RESEARCH ARTICLE

Unveiling the cognitive scaffold: Metacognitive correlates of academic resilience in biology learners

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Abstract: Good metacognitive allows individuals to more easily adapt to changes in the learning environment and face challenges that arise. They tend to be more flexible in changing their learning strategies according to new needs and situations. The aim of this research is to determine the correlation between metacognitive and the academic resilience of students concentrating on biology subjects at State of Senior High School 1 Tasikmalaya. This research was carried out from January to March 2024. The method used was correlational with a population of 950 students. Sampling was carried out using a quota sampling technique, that 10% of the population was taken which represents the research characteristics of 211 students. The study instruments used consisted of 3 validated instruments, including the Metacognitive Awareness Inventory (MAI) and Academic Resilience 30 (ARS-30). The data were analyzed using a bivariate correlation regression test. Based on the study results, it shows that there is a correlation between metacognitive and (R= 0.792; R2 = 0.627). The Effective Contribution (EC) given by metacognitive to academic resilience, is 15.7%. So, it could be concluded that the correlation between metacognitive to students' academic resilience in biology subjects at State of Senior High School 1 Tasikmalaya is in the strong category because it is in the regression criteria between 0.60 – 0.799.

Keywords: academic resilience; biology; correlation; metacognitive

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Introduction

Currently, resilience is important for adolescent mental health as life support during the transition phase after the pandemic (Florensa et al., 2023; Medlicott et al., 2021). Post-pandemic conditions have an impact on how teenagers' future orientation changes, which can affect their academic achievement (Muspawi, 2020). In particular, 21st century education has introduced a new paradigm that focuses on students mastering various abilities in the learning process (Jovanka et al., 2021; Turiman et al., 2012). Therefore, resilience is important in learning in this modern era as one of the basic abilities of the 21st century (Dwiastuti et al., 2021; Scott, 2015).

Resilience tends to require participants to be able to set realistic goals, maintain motivation, and use effective learning strategies to achieve learning goals, so that academic resilience is considered important as a basic ability in this modern era of education (Martin & Marsh, 2009). Resilience in the academic realm identifies the reasons why students are at risk of succeeding or failing in the academic realm (Salim & Fakhrurrozi, 2020). Several aspects that affect resilience include self-regulated learning, self-ability, metacognitive control, perseverance, and low anxiety (Eva et al., 2021; Raghunathan et al., 2022; Tran et al., 2023).

From this aspect, the important competency that students must at least master in the learning process is metacognitive. At various levels of education, metacognitive skills need to be emphasized and given full attention, so that students can increase awareness and responsibility for their own knowledge and thinking (Panchu et al., 2016a; Suwandi et al., 2024). It is because most education systems still tend to emphasize cognitive aspects, teaching approaches that are still teacher-centered (Aini et al., 2022;

Mohammad & Kamran, 2023; Nuragnia et al., 2021). So that usually educators only assess students based on their cognitive learning outcomes without trying to build their metacognitive skills. Therefore, it is necessary to empower students' potential, especially in terms of empowering thinking, and training students to become independent learners (Aziziy et al., 2015; Ermin, 2021). Especially in subjects that are always developing and problem-based, such as biology (Marthaliakirana et al., 2022; Sari et al, 2020).

According to interviews with students on their learning experiences at State of Senior High School 1 Tasikmalaya, biology is a complicated topic that demands in-depth understanding to study (Fauzi & Fariantika, 2018). This is similar to the biological concept, which investigates scientific facts about real-world events as well as abstract concepts or objects like chemical metabolic processes, hormone systems, coordination systems, and so on (Adegboye et al., 2017; Hossain et al., 2018; McComas et al., 2018). So students must have metacognitive skills to encourage their ability to think critically in solving problems (Choirudin & Sahlan, 2023; Dwyer et al., 2014; Marthaliakirana et al., 2022).

Based on the results of the preliminary study through questionnaires, it was found that students' metacognitive abilities were 79%. Supported by observation results which show that students' abilities in managing information are uneven when given direct assignments along with the problem-solving strategies that will be used to solve them. It does not align with metacognitive abilities in choosing the right way and integrating progress in solving issues (Wagener, 2013; Yeh et al., 2019). As a consequence, students cannot manage their learning strategies well. So it can have an impact on students' ability to understand the material and manage their time and their learning methods. Apart from that, based on interviews with 40 students, they also stated that academic pressure affected them. However, the interesting thing that the author found was that students were still able to survive the academic pressure relying on their thinking abilities. Students can still complete assignments, exams, and remedial work according to the instructions given by the teacher, even by asking friends for help. This shows that there is conformity with the resilience indicator, namely adaptive assistance in asking for the necessary support from other people (Khairunnisa & Setyowati, 2022; Zhang et al., 2021).

