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METACOGNITIVE STRATEGIES AND ACHIEVEMENT EMOTIONS AS PREDICTORS OF STUDENTS' ACADEMIC SELF EFFICACY IN LEARNING SCIENCE

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ABSTRACT
The study examined the impact of metacognitive strategies and achievement emotions on students' academic self-efficacy in learning science. It involved 344 respondents from three public secondary schools in the Division of Tagum City, selected through stratified random sampling. Data were collected using three questionnaires: the Motivated Strategies for Learning Questionnaire (MSLQ), Achievement Emotions Scale (AES), and Academic Self-Efficacy Scale (ASES). The results showed that metacognitive strategies were frequently observed, achievement emotions were somewhat manifested, and students' academic self-efficacy in learning science was moderate. Moreover, the results indicate that both metacognitive strategies and achievement emotions significantly correlated with and predicted students' academic self-efficacy in learning science. The study suggests that teachers should promote metacognitive strategies and foster positive achievement emotions to enhance students' academic self-efficacy.
KEYWORDS: *science education, metacognitive strategies, achievement emotions, academic self-efficacy, descriptive and correlational design, regression analysis, Tagum City, Davao del Norte, Philippines*

INTRODUCTION
Background of the study
Self-efficacy is crucial for students' learning in science, as it reflects their self-perception and ability to achieve their goals (Chen et al., 2020). According to Kwarikunda et al. (2022), despite resources in science education, students in both developed and developing countries often have low self-efficacy in science topics. A decrease in metacognitive strategies can negatively impact academic self-efficacy, as students find tasks more challenging (Wu et al., 2022). Additionally, negative emotions like anxiety and fear can restrict students' potential to increase their self-efficacy levels in academic endeavors (Yang et al., 2017). Therefore, teachers must create a learning environment that enhances students' academic self-efficacy in science, promoting greater willingness to complete tasks.

In Malaysia, a study found that academic self-efficacy among students is declining due to the influence of achievement emotions felt from direct observation of their classmates, who frequently serve as a point of comparison for their academic capacity (Hasan et al., 2020). The same result was discovered in a study conducted by Grotan et al. (2019) among Norwegian students and Hitches and Ehrich (2022) among Australian students, who have experienced low academic self-efficacy in learning science because of emotional difficulties such as anxiety and depression. In the Philippines, students also face low self-efficacy towards science education, despite possessing fundamental skills (Soltani & Askarizadeh, 2021). Blanco et al. (2020) found that students' self-efficacy in Cebu is negatively impacted by inadequate scientific skills and positive achievement emotions, while Dullas (2018) found low academic self-efficacy in Nueva Ecija and Villavicencio (2018) reported 7 out of 10 high school students struggling. Furthermore, Gurcay and Ferah's (2018) research in the Davao region also showed a decline in students' academic self-efficacy, particularly in science learning.

A study found that students' lower self-efficacy in academic endeavors is due to a decrease in metacognitive strategies and increased negative emotions in science classes. this research explores the relationship between students' academic self-efficacy in learning science in Tagum City's school division and achievement emotions and metacognitive methods. Despite previous research in Western nations showing a positive correlation between metacognitive techniques, achievement emotions, and academic self-efficacy, the impact of these variables on the educational landscape, particularly in science learning, remains unproven.

Given the challenges faced by the Education department, especially with the implementation of distance learning, this study is crucial for understanding how metacognitive strategies and emotions affect students' academic self-efficacy. The findings will provide valuable insights for teachers to enhance metacognitive strategies and emotional well-being, ultimately improving students' academic self-efficacy in learning science. The study's results will be disseminated to educational

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institutions and presented at various local and international academic forums and conferences to contribute to evidence-based solutions for enhancing students' academic self-efficacy.

Research Questions

The research aimed to answer the following:

1. What is the level of metacognitive strategies in terms of:
   - 1.1. Rehearsal;
   - 1.2. Elaboration;
   - 1.3. Organization;
   - 1.4. Critical Thinking; And
   - 1.5. Metacognitive Self-Regulation?
2. What is the extent of achievement emotions in terms of:
   - 2.1. Class Related Emotions;
   - 2.2. Learning-Related Emotions; And
   - 2.3. Test Emotions?
3. What are the students' academic self-efficacy level in learning science?
4. Is there a significant relationship between:
   - 4.1. metacognitive strategies and students' academic self-efficacy in learning science?
   - 4.2. achievement emotions and students' academic self-efficacy in learning science?
5. Do metacognitive strategies and achievement emotions significantly predict students' academic self-efficacy in learning science?

