

## The correlation between metacognitive skills and scientific attitudes towards the retention of male and female students in South Sulawesi, Indonesia

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### ABSTRACT

This was quantitative correlational research, which investigated the correlation between metacognitive skills and scientific attitudes towards the retention of male and female students in South Sulawesi, Indonesia. The research sample was biology education students in the second semester, with 104 students consisting of 47 males and 57 females. The instruments employed in this study were those for assessing metacognitive skills, scientific attitudes, and retention. Metacognitive skills and retention were measured using essay tests, while scientific attitudes were measured using observation sheets. The results indicated that the value of the simultaneous contribution of metacognitive skills and scientific attitudes towards the retention of female students was higher than that of male students. The effective contributions of metacognitive skills and scientific attitude towards male students' retention were 3.33% and 24.67%. Metacognitive skills and scientific attitudes both contribute 14.5% and 17.2%, respectively, to female students' retention.

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## 1. INTRODUCTION

Retention is an essential indicator in the learning process [1], [2]. Retention is the capacity to recall a piece of learning content for a specified period of time. It is also a fundamental component of learning [3]. Memory has a vital role in the learning process in memorization, but also more on the dimension of critical thinking, learning, associating, remembering, and using all the knowledge and abilities obtained [4], [5]. Additionally, a study defined retention as a person's capacity to store information acquired in memory [6].

The learning process is not possible without retention, and retention will not be possible, without the learning process [7], [8]. Therefore, every person needs to have retention in any case. For instance, if a student is presented with an issue to solve, the student should be able to hone his critical thinking and retention skills [9], [10]. However, retention can be influenced by various factors, one of which is metacognitive skills.

Recent research in science learning emphasizes the importance of applying metacognitive skills [11]. Metacognitive skills become the basis of independent learning in the 21st century [12], [13].

Metacognitive skills are higher-order thinking skills about thinking that involve cognitive processes [14], [15]. Every student must have metacognitive skills in planning, monitoring, and evaluating in the problem-solving process [16], [17]. Also, students who have good metacognitive skills can control their minds, be able to quickly recognize learning material that they do not know and be able to decide, continue or stop the learning process [18], [19].

In addition to metacognitive skills, scientific attitude is also a factor contributing to retention. Scientific attitude is defined as a tendency, readiness, honesty, curiosity, willingness to give responses/actions/behavior in science that has been proven true [20], [21]. Also, scientific attitude is one-way used by researchers to be considered in making decisions or taking actions [22]. This scientific attitude becomes the basic goal of science learning to be developed and must be achieved by all students because scientific attitude is one of the cognitive components [23], [24].

In addition to metacognitive skills, scientific attitudes, and retention; gender also influences the learning processes [25]. Gender, in a narrow sense, is the gender differences, namely male and female [26]. Gender is an essential factor in the learning process and affects various things, for example, in problem solving of science learning, female students are superior to male students [27]. This condition is caused by the fact that male students' metacognition is not very good to be used in the learning process, compared to that of female students [28]. In general, gender differences become disparities in science, from birth until higher education levels [29]. The efforts to achieve gender equality in education have still been continually made [30]. Gurel found that female students had better knowledge than male students. Thus, gender is believed to have a correlation with students' thinking development, including metacognitive skills [31].

Many kinds of correlational research using metacognitive skills as the predictor variable have been conducted in the last decade. The studies found a substantial relationship between students' metacognitive skills and retention [1], [32]-[34]. Additionally, it was discovered that students' metacognitive skills correlated positively with the improvement of their learning outcomes [35]. Research results related to metacognitive skills and scientific attitudes in Indonesia's learning process are still relatively low. The research conducted in senior high schools reported that students' metacognitive skills were categorized as low [36]. Other research results also show that relatively university-level metacognitive skills are still low [37]. The research results of Amnah supporting the low value of metacognitive skills possessed by these university students, also reported that the data of metacognitive skills were in the category of "very risky", and the scientific attitude was in the "low" category [38]. Therefore, metacognitive skills and scientific attitudes need to be empowered and enhanced.