The correlation between metacognition and students' academic resilience has not been widely studied by previous researchers (Baniani & Davoodi, 2021; Trigueros et al., 2020). Therefore, this provides an opportunity to conduct a deeper study regarding the relationship between metacognition and students' academic resilience in biology subjects. If the correlation is known, this is useful as a basis for teachers to create learning that develops metacognitive skills and trains academic resilience in the learning process. In addition, there are still few studies regarding academic resilience in Indonesia based on a scoping literature review (Dwiastuti et al., 2021). So this research was conducted to examine the correlation between metacognition and students' academic resilience.

Method

This study used a correlational study method and was conducted from January until March 2024. The variables studied included metacognition as a dependent variable and academic resilience as an independent variable. The study population consists of all students who learn biology at State of Senior High School (SSHS) 1 of Tasikmalaya, West Java Province, during the 2023–2024 academic year, totaling 950 participants. Even though the actual sample is 211 people, this study uses a quota sampling technique, in line with the view of Arikunto (2013), which states that if the population exceeds 100, a 10% sample can be taken. The selection of this sampling technique was carried out with consideration of reflecting the composition of the population proportionally and embracing variations from various groups or sub-populations.

The instrument used in this study has gone through a validation process and consists of the Metacognitive Awareness Inventory (MAI) questionnaire (Table 2) from Schraw and Dennison (1994), which is divided into two main components: knowledge about cognition (including declarative, procedural, and conditional knowledge) and cognitive regulation (i.e. planning, information management, monitoring debugging or repair, and evaluating). Meanwhile, the Academic Resilience Scale (ARS-30) from Cassidy (2016) is used to measure academic resilience, with indicators such as persistence, reflection, adaptive help-seeking, negative affect, and emotional response (Table 3). Each statement in ARS-30 is filled in using a Likert scale, where the scores are strongly agree (4), agree (3), disagree (2), and strongly disagree (1). In the MAI questionnaire, the Gutman scale is used, namely true or false, with a score of 1 for statements that are considered true and a score of 0 for statements that are considered false.

The data analysis technique applied involves bivariate and multivariate correlation regression tests. Previously, the data obtained would be tested using normality, linearity, multicollinearity, and heteroscedasticity tests as prerequisite test steps. Data was obtained via a questionnaire in the form of a Google Form that was distributed to respondents. The instruments were created by the researcher and evaluated by an expert team. After designing the instruments, they were disseminated to respondents via a WhatsApp group. After gathering the data, the data was evaluated descriptively and quantitatively in the form of a bar diagram. If there is an invalid instrument statement, it is not used and discarded. The following is a grid of questions from the study instruments used.

Table 1**.** Self-regulated learning instrument grid

Name of Instrument	Variable	Indicator	Favorable	Unfavorable	Total
Motivated Strategies for Learning Questionnaire (MSLQ)	Self-Regulated Learning	Cognitive strategy use	4, 9, 19, 23, 27, 31, 35*, 37*, 39*, 41, 42, 43*	14	13
		Self-regulation	5, 20, 24*, 28, 38, 40	32, 36, 10	9
	Motivation to Learn	Intrinsic value	2, 7, 12, 17*, 22, 26, 30, 34, 44	-	9
		Self-efficacy	1, 6, 11, 15, 16, 21, 25, 29, 33	-	9
		Test anxiety	3, 8, 13, 18	-	4
Total Statement Items					44

Description : *(Invalid statement)
Source : Pintrich and Groot (1990)

Table 2. Metacognitive instrument grid

Name of Instrument	Variable	Indicator	Number of item	Total
Metacognitive Awareness Inventory (MAI)	Cognitive Knowledge	Declarative	5, 10, 12, 16, 17*, 20*, 32, 46	8
		Procedural	3, 14, 27, 33	4
		Conditional	15, 18, 26, 29, 35	5
	Cognitive Regulation	Planning	4, 6, 8, 22, 23, 42, 45	7
		Information Management Strategies	9, 13, 30*, 31, 37*, 39, 41, 43, 47, 48	10
		Monitoring	1, 2, 11, 2, 28, 34, 49	7
		Debugging	25, 40, 44, 51, 52	5
		Evaluation	7, 19, 24*, 36, 38, 50	6
Total Statement Items				52