METHOD

Research Design

This study adopts a quantitative research approach, specifically employing descriptive-correlational designs. According to Broadbent (2017), quantitative research facilitates the use of survey questionnaires to collect quantitative data and identify correlations between variables. Descriptive-correlational design focuses on examining relationships between variables, indicating the strength and breadth of their associations (Tan, 2019). This design was chosen to quantify the strength and significance of causal relationships between metacognitive strategies, achievement emotions, and students' academic self-efficacy in learning science. Such an approach allows for a comprehensive analysis of the interplay between these variables and their potential impact on academic performance.

Research Respondents

Grade 10 students enrolled in three selected public schools in Tagum City Division for SY 2023-2024 were the study respondents, selected using stratified random sampling. A sample size of 340 was determined from a population size of 2,889 using the Online Raosoft Sample Size Calculator. Figure 1 shows a map highlighting Tagum City, Davao del Norte, Philippines, where the study was conducted.

Source: InTagum (https://investintagum.blogspot.com/p/about-tagum.html)

Figure 1: Vicinity Map of Tagum City Highlighting the Participating Schools

Research Instruments

Three survey questionnaires, including the Metacognitive Strategies Scale (MSS), Achievement Emotions Questionnaire (AEQ), and Academic Self-efficacy Scale (ASES), were utilized to collect data from the respondents. These instruments underwent content validation by experts and pilot testing to ensure reliability. The MSS, developed by Duncan and Mckeachie (2015), consists of 28 items categorized into five subfactors, with Cronbach's alpha reliability coefficients ranging from 0.51 to 0.93. Meanwhile, the AEQ, designed by Pekrun et al. (2011), includes twenty-two questions divided into three subscales, with a Cronbach's alpha reliability coefficient of 0.75. Lastly, the ASES, adapted from Abdul and Mohammed (2006), features forty items with a test-retest correlation coefficient of 0.85 and split-half reliability of 0.90. Five-point Likert scale was used to assess the items of the questionnaires.

Statistical Treatment of Data

The following statistical techniques were used to examine and evaluate the collected data.

Mean. This statistical approach was used to determine the level of students' metacognitive strategies, achievement emotions, and academic self-efficacy in learning science.

Pearson r. This tool was used to determine the correlation among the study variables.

Multiple Regression Analysis. This was applied to determining if metacognitive strategies and achievement emotions significantly predicted students' academic self-efficacy in learning science.

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RESULTS

Table 1: Level of Metacognitive Strategies

Items	SD	Mean	Descriptive Equivalent
Rehearsal			
1. read my class notes and the course readings repeatedly.	0.89	4.07	High
2. memorize keywords to remind me of essential concepts in the class.	0.90	4.22	Very High
3. make lists of important terms and memorize the list.	0.90	4.04	High
Category Mean	**0.90**	**4.11**	High
Elaboration			
1. pull together information from different sources, such as lectures, readings, and discussions.	0.92	3.98	High
2. try to relate ideas in this subject to those in other courses whenever possible.	0.95	3.66	High
3. try to relate material to what I already know.	0.90	4.05	High
4. try to connect the readings with the lecture's topics to comprehend the material.	1.00	3.97	High
5. try to apply ideas from the course readings in other class lectures and discussions.	1.04	3.77	High
Category Mean	**0.96**	**3.87**	High
Organization			
1. go through the readings and my class notes and try to find the most essential ideas.	0.87	4.37	Very High
2. write summaries of the main ideas from the readings and concepts from the lectures.	1.06	3.93	High
3. make simple charts, diagrams, or tables to help me organize course material.	1.22	3.30	Moderate
4. go over my class notes and outline important concepts.	1.11	3.85	High
Category Mean	**1.07**	**3.86**	High
Critical Thinking			
1. I often find myself questioning things I hear or read to decide if I find them convincing.	0.97	4.00	High
2. try to decide whether there is good supporting evidence on the presented concept in class.	0.94	3.81	High
3. treat the course material as a starting point and develop my ideas about it.	1.03	3.88	High
4. try to play around with ideas of my own related to what I am learning in this course.	1.07	3.77	High
5. think about possible alternatives whenever I read or hear an assertion or conclusion in the class.	1.06	3.71	High
Category Mean	**1.01**	**3.84**	High
Metacognitive Self-Regulation			
1. try to stay focused on important points to ensure that I fully comprehend the information presented.	0.93	4.24	Very High
2. Makeup questions to help focus on reading.	1.04	3.95	High
3. go back and figure out when I become confused about something I am reading for this class.	0.99	4.16	High
4. change how I read the materials if course materials are difficult to understand.	1.08	3.87	High
5. see how it is organized before thoroughly studying new course materials.	1.08	3.84	High
6. ask myself questions to ensure I understand the material I have been studying in the class.	1.03	4.04	High
7. try to change how I study to fit the course requirements and teacher's teaching style.	1.11	3.65	High