Related to research on gender, it was reported that female students were superior to male verbal skills [39]. There is a difference between male and female students in learning; females are more mature in language, more vital memorization, more confident, and able to handle the situation more successfully [40], [41]. It can also be seen that the female students tend to have better questioning skills, sensitive to social work, better cooperation skills, more precise, and more credible than the male students [42].

The female students have better skills in explaining problem solving procedures and strategies clearly and organized [43]. Female students develop better metacognitive skills than the male students [44]. Garzon, Bistos, and Lizarazo research discovered that there was no statistically significant difference between female and male metacognitive skills [45]. This outcome is consistent with the previous findings showing there is no statistically significant difference between female and male scientific attitudes [46]. Nevertheless, a study reported that gender had a significant effect on students' learning styles and scientific attitudes [47].

There has been a dearth of research into the various correlations between metacognitive skills and scientific attitudes towards male and female students' retention. Therefore, it is necessary to conduct this research because the multiple correlation between the predictor and criterion variables is stronger and more real than a single correlation. Numerous studies continue to focus on straightforward relationships between metacognitive skills and scientific attitudes, metacognitive skills and retention, and metacognitive skills and learning outcomes. Additionally, they examine the relationship between metacognitive abilities and critical thinking, as well as the relationship between metacognitive abilities and other characteristics.

Therefore, this research was conducted to investigate the correlation between metacognitive skills and scientific attitudes towards the retention of male and female students, especially in South Sulawesi, Indonesia. These research results are expected to give students or teachers/lecturers the right learning strategy or learning model, which improves students' learning results. Besides, it can also give useful information for educational curriculum development.

## 2. RESEARCH METHOD

### 2.1. Research model

This research is a correlational study. This study aims to determine the relationship between metacognitive skills and scientific attitudes towards student retention. Metacognitive skills and scientific attitudes in this study act as predictors and student retention acts as criteria.

### 2.2. Participants

The study enrolled 104 biology education students in the second semester of the 2017/2018 academic year, 47 of whom were male and 57 of whom were female. These samples were distributed over Universitas Muhammadiyah Makassar and STKIP Pembangunan Indonesia, Makassar. This study was conducted from April to August 2018.

### 2.3. Research instrument

The instruments in this research were used to measure students' metacognitive skills, scientific attitudes, and retention. The students' metacognitive skills and concept gaining were measured using an integrated essay test [48], with open-ended assessment pattern in Environmental Knowledge Course. The essay test consisted of 14 test items which had been declared valid and reliable. The instrument's validity test was done by performing confirmatory factor analysis. It obtained a factor weighting value of  $>0.3$  and a T-value of  $\pm 1.96$  (all metacognitive skills instrument items were declared valid). The Alpha Cronbach's coefficient related to the metacognitive skills instruments shows a value of 0.959 (consistent or reliable).

The data of the students' scientific attitudes were obtained using observation sheets. The scientific attitude questionnaire consisted of 36 valid and reliable statements. The scientific attitude indicators used referred to the nine indicators, namely: curiosity, rationality, willingness to suspend judgment, positive attitude towards failure, intellectual honesty, objectivity, open-mindedness, humility, cooperation [22]. Every five students will be observed by one observer so that the results obtained are more accurate. The results of the expert validation for the scientific attitude questionnaire and for the scientific attitude observation sheets obtained an average score of 4.00 (very valid category) and 3.90 (very valid category) respectively. The data of the students' scientific attitude were obtained by looking at the weight of the instrument factor  $>0.3$  and a T-value of  $\pm 1.96$ , which was declared valid. The Cronbach's Alpha coefficient shows a value of 0.977, which was declared consistent or reliable.