Description : *(Invalid statement)
Source : Schraw and Dennison (1994)

Table 3. Academic resilience instrument grid

Name of Instrument	Indicator	Favorable	Unfavorable	Total
Academic Resilience Scale (ASR-30)	Perseverance	2, 4, 8, 9, 10*, 11, 13, 16, 17, 30*	1, 3, 5, 15	14
	Reflecting and adaptive help-seeking	18*, 20, 21, 22, 24, 25, 26, 27, 29	-	9
	Negative affect and emotional response	23	6, 7, 12, 14, 19, 28*	7
Total Statement Items				30

Description : *(Invalid statement)
Source : Cassidy (2016)

Results and Discussion

The correlation coefficient (R) value is 0.792 and the determination coefficient (R2) is 0.627. So it can be concluded that the metacognitive variable contributes 62.7% while the remaining 37.3% is another variable that was not examined in this study. It can be seen in the Table 4.

Table 4. Summary of metacognitive correlation test results with students' academic resilience

Model	R	R-Square	Adjusted R-Square	Std. Error of the Estimate	Change Statistics				
					R-Square Change	F Change	df1	df2	Sig. F Change
1	.792[a]	0.627	0.625	3.051	0.627	351.396	1	209	0.000

a. Predictors: (Constant), Metacognitive

The regression equation Ў = a + bx. The a score is 56.323 while the b score is 0.750. So the regression equation obtained is Ў = 56.323 + 0.750x. It can be seen in the Table 5.

Table 5. Summary of metacognitive correlation test results with students' academic resilience

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	56.323	1.406		40.058	0.000
	Metacognitive	0.750	0.040	0.792	18.746	0.000

a. Dependent Variable: Academic Resilience

Metacognitive can affect the formation of academic resilience because it is caused by several interrelated things, including positive beliefs about worries, cognitive awareness, cognitive beliefs, negative beliefs about uncontrolled thinking and the need to regulate thoughts (Moyano et al., 2020). The influence of metacognitive on resilience can be related to understanding the individual's own metacognitive beliefs, this is because metacognitive integrates information received from various sources including the current situation, past experiences and cognitive awareness experienced by the individual (Nejati et al., 2019). For example, if students continuously think and worry about problems but do not try to correct these beliefs by finding solutions, this will hinder the formation of resilience. Meanwhile, students who have positive beliefs are used to proactively solve existing problems, which will influence the development of individual resilience (Baniani & Davoodi, 2021; Hakimi et al., 2019).

Based on the study results, the metacognitive of students at SSHS 1 of Tasikmalaya in biology subjects is still under average. According to the interview results, most students have not implemented metacognitive as well. For instance, in terms of developing skills and strategies used to process information more efficiently. So students' metacognitive still needs to be improved through learning activities. Metacognitive can be related to academic resilience, if students are able to persist in empowering their metacognitive skills through thinking regulation. This is in line with the statement that students with higher metacognitive skills are more flexible in adapting to various learning situations and adapting their strategies according to needs (Hamzah et al., 2023). Therefore, metacognitive is needed so that students can persist with good quality learning and academic results.

This study on the correlation between metacognitive and students' academic resilience is consistent with previous research findings. Like study conducted by Mehrabian et al (2022) which concluded that there is a correlation between male and female teachers' resilience and their problem solving skills and metacognitive skills with a strong significant correlation category. Students' metacognitive achievements can be determined from the answers to the MAI questionnaire. Based on students' answers, different average scores were obtained for each indicator in the metacognitive component. The average score for metacognitive knowledge can be seen in the diagram in Figure 1.

