning that is reflected in the learning activities (Fitriani, Asy'ari, Zubaidah, & Mahanal, 2019; Styers, Van Zandt, & Hayden, 2018).

The research findings become a reflection for teachers to be more effective in diagnosing and improving students' motivation as well as encouraging autonomy over control in the classroom. It is important to foster students' critical thinking for it is needed in biology learning (Ristanto et al., 2020; Astalini, 2018). Learning is based on a process that characterize 21st century characteristics to solve complex life problems; therefore it requires effective and efficient solution (Saputri, 2018). Critical thinking is important since it allows students to effectively deal with social, scientific problems, and real life that demand real practice (Bustami et al., 2019; Harahap et al., 2020; Noviyanti et al., 2019).

Students who have high motivation tend to succeed in tasks or school assignments and could face learning difficulties through independence learning, discuss with friends, and ask the teachers (Dewi, 2018). The higher the learning motivation, the better is the critical thinking skills (Cholishoh, 2015). Therefore, students' motivation factor plays an important role in Biology learning and problem solving skills because it will determine students' belief that they could do the Biology learning well (Djamahar et al., 2020; Chumbley, 2015). The critical thinking skills and learning motivation are interconnected. It forms a pattern that there is a contribution of students' thinking to the biology learning motivation in the excretory system (Djamahar et al., 2020; Ristanto et al., 2020). Next, learning will direct students to be involved in activating their reasoning; hence, it will affect their motivation to do something at school, especially during the biology learning.

CONCLUSION

There was a positive relationship between critical thinking and learning motivation. The coefficient of determination $(Rxy)^2 = (0.128)^2$ indicated that 1.6% of variation in the critical thinking contributed to learning motivation. The research thus has contribution in terms of providing suggestion or input to teachers to conduct learning that put a learning process that activates students' critical thinking skills forward. In addition, students could be encouraged to be actively involved and have high motivation in biology learning, especially in the excretory system. The research learned that time limitation was thing that should be anticipated as it was relatively short since it carried out using sample of 9th grade students who were busy preparing their final exam. Thus, further research could add other variables that support and correlate to

students' biology learning motivation.

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