### 2.4. Data collection

The data were collected from the pretest, posttest, and retention test (two weeks after the posttest). The classroom learning activities were conducted for 16 meetings, in which two meetings were used for tests and 14 meetings were for learning activities. The rubric for metacognitive skills in this research referred to the developed metacognitive skill score rubric [48]. The rubric included eight measures (0-7), which were used to evaluate students' responses to each test item. According to Green [49], the levels of metacognitive skills are as: "super (85-100), ok (68-84), development (51-67), cannot really (34-50), risk (17-33), and not yet (0-16)." The rubric scores were calculated using the metacognitive skill formula [48].

$$\frac{y1+2x}{3} = y2$$

Description:

y1 = concept gaining score

y2 = the combination between concept gaining score and metacognitive skills score

x = metacognitive skills score

The data of the students' scientific attitudes were obtained using observation sheets that had been validated by experts. The categories of the results of observations were determined by giving scores and criteria (very low, low, medium, good, and very good), while the scientific attitude questionnaire used the Likert scale.

### 2.5. Data analysis

The Kolmogorov-Smirnov test was used to examine whether or not the research data were regularly distributed. Following that, the hypothesis was investigated using multiple regression analysis with a 5% significance level to ascertain the correlation and contribution of metacognitive skills and scientific attitudes on student retention.

### 3. RESULTS AND DISCUSSION

#### 3.1. The correlation between metacognitive skills and scientific attitudes towards the retention of male students

The correlation between metacognitive skills and scientific attitudes regarding retention of male students is summarized in Table 1 to Table 3. The Anova test results in Table 1 indicate that the F value is 8.560 with a significance level of 0.001. This demonstrates a significant association between metacognitive skills and scientific attitudes toward male students' retention. The results of the analysis in Table 2 show that the regression equation was  $Y=16.141+0.063X_1+0.569X_2$ . The results of the analysis in Table 3 show that the correlation coefficient (R) is 0.529 having a contribution value ( $R^2$ ) of 0.280. This means that the value of the simultaneous contribution of metacognitive skills and scientific attitudes towards retention is 28%.

Table 1. Summary of Anova on the correlation between metacognitive skills and scientific attitudes towards the retention of male students

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	512.286	2	256.143	8.560	.001 <sup>b</sup>
	Residual	1316.691	44	29.925		
	Total	1828.977	46			

Table 2. Regression coefficient of metacognitive skills and scientific attitudes towards the retention of male students

Model		Unstandardized coefficients		Coefficients standardized Beta	t	Sig.
		B	Std. Error			
1	(Constant)	16.141	9.614		1.679	.100
	Meta	.063	.134	.108	.470	.641
	Scientific attitude	.569	.213	.616	2.668	.011

Table 3. Summary of the results of multiple regression related to the correlation between metacognitive skills and scientific attitudes towards retention of male students

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.529 <sup>a</sup>	.280	.247	5.47036

Table 4 summarizes the findings of an examination of the influence of metacognitive skills and scientific attitudes to male students' retention. The results of the analysis in Table 4 show that the effective contributions of metacognitive skills and scientific attitudes towards retention are 3.33% and 24.67%, respectively.

Table 4. Contributions of metacognitive skills and scientific attitudes towards the retention of male students

Variable	RC (%)	EC (%)
X1 (metacognitive skills)	11.89	3.33
X2 (scientific attitude)	88.11	24.67
Total	100	28.0

#### 3.2. The correlation between metacognitive skills and scientific attitudes towards the retention of female students

The correlation between metacognitive skills and scientific attitudes regarding retention of female students is summarized in Table 5 to Table 7. The results of the Anova test in Table 5 show that the F value=12.519 with a significance value of 0.000. The analysis results show a very significant correlation between metacognitive skills and scientific attitudes towards the retention of female students. The analytical results in Table 6 indicate that the regression equation found is  $Y=17.860+0.191X_1+0.319X_2$ . The results of the analysis in Table 7 show that the correlation coefficient (R) is 0.563 having a contribution value ( $R^2$ ) of 0.317. This suggests that the combined effect of metacognitive skills and scientific attitudes on retention is 31.7%.