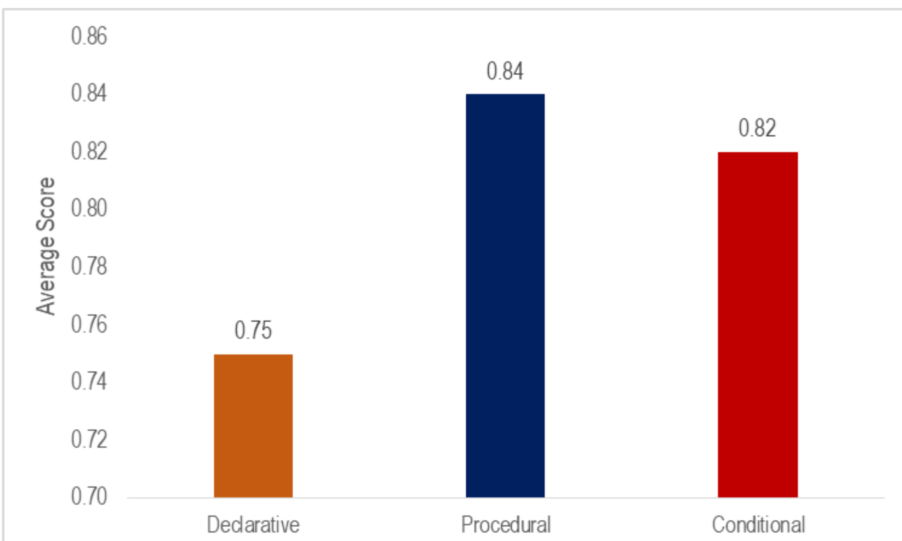

Figure 1. Average score of metacognitive knowledge components

Figure 1 shows that the average score for each student indicator is not significantly different, around 0.75 to 0.84. The highest score is found in the procedural knowledge indicator with an average score of 0.84. Meanwhile, the lowest score was found in the declarative knowledge indicator with an average score of 0.75. A more detailed explanation of each indicator is explained in the following explanation.

The indicator of procedural knowledge consists of four statement items with an average score of 0.84. Procedural knowledge relates to a person's knowledge of the procedures and strategies that will be used in learning. It is align with the statement that procedural knowledge is a set awareness about how to do something (Saygili, 2017). This procedural knowledge is important for students to have because it can help them solve problems and achieve goals. Based on the average score above, the declarative knowledge score shows the highest score (Figure 1). Referring to the results of the interview, students are able to identify the steps needed to complete the task by following the technical work, so that they know what they need to do to complete the task. Especially during practicum, students are able to explain each procedure or work step before drawing conclusions. Procedural knowledge can be built through activities that complete exercises through practical skills and solve problems (Saygili, 2017; Wardoyo et al., 2021). Therefore, students' procedural knowledge can help them apply their learning procedures and train their thinking skills systematically. So if procedural knowledge is developed, students' metacognitive knowledge will also develop.

The indicator of declarative knowledge consists of six statement items with an average score of 0.75. Declarative knowledge relates to a person's knowledge about himself as a student and the factors that influence his learning process (Frisk & Larson, 2011; Panchu et al., 2016b). Such as what information must be studied before studying biology, strengths and weaknesses in understanding concepts in biology and knowing the learning strategies and resources needed. This is in line with the statement that declarative knowledge is knowledge about something which includes knowledge of oneself as a student and the factors that accompany it (Alghadari et al., 2022). Based on the average score above, the declarative knowledge score shows the lowest score (Figure 1). It is supported by the interviews results, that students do not yet know their own strengths and weaknesses in studying biology. However, regarding the learning resources needed, participants can already find out about various educational platforms, e-books, and networks that support their learning resources. According to the literature if students have high declarative knowledge then they know their strengths and weaknesses (Panchu et al., 2016b; Wardoyo et al., 2021). By knowing deficiencies in a subject, for example, a student can anticipate failure by preparing themselves when facing an exam. Thus, declarative knowledge needs to be increased so that their metacognitive knowledge increases.