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8. I am continuously working to enhance my reading comprehension skills to comprehend and retain the information presented in class fully.	0.97	4.10	High
9. try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	0.99	3.89	High
10. try to determine which concepts I do not understand well.	0.92	4.21	Very High
11. set goals for myself to direct my activities in each study period.	1.07	4.03	High
Category Mean	**1.02**	**4.00**	High
Overall Mean	**0.99**	**3.94**	High

Table 1 shows the level of students' metacognitive strategies in learning science. Rehearsal strategies have the highest mean of 4.11, while critical thinking has the lowest mean of 3.84. These strategies are more commonly observed than in other domains. Metacognitive strategies have an overall mean of 3.94, indicating high levels of observation. However, organization has the highest standard deviation of 1.07, and rehearsal has the lowest standard deviation of 0.90. Students' responses to organization items are more varied than those of other strategies.

The study reveals that metacognitive strategies are the most effective in learning, with elaboration, organization, and rehearsal being the most used. This trend is also observed in international studies, with high school students in Turkey, Uganda, and the Philippines primarily using rehearsal for science learning. Kwarikunda et al. (2022) found that rehearsal strategies were used primarily in physics learning, possibly due to limited knowledge in low-secondary schools. Surface-level strategies like rehearsal and elaboration were preferred over deep-level ones.

Table 2: Extent of Achievement Emotions of Students

Items	SD	Mean	Descriptive Equivalent
Class-Related Emotions			
1. enjoying being with it.	0.84	4.30	Very High
2. being proud of myself.	1.12	3.96	High
3. getting angry.	1.24	2.09	Low
4. feeling uneasy every time I think about it.	1.29	2.73	Moderate
5. feeling embarrassed.	1.25	2.35	Low
6. feeling hopeless in the subject.	1.35	2.42	Low
7. getting bored.	1.28	2.23	Low
Category Mean	**1.20**	**2.87**	Moderate
Learning-Related Emotions			
1. enjoying acquiring new knowledge.	0.79	4.43	Very High
2. having an optimistic view toward studying.	0.95	3.85	High
3. getting irritated when studying.	1.30	2.56	Moderate
4. getting tense and nervous while studying.	1.33	2.75	Moderate
5. feeling ashamed that I can't absorb simple ideas.	1.40	3.01	Moderate
6. feeling hopeless when I think about studying.	1.32	2.50	Low
7. feeling bored because of the material.	1.20	2.16	Low
Category Mean	**1.18**	**3.03**	Moderate
Test-Related Emotions			
1. feeling challenged because it is enjoyable.	1.03	4.03	High
2. having great hope that my abilities will be sufficient.	1.09	3.83	High
3. being proud of how well I mastered the exam.	1.17	3.70	High
4. feeling very relieved that I will pass it.	1.20	3.81	High
5. being annoyed about having it.	1.24	2.39	Low
6. feeling panicky upon answering.	1.32	3.19	Moderate
7. feeling ashamed that I will fail.	1.41	3.51	High
8. having lost all hope that I can do well on the exam.	1.45	2.94	Moderate
Category Mean	**1.24**	**3.42**	High
Overall Mean	**1.21**	**3.11**	Moderate

Table 2 shows the achievement emotions of students in science subjects. Test emotions have the highest mean and standard deviation of 3.42 and 1.24, indicating strong manifestation. Class-related emotions have the lowest mean and standard deviation of 2.87 and 1.20, respectively, suggesting moderate manifestation. Learning-related emotions have the lowest

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standard deviation of 1.18, indicating a moderate variation. Overall, the extent of achievement emotions is moderate, with a mean of 3.11 and an SD of 1.21, implying that students in science subjects slightly manifest achievement emotions. These results were supported by Park's study (2022) and Zhou and Wu (2021), who found that students exhibit test-related emotions more than class-related and learning-related emotions. However, in science subjects, positive and negative emotions significantly influence feelings across all indicators (class-related, learning-related, and test emotions).