Table 5. Summary of Anova on the correlation between metacognitive skills and scientific attitudes towards the retention of female students

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	535.881	2	267.941	12.519	.000 <sup>b</sup>
	Residual	1155.779	54	21.403		
	Total	1691.660	56			

Table 6. Regression coefficient of metacognitive skills and scientific attitudes towards the retention of female students

Model		Unstandardized Coefficients B	Std. Error	Coefficients Standardized Beta	t	Sig.
1	(Constant)	17.860	8.135		2.196	.032
	Meta	.191	.102	.286	1.883	.065
	Scientific attitude	.319	.147	.330	2.176	.034

Table 7. Summary of the results of multiple regression related to the correlation between metacognitive skills and scientific attitudes towards retention of female students

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.563 <sup>a</sup>	.317	.291	4.62637

The results of the analysis of the contribution of metacognitive skills and scientific attitudes towards the retention of female students can be seen in Table 8. The results of the investigation in Table 8 indicate that metacognitive skills and scientific attitudes make beneficial contributions to retention of 14.5% and 17.2%, respectively.

Table 8. Contributions of metacognitive skills and scientific attitudes towards the retention of female students

Variable	RC (%)	EC (%)
X1 (metacognitive skills)	45.75	14.5
X2 (scientific attitude)	54.25	17.2
Total	100	31.7

According to the results of the multiple linear regression analysis, there is a strong correlation between metacognitive skills and scientific attitudes toward retention in both male and female students. The regression equation is  $Y=16.141+0.063X_1+0.569X_2$  with the simultaneous contribution between metacognitive skills and scientific attitudes towards male students' retention as much as 28%. The regression equation is  $Y=17.860+0.191X_1+0.319X_2$  with simultaneous contribution between metacognitive skills and scientific attitudes towards female students' retention as much as 31.7%. Furthermore, this research shows that the contribution of metacognitive skills and scientific attitudes towards retention in female students is higher than that in male students.

The findings of this study corroborate previous research indicating that female pupils possess superior verbal abilities over male students [41]. This is consistent with the theory stating that males' and females' brain functions are different [50]. The differentiating factor between female students and male students is in language and skills [51]. Female pupils listen and speak with their left brains, whereas communication tasks are mostly conducted with their left brains. Thus, the left brain is critical for female language abilities [52]. Female students are more sensitive to social work and group work, and they have better questioning skills and are more credible and stronger in language and writing than male students [53]. The male students are superior in reasoning abilities, visual-spatial, mathematics and mechanics, while the female students are superior in accuracy, precision, and thinking [54].

Other research also shows that women are more concerned with concrete, practical, emotional, and personal things, while men are concerned with intellectual, abstract, and objective things. Therefore, women are superior, more accurate, and more detailed in doing stuff than men [55], [56]. Moreover, female students also use more learning strategies in the learning process to have high intelligence [57], [58]. The male students tend to show positive attitudes towards science and to have the desire to be scientist as the future-career path [59].

Internal factors and external factors can influence retention. The internal factors include health, talents, interests, motivation, intelligence, and memorization skills. In comparison, the external factors

include family, school, environment, and community factors. Metacognitive skills and scientific attitudes are internal factors that are self-developed in students. Thus, female students have more optimal metacognitive skills than male students [60]. The students who have good metacognitive skills will have more confidence in actualizing themselves in scientific activities and scientific processes. As a result, the learning objectives can be more effectively achieved [61], [62]. The effectiveness of achieving learning objectives plays a role in increasing retention.

Scientific attitude refers to the capacity to act consistently, rationally, and objectively in a particular way in response to challenges, which is manifested in one's behavior [63]. Scientific attitude includes curiosity, open-mindedness, discovery attitude, open attitude, honesty, critical thinking, goals, responsibilities, cooperation, and firm attitude [64]. People who have positive scientific attitudes will positively affect their learning process [65]. This fact can be seen from the results of effective contributions in this research (Table 4 and Table 8).