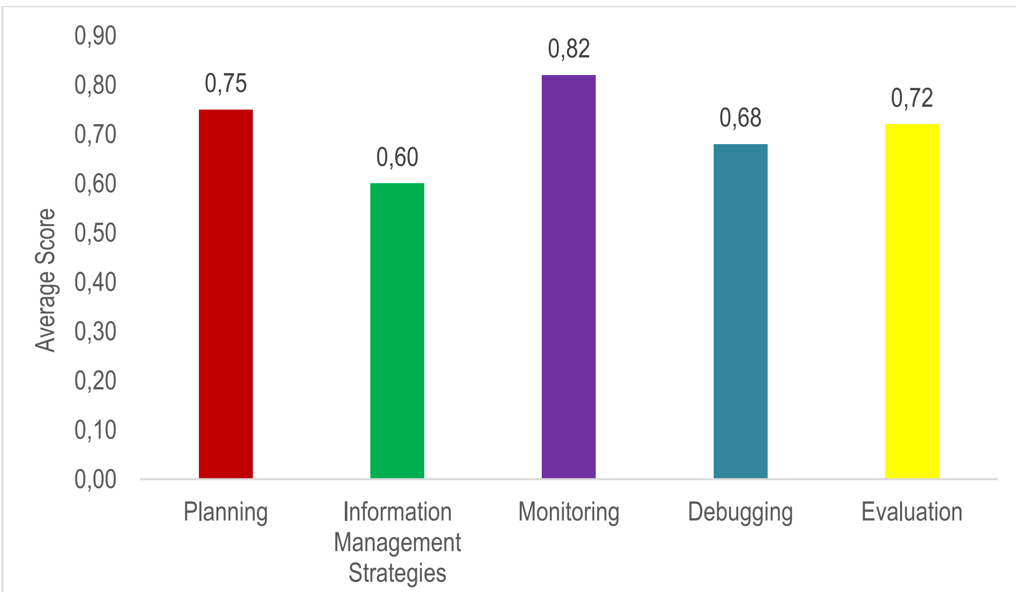

Figure 2. Average score of cognitive regulation components

Apart from other components in metacognitive is cognitive regulation. Based on the bar diagram in Figure 2 above, the average score for each student indicator is different. The highest score is in the monitoring indicators with an average score of 0.82. Meanwhile, the lowest score was found in the information management strategy indicator with an average score of 0.60. A more detailed explanation of each indicator is explained in the following explanation.

The indicator of the monitoring strategy consists of seven items with an average score of 0.82. Monitoring understanding can take the form of recalling what has been understood. This indicator is also related to the approach used in psychology to understand how individuals process, save and use information, as well as their awareness to test themselves when students learn (Fitria et al., 2020). Based on the results, the average score is included in the highest category as seen in Figure 2, so it can be indicated that it is good. This can be seen during observations and interviews that were carried out when entering new learning material and trying to connect old knowledge with new knowledge. Some students were able to recall the material that had been studied. Sometimes they will also ask themselves periodically whether he has achieved goals in learning. In line with the study that states monitoring activities help students understand the material and integrate it with their initial knowledge and also help construct a resolution process the problem is whether it is in accordance with what is known (Wardana et al., 2020). However, the monitoring performed by the pupil in testing his own knowledge does not all do it, as doing every exercise issue, they tend to do it when getting a task. Therefore, in order to get better monitoring in learning, students need to regularly train and examine their understanding to have good cognitive regulation.

The information management strategies indicator consists of eight statements with an average score of 0.60. Information management strategy is students' ability to manage information more efficiently (Schraw & Dennison, 1994). Based on the study results, the average score for information management strategies is the lowest score. This can be seen when in the learning process, students are given the task of looking for various references, they are able to look for them, but the credibility of the sources used is still not appropriate. In addition, based on interviews, most of them did not take notes and summarize important information during direct learning in class. Students tend to want to get instant information from the internet without needing to record it. Only a few students are diligent in explaining the material in their notebooks. Strategy activities for managing information help students pay careful attention to structuring problems in their own words to find out information related to something they know (Wardana et al., 2020). This shows that students who still lack information management strategies are not yet aware of how to organize and concentrate important information for learning. So there is a need for improvements to process information more efficiently through good cognitive regulation.

Conclusion

There is a correlation between metacognitive skills and academic resilience in biology learning. The correlation is categorized as strong, with R = 0.792, while R2 (coefficient determination) is 0.627. It means that the contribution of metacognitive skills is 62.7%, and the remaining part as much as 37.3% is influenced by other variables not examined in this study. Based on study findings, it is recommended that metacognitive skills can be implemented into the learning process, especially in the planning, monitoring, and evaluation stages, so that students can get used to being trained in managing their cognitive activities. In particular, it can have an impact on the formation of a resilient character. Further study can be carried out regarding other psychological skills that are related to increasing academic resilience.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

All team members contributed equally in the writing of this article. They carry out collaborative activities according to the tasks and functions that have been mutually agreed upon, from study planning to writing articles for journals.

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