



## THE CONNECTION BETWEEN STUDENTS' RETENTION AND CRITICAL THINKING SKILLS IN DIVERSE ACADEMIC SKILLS IN BIOLOGY LEARNING

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### ABSTRACT

This research aims to investigate the connection between students' retention and critical thinking skills in diverse academic skills in biology learning. The research samples were 202 tenth-grade students in the second semester who learned biology. A class equivalence test determined four high and four low academic skills classes. An essay test was employed in this study to examine retention and critical thinking skills. The study indicates a significant connection between students' retention and critical thinking skills in various academic skills in high school biology learning. High academic skills have a lower contribution of critical thinking skills to retention than low academic skills. Students' less serious learning attitudes and practices give a low contribution of critical thinking skills to retention in high academic skills. The regression equation lines between students' retention and critical thinking skills in diverse academic skills are not parallel and do not coincide. The regression equation line for low academic skills seems steeper than that for high ones. It means that students' retention improvement rate due to the influence of critical thinking skills in high academic skills is lower than in low academic skills.

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### INTRODUCTION

Learning is a phase in the thinking process where knowledge is found or altered to provide the desired understanding. The knowledge acquired will have greater meaning if it is not quickly forgotten. Learning success is measured differently than how well students perform on exams. However, it depends on students' capacity to keep material in long-term memory for a longer time, known as retention (Anderson & Krathwohl, 2001; Jones et al., 2015; Afoan & Corebima, 2018).

Retention is the ability to capture information, accept it as part of the thinking process, retrieve it, and get it back when needed (Rets, 2017; Elekaei et al., 2020; Saputri & Corebima, 2020). It is essential to empower retention indicator. Retention for each student is diverse and depends on the learning model applied by teachers in managing learning in schools (Palennari, 2016; Ismirawati et al., 2018; Amin et al., 2020; Bahri et al., 2021; Usman et al., 2021). In addition, the increase in academic skills in learning is also influenced by the students' retention (Ismirawati et al., 2018; Mahanal et al., 2019; Usman et al., 2021). According to Afoan and Corebima (2018) and

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Adiansyah et al. (2021), retention is generally the main way to measure students' academic skills. Besides, the readiness factor of educational institutions today in empowering increased retention of students with diverse academic skills is critical to consider by education providers, including teachers (Bingham & Solverson, 2016; Rets, 2017). Several research results reveal that educational institutions specialize in empowering students' retention and success, including in learning biology (Ismirawati et al., 2018; Amin et al., 2020; Usman et al., 2021). Previous research reports state that retention is vital to students' learning success (Palennari, 2016; Talar & Gozaly, 2020). As a result of retention, teachers can gauge how well their students acquire new material and determine whether they can permanently retain it (Palennari, 2016; Mahanal et al., 2019; Usman et al., 2021). According to Rose and Nicholl (1997) and Santrock (2004), retention is the quantity of knowledge students absorb, store in long-term memory, and re-express regularly.

Critical thinking skills drive students' academic skills in learning and influence empowerment to boost retention (Palennari, 2016; Usman et al., 2021). On the other hand, there are so many students' attributes that significantly affect the retention of their learning outcomes, including the readiness of educational institutions to empower retention, such as critical thinking skills in students with diverse academic skills (Bingham & Solverson, 2016; Amin et al., 2020; Usman et al., 2021). A critical thinking skill essential for professional and academic success in many domains, including decision-making, is the ability to think rationally and critically (Saputra et al., 2019; Ghazlene et al., 2022).

Critical thinking skills are manifested in self-regulation assessments that create analysis, interpretation, inference, and evaluation, as well as an explanation of precise, theoretical, procedural, criteriological, or other contextual explanations for the assessment (Živković, 2016; Zubaidah et al., 2018). Critical thinking also involves reactivating the ability for analysis, data evaluation, question identification, logical conclusion, and understanding of the implications of arguments (Liu et al., 2014; Li, 2016; Wahidin & Romli, 2020). Critical thinking skills are critical in solving problems related to social, scientific, and functional problems for students in life (Vieira & Tenreiro-Vieira, 2016; Zulfiani et al., 2020; Ramdani et al., 2021). Critical thinking skills are also required to answer problems critically, such as reasoning, estimating, problem-solving, decision-making, and examining out-

comes and processes (Dwyer et al., 2014; Magrabi et al., 2018; Kozikoglu, 2019). Students with critical thinking skills in learning can formulate problems, give arguments, conduct deductions, conduct inductions, evaluate, and decide to take the necessary action (Ennis et al., 1985; Li, 2016; Sidiq et al., 2021).