Previous research findings indicated a considerable disparity in attitudes toward science between female and male students [66]. The research results conducted by Mihadiz, Duran, and Dogan showed that the female students had better scientific attitudes than the male students [67]. On the other hand, some other studies found no substantial difference in female and male students' views toward science.

The effective contribution of metacognitive skills towards retention in this research is much as 17.83%, and the effective contribution of scientific attitudes towards retention is as much as 41.87%. This research proves that metacognitive skills and scientific attitudes simultaneously provide a significant effective contribution towards retention of both male students and female students. Therefore, students must possess good metacognitive skills and scientific attitudes to achieve satisfying learning results. This result is in line with report saying that metacognitive skills and scientific attitudes are two important factors in the learning process, and both have a strong correlation with retention [68].

Metacognitive skills also play an important role in regulating and controlling one's cognitive processes, and a critical aspect of cognitive components is the scientific attitude [69]. To be an independent learner requires not only metacognitive skills and the ability of the male and female students, but also the development of the students' scientific attitudes and retention [70]. This is in line with the research results reporting that the students who have good academic achievement will most likely have good metacognitive skills, scientific attitudes, and retention [71]. Therefore, the students are capable of showing good attitudes to organize their learning more effectively and to decide the best time for learning and for reviewing the learning materials [72].

Similar research results also reported that the metacognitive skills and the scientific attitudes of both male and female students are cognitive components which are interrelated with each other [73]. Therefore, it is important to develop students' scientific attitudes [74]. The development of scientific attitudes is not only for research purposes or science learning purposes but also for human life quality for both males and females [75]. The increase of scientific attitudes is also related to gender, academic achievement, parents' profession, education, economics, and learning styles that become the characteristics of the students in interacting and reacting to the learning environment during the learning process [74], [76]. Besides, scientific attitudes also significantly affect students' minds or memories and actions [77].

To increase the contribution of scientific attitudes towards retention can be done by implementing appropriate learning strategies [78]. This is important because retention is one of the key components of learning success [7]. Students who have high metacognitive skills and scientific attitudes will quickly memorize the learning material to get high test results. This opinion is in line with the research results, stating that retention does not only involve the process of remembering or memorizing but also involves one's cognitive ability in evaluating his or her success [79], [80].

Related to the results of this research proving that metacognitive skills and scientific attitudes have a significant correlation with retention, metacognitive skills and scientific attitudes are interconnected. Metacognitive skills involve a cognitive process. Similarly, scientific attitudes require cognitive processes to simultaneously empower retention, thus obtaining a very effective contribution to the improvement of retention of both male students and female students in learning. Furthermore, other factors that can influence and increase students' retention can be further investigated in future research.

The results of this research are expected to give contributions to educators, both teachers and lecturers, in various disciplines to empower students' metacognitive skills and scientific attitudes in the learning activities. The learning scenario which involves those components is expected to enrich the quality of science learning. Teachers and lecturers should be able to guide their students to develop their scientific attitudes through investigation activities. Furthermore, teachers and lecturers should train their students to do planning, monitoring, evaluating, and solving problems. This effort is expected to provide a more meaningful learning which can effectively increase students' retention. It is expected that both male and female students can contribute to the advancement of science and the increase of competence to face the global challenges.

#### 4. CONCLUSION

The study found that there is a substantial relationship between metacognitive skills and scientific attitudes toward retention among male and female students in South Sulawesi, Indonesia. The combined effect of metacognitive skills and scientific attitudes on female students' retention is 31.7% more than the combined effect on male students' retention, which is 28%. The effective contributions of metacognitive skills and scientific attitudes towards male students' retention are 3.33% and 24.67%, respectively. Furthermore, the effective contributions of metacognitive skills and scientific attitudes towards female students' retention are 14.5% and 17.2%, respectively. This study illustrates the need for maximum empowerment of metacognitive skills, scientific attitudes that will be useful to raise the student retention, especially for male students during the biology learning process. In addition, this study can be used as a comparison for other studies in examining the relationship between metacognitive skills, scientific attitudes and retention.

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