Table 3: Level of Students' Academic Self-efficacy in Learning Science

Items	SD	Mean	Descriptive Equivalent
In my science class, I …			
1. am capable of learning.	0.93	4.21	Very High
2. cannot read and understand my textbooks well.	1.26	3.65	High
3. sense that I am quick to pick the points from what I read.	1.09	3.38	Moderate
4. feel that I am incapable of remembering things.	1.26	2.87	Moderate
5. can do my projects well.	1.11	3.67	High
6. cannot manage time efficiently for learning.	1.23	2.86	Moderate
7. can use my teacher's assistance in my educational needs.	1.20	3.57	High
8. I failed to find out the necessary sources for my study.	1.26	2.81	Moderate
9. can ask for help from my peers whenever I need it.	1.11	3.89	High
10. fail to set higher goals in my study.	1.32	3.06	Moderate
11. can usually find out a few solutions when confronted with problems in my study	0.97	3.82	High
12. cannot express ideas well while attending examinations.	1.20	2.84	Moderate
13. find it difficult for me to read and understand the textbooks in the English language.	1.37	3.37	Moderate
14. can recollect what I have learned during exams.	1.08	3.57	High
15. often fail to comprehend the actual meaning of what I study.	1.21	3.02	Moderate
16. can prepare my class notes neatly if appropriately taught.	1.08	3.81	High
17. fail to find time for learning amid many chores.	1.26	2.97	Moderate
18. unable to organize my study resources.	1.25	3.05	Moderate
19. am assured that I have a few friends who would be helpful in my study.	1.13	3.97	High
20. cannot clarify my doubts with my teacher during class.	1.24	3.02	Moderate
21. can accomplish my aims in learning.	1.11	3.67	High
22. Cannot answer the essay-type questions well.	1.29	3.15	Moderate
23. experience that I am weak in understanding the discussions of my teacher.	1.34	3.04	Moderate
24. can develop the reading skills required to learn the subject.	1.02	3.95	High
25. cannot recall the related knowledge from the earlier classes when I study a new concept.	1.21	2.96	Moderate
26. can utilize the available library facility for my study.	1.25	3.19	Moderate
27. observe that I fail to prepare my tasks and assignments on time.	1.26	3.07	Moderate
28. can compensate for the loss well if I miss some classes for some reason.	1.21	3.47	High
29. consider that I failed to develop a healthy relationship with my teachers.	1.34	3.33	Moderate
30. am confident that I can perform well in challenging examinations.	1.20	3.47	High
31. cannot deal efficiently with unexpected problems in my study.	1.21	2.86	Moderate
32. am calm during exams since I trust my capabilities.	1.15	3.65	High
33. I cannot complete homework independently without help from guidebooks, previous notes, etc.	1.35	2.64	Moderate
34. can usually handle the problematic situations in the study.	1.07	3.46	High
35. can answer well if a sudden test is conducted.	1.14	3.32	Moderate
36. can become one of the top students if I try.	1.24	3.65	High
37. cannot answer the questions that teachers ask me.	1.25	3.23	Moderate

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38. Can score well in the short answer type questions.	1.06	3.74	High
39. cannot accomplish challenging tasks and problems in class.	1.26	3.31	Moderate
40. can answer twisted questions.	1.16	3.26	Moderate
Overall Mean	**1.19**	**3.35**	Moderate

Table 3 shows students' academic self-efficacy in learning science. The highest mean was 4.21, indicating high self-efficacy among respondents. The lowest mean was 2.64, indicating moderate self-efficacy but high variation. The overall mean was 3.35, indicating average self-efficacy. The standard deviation of 1.19 indicated high variability, indicating different responses on every item. The overall mean was 3.35, indicating moderate self-efficacy among respondents. The high variability in responses suggests that students have different perspectives on learning science. Previous studies show that secondary school students have moderate academic self-efficacy in learning science, which aligns with current research. South Korean secondary students perceive their self-efficacy in science as middle-level, with a standard of 3.16. Overall, students have a moderate level of self-efficacy in learning, especially in science subjects, according to Alcoverde et al. (2022).

Table 4: Significance of the Relationship Between Variables

Variables Correlated	r-values	p-values	Remarks
Metacognitive Strategies & Academic Self-Efficacy	.370	0.000	Significant
Achievement Emotions & Academic Self-Efficacy	-.301	0.000	Significant

Table 4 reveals a moderately positive correlation between metacognitive strategies and academic self-efficacy in learning science, with a r-value of 0.370. Conversely, a moderately negative correlation between achievement emotions and academic self-efficacy was observed. The findings suggest that as students use metacognitive strategies, their academic self-efficacy also increases, while achievement emotions decrease when they increase. This study supports previous research showing that metacognitive strategies positively correlate with students' academic self-efficacy in science. It also suggests that students who effectively use metacognitive strategies