Students must think critically in modern educational changes (Pujianti & Rusyana, 2020). Critical thinking emphasizes understanding meaning, finding out causes, and proving as a consideration in making decisions (Zubaidah et al., 2018). Critical thinking is crucial to the learning process, especially in biology. Biology learning involves more than memorizing principles, concepts, or facts; it is also tied to a discovery process concerning natural events. The link between critical thinking and biology learning is for students to solve problems and make decisions. Academic skill is one of the predictors of student success in boosting critical thinking skills (Mahanal et al., 2019). Teachers must encourage student learning that requires critical thinking skills and allows students to construct the concepts they learn actively. According to the findings, teachers must foster critical thinking skills, particularly those in high school. Encouraging critical thinking skills impacts the retention of students with various academic strengths (Jones et al., 2015; Zubaidah et al., 2018; Usman et al., 2021; Danil, 2022). Besides improving academic skills, empowering critical thinking skills can also increase students' retention (Ismirawati et al., 2018; Mahanal et al., 2019).

Empowering retention and critical thinking skills must also be considered in high school students with diverse academic skills in learning biology. Academic skill is students' capacity to use their knowledge to solve problems or complete assignments (Woolfolk, 2010; Lam & Zhou, 2019). Students' academic skills are grouped into high and low (Ozguc & Cavkaytar, 2015; Prayitno et al., 2017). Therefore, students' academic skills need to be empowered through various efforts, including empowering retention and critical thinking skills.

This research needs to be conducted in schools because many schools in Indonesia apply homogeneous classes, both for high and low academic skills. A heterogeneous class allows students to achieve positive learning results with high and low academic skills (Prayitno et al., 2017; Siswati & Corebima, 2017). Teachers need to focus more on the academic skills of their students, particularly those who are less academically skilled, because they require particular care

during the learning process (Afoan & Corebima, 2018; Ismirawati et al., 2018; Usman et al., 2021). An appropriate learning model can direct teachers' attention to strengthening students' academic skills. The exploration of the connection between students' retention and critical thinking skills in diverse academic skills is intended to yield better information about how the predictor variables (critical thinking skills) explain the criteria (retention) to obtain good predictive results in concluding the findings of this study. This research will reveal whether the predictor variable (critical thinking skills) and criteria (retention) are related.

Several results of previous research reveal a lot about the connection between independent variables (predictors) and dependent variables (criteria) associated with students' academic skills (Lam & Zhou, 2019; Shirazi & Heidari, 2019; Amin et al., 2020; Saputri & Corebima, 2020; Siqueira et al., 2020; Adiansyah et al., 2021; Tentama & Nur, 2021; Usman et al., 2021). However, no research has been conducted to investigate the connection between retention and critical thinking skills in students with diverse skills in biology learning. As a result, the study's findings are related. In that instance, a different regression equation test will be performed to highlight the parallels between the regression lines created and to showcase which academic skills show a significant connection between students' retention and critical thinking skills. This study aims to discover the connection between students' retention and critical thinking skills in diverse academic skills in learning biology.

## METHODS

This correlational quantitative descriptive study aims to examine the connection between two variables in biology learning in various academic skills. Fraenkel and Wellen (2008) mention that correlational research is included in descriptive research because this research is an attempt to describe occurring conditions. This research model required a researcher to describe the current condition in a quantitative context reflected in the variables. Arikunto (2010) states that correlational research originates from the problem to be studied. Correlational research determines whether there is a connection or influence between two or more variables. In this study, the variable that acted as a predictor was critical thinking skills, while retention was a criterion. The research was conducted face-to-face in class for 1 (one) semester. The research subjects used as

samples were tenth-grade high school students who took biology lessons in the second semester: 73 students were from SMA Negeri 1 Gandapura, 23 students from SMA Negeri 3 Bireuen, 26 students from SMA Negeri 1 Jangka, 50 students from SMA Negeri 1 Peusangan, and 30 students from SMA Negeri 1 Peusangan Siblah Krueng. The sampling technique used random cluster sampling. A total of 202 research samples were spread over eight classes: four low academic skills classes with 106 students and four high academic skills classes with 96 students. Each class applied the Problem-based Learning (PBL), Direct Instruction (DI) learning model, integrated PBL-DI, and conventional learning classes. All class samples were tested first for class equivalence in the placement test with valid and reliable multiple-choice questions. Equivalence test analysis used SPSS 23 for Windows. The research data were obtained by combining the results of the application of 4 (four) learning models. The data were grouped into high academic skills and low academic skills.

Data collection techniques and instruments used test instruments. The test instrument used to measure critical thinking and retention skills was in the form of valid and reliable essays. The instrument of the essay test questions for each variable was different. The scoring rubric used to score critical thinking skills was a modification of the instrument developed by Zubaidah et al. (2015) with a scale of (0-5), while for retention, using the rubric of Hart (1994) with a scale of (0-4). The essay test for critical thinking skills was given at the start and end of the study, while the retention test was administered three weeks after the learning was done.

Data were analyzed using correlation analysis and simple linear regression, followed by the F-test (ANOVA) assisted by the SPSS 23 program. If the correlation analysis results show a connection between students' retention and critical thinking skills in diverse academic skills with a significance value smaller than 0.05 ( $p < 0.05$ ), a regression test will be conducted to determine how much influence the connection between two variables have in diverse academic skills. The revealed regression equation will be studied further, the extent of which is related to the different tests between the two regression equations. However, before correlation analysis and simple linear regression, the Kolmogorov-Smirnov Test was used to determine the data's initial normality. If the Asymp Sig. value (2-tailed) was larger than 0.05 ( $> 0.05$ ), and the data were normally distributed.

**RESULTS AND DISCUSSION**

Before testing the hypothesis (correlation analysis and simple linear regression) between variables,

the data normality test was tested with the Kolmogorov-Smirnov Test. Table 1 presents the normality test results.

**Table 1.** The Results of the Kolmogorov-Smirnov One-Sample Normality Test of High Academic Skills

		X Critical thinking	Y Retention
N		96	96
Normal Parameters <sup>a,b</sup>	Mean	78,8125	62,8776
	Std. Deviation	5,80379	4,75288
	Absolute	,091	,080
Most Extreme Differences	Positive	,075	,053
	Negative	-,091	-,080
Test Statistic		,091	,080
Asymp. Sig. (2-tailed)		,046 <sup>c</sup>	,151 <sup>c</sup>

The findings from a simple linear regression analysis in Table 2 clarify the connection between two variables in high academic skills.

**Table 2.** The Regression Results of Retention and Critical Thinking Skills in High Academic Skills

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,325 <sup>a</sup>	,105	,096	4,51950

Based on Table 2, the reliability value (R<sup>2</sup>) is 0.105, and the correlation coefficient (R) is 0.325. It suggests that while other factors account for 89.5% of the improvement in retention, critical thinking skills

can contribute 10.5% of it. The ANOVA test is applied to the analysis results to see if the predictor can accurately predict the following criteria, as indicated in Table 3.

**Table 3.** The ANOVA Test Results of the Connection between Students' Retention and Critical Thinking Skills in High Academic Skills

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	226,007	1	226,007	11,065	,001 <sup>b</sup>
Residual	1920,032	94	20,426		
Total	2146,038	95			

Table 3 summarizes ANOVA results and reveals that the F<sub>count</sub> value is 11.065 with a significance value of 0.001 (p<0.05). It demonstrates that students' retention and critical thinking skills

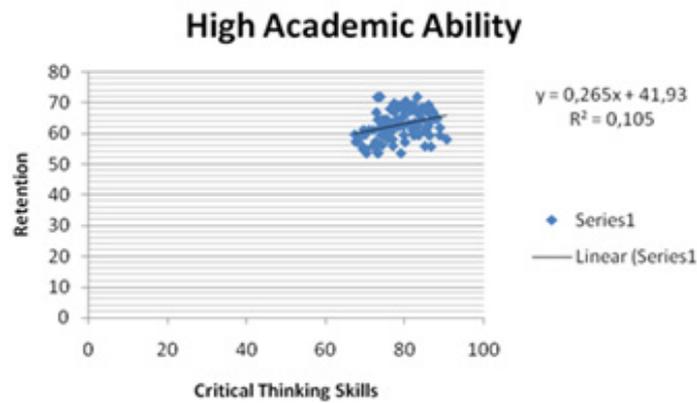
in high academic skills are linked. Table 4 outlines the results of the regression equation analysis, which oversees the connection between two variables in high academic skills.

**Table 4.** Regression Coefficient of the Connection between Retention and Critical Thinking Skills in High Academic Skills

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	41,933	6,314		6,642	,000
XCriticalHigh	,266	,080	,325	3,326	,001

The regression line equation for investigating the connection between two variables in high academic skills is Y=0,266X+41,933, as shown in Table 4.

Figure 1 depicts the equation's connection between the two variables.



**Figure 1.** Regression Equation of the Connection between Retention and Critical Thinking Skills in High Academic Skills

Before testing the hypothesis (correlation analysis and simple linear regression) between variables, the data normality test was first tested with the Kolmogorov-Smirnov Test. Table 5 reveals the Normality test results.

**Table 5.** The Kolmogorov-Smirnov One-Sample Normality Test in Low Academic Skills

		XCriticalLow	YretentionLow
N		106	106
Normal Parameters <sup>a,b</sup>	Mean	67,8868	67,8868
	Std. Deviation	7,18029	7,32394
Most Extreme Differences	Absolute	,100	,076
	Positive	,067	,051
	Negative	-,100	-,076
Test Statistic		,100	,076
Asymp. Sig. (2-tailed)		,011 <sup>c</sup>	,155 <sup>c</sup>

The findings from a simple linear regression analysis in Table 6 clarify the connection between two variables in low academic skills.

**Table 6.** The Regression Results of Retention and Critical Thinking Skills in Low Academic Skills

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,963 <sup>a</sup>	,928	,927	1,97242

Based on Table 6, the reliability value ( $R^2$ ) is 0.928, and the correlation coefficient (R) is 0.963. It suggests that while other factors account for 7.2% of the improvement in retention, critical thinking skills can contribute to 92.8% of it. The ANOVA test is applied to the analysis results to see if the predictor can accurately predict the following criteria, as indicated in Table 7.

**Table 7.** The ANOVA Test Results of the Connection between Retention and Critical Thinking Skills in Low Academic Skills

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5227,598	1	5227,598	1343,706	,000 <sup>b</sup>
1 Residual	404,605	104	3,890		
Total	5632,203	105			

Table 7 shows the  $F_{count}$  of 1343.706 with a significance value of 0.000 ( $p < 0.05$ ). It implies that retention and critical thinking skills in high academic skills are closely related. Table 8 contains the findings

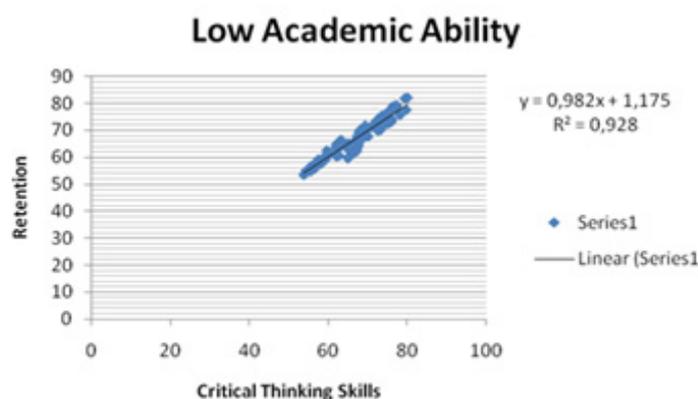
of the regression equation analysis that examined the connection between two variables in low academic skills.

**Table 8.** Regression Coefficient of the Connection between Retention and Critical Thinking Skills in Low Academic Skills

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	1,175	1,830		,642	,522
XCriticalLow	,983	,027	,963	36,657	,000

Table 8 shows that the regression line equation for correlation analysis between two variables in low academic skills is  $Y=0.983X+1.175$ .

Figure 2 illustrates the connection between the two variables with the equation.



**Figure 2.** Regression Equation of Connection between Retention and Critical Thinking Skills in Low Academic Skills

The results of the difference test on the regression equation line between students' retention and

critical thinking skills in diverse academic skills are shown in Table 9.

**Table 9.** The Difference Test of Regression Equations of Connection between Retention and Critical Thinking Skills in Diverse Academic Skills

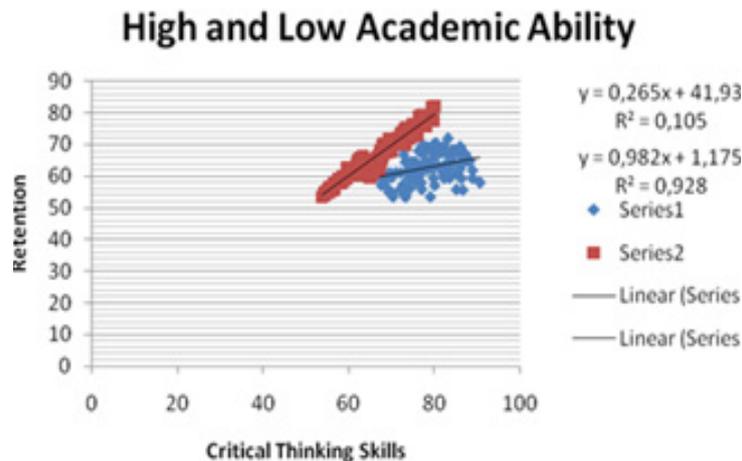
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6717,643	3	2239,214	190,724	0,000 <sup>b</sup>
	b1, b2	1033,701	1	1033,701	88,04508	0,000
	b1, b2, b3	5921,22	2	2960,61	252,1688	0,000
	Residual	2324,637	198	11,741		
	Total	9042,280	201			

Table 9 demonstrates that the regression line involving retention and critical thinking skills in various academic skills is not parallel or coincidental. The parallelism test yielded  $0.000 < 0.05$ , indicating that the two regression lines are not parallel. Meanwhile, in the overlap test, a significance level of  $0.000 < 0.05$  is obtained, meaning that the two regression lines do

not coincide. Table 9 demonstrates that the regression line involving retention and critical thinking skills in various academic skills is not parallel or coincidental. The parallelism test yielded a  $0.000 < 0.05$  significance level, indicating that the two regression lines are not parallel.

Meanwhile, a significance level of 0.0000.05 is reached in the overlap test, indicating that the two regression lines do not coincide. In other words, the retention improvement rate owing to the influence of

critical thinking skills varies greatly between diverse academic skills. The regression equation for the high and low academic skills is shown in Figure 3.



**Figure 3.** Regression Equation of the Connection between Retention and Critical Thinking Skills in High and Low Academic Skills

The research reveals a close connection between students' retention and critical thinking skills in diverse academic skills in high school biology learning in Bireuen, Aceh Province, Indonesia. The results are supported by several previous research. Metacognitive skills and learning outcomes considerably impact students' retention in biology learning (Afoan & Corebima, 2018). According to Usman et al. (2021), students' retention rates in biology learning in diverse academic skills significantly correlate with metacognitive skills. Adiansyah et al. (2021) find a significant connection between scientific attitudes, metacognitive skills, and retention in both male and female students, with female students contributing more to retention than male students. However, some of the findings of these studies do not demonstrate a connection between students' retention and critical thinking skills in diverse academic skills.

This study also indicates variations in how critical thinking skills affect students' retention in various academic skills. Students with high academic skills have a smaller contribution of critical thinking skills to their retention than those with low academic skills. The high and low retention rate in students with diverse academic skills is caused by various factors, such as teachers' learning activities and students' metacognitive and critical thinking skills. Metacognitive and critical thinking skills are part of the internal factors in each student that must be developed to support success in learning, including retention (Siswati

& Corebima, 2017; Talar & Gozaly, 2020). Critical thinking is a metacognitive process that can solve problems encountered, logical ideas, and appropriate conclusions (Endorgan, 2020; Yang & Mohd, 2020; Mafarja et al., 2022).

Critical thinking skills influence students' understanding and memory of what they learn during the learning process. Empowering critical thinking skills in the biology learning process with meaningful learning will increase students' understanding stored and maintained in their memory for a long time to increase student retention (Boleng et al., 2017; Bustami et al., 2018). Critical thinking is a disciplined intellectual process that continually and proficiently envisions, employs, examines, generates, and reviews evidence collected from or acquired through observation, experience, reflection, reasoning, and communication as an empirical basis for beliefs and actions (Fuad et al., 2017; Misrom et al., 2020; Sidiq et al., 2021). Sya'bandari et al. (2019) and Adiansyah et al. (2021) also report that gender, race, and ethnicity significantly influence the retention rate. Meanwhile, the retention improvement rate is also influenced by students' social environment and motivation (Smith et al., 2022). In addition, parents' educational backgrounds, gender, economic difficulties, and ethnicity also affect the rate of increase in student retention (Hughes et al., 2013; Razavi, 2018).

The regression equation lines between students' retention and critical thinking skills in diverse academic skills are not parallel and do not

coincide, according to the different test findings in Table 9. In addition, the regression equation line for students with low academic skills is steeper than that for students with high academic skills, as shown in Figure 3. It means that the retention improvement rate due to the influence of critical thinking skills on students with high academic skills is lower than the improvement rate in students with low academic skills. Furthermore, the change in the effect of critical thinking skills on the retention of students with low academic skills causes an effect more quickly than in students with high academic skills. This result supports earlier findings that students with high academic skills have a smaller contribution of critical thinking skills to their retention when compared to students with low academic skills.

The factor that causes the low retention rate in students with high academic skills is due to students' attitudes and study habits. The researchers' observations during the research process show that the attitudes and study habits of students with academic skills are not good. These students feel they are already superior, so they ignore or even consider it "trifling" and "easy" to participate in various school learning activities, including biology. The unfavorable attitudes and study habits of students with high academic skills are believed to affect the weakness of retention and critical thinking skills.

Another fact revealed in this study is the high retention rate in students with low academic skills. It is due to the attitudes and good study habits of students with low academic skills. Students with low academic skills have persistence and seriousness in participating in learning activities taught by teachers using learning models such as PBL, DI, and integrated PBL-DI, proven to empower and improve critical thinking and retention skills. A suitable model can influence learning and improve students' critical thinking skills (Mabrurroh & Suhandi, 2017; Wartono et al., 2018; Danil, 2021).

The seriousness and persistence of the low academic students in their attitudes and study habits are influenced by the learning methods applied by these students. While all students employ the same learning model, their achievement varies because of the various learning methods. Good learning outcomes are only achieved by students who use effective learning methods. On the other hand, students who use ineffective learning methods will produce poor learning outcomes (Tentama & Nur, 2021).

Meanwhile, Everaert et al. (2017) argue that students with good learning attitudes and

study habits can influence learning motivation and, in the end, increase retention of learning outcomes. Naimnule and Corebima (2018) and Ehsanpur and Razavi (2020) state that the main key to successful student learning is good learning habits, a strategy to obtain good learning outcomes, including increasing retention rates. Students with good learning strategies and habits tend to have high academic skills (Zhou et al., 2016; Özsoy et al., 2017). Good attitudes and study habits will positively influence students, such as making a study schedule that is carried out and self-accounted for. With a study schedule, students can divide when to study, when to repeat so they do not easily forget the lesson, and when to prepare for school the next day (D'Souza & Broeseker, 2022).

## CONCLUSION

This study indicates a connection between various academic skills and students' retention and critical thinking skills in high school biology learning. Students with high academic skills contribute lower critical thinking skills to retention than those with low academic skills. The regression equation lines connecting retention and critical thinking skills in students with a wide range of academic skills are neither parallel nor coincide. The regression equation line for students with low academic skills appears steeper than that for students with high academic skills. It means that the retention improvement rate for students with high academic skills due to the influence of critical thinking skills is lower than the improvement rate for students with low academic skills. This study implies that changes in the effects of critical thinking skills on students' retention occur faster in low academic skills than in high academic skills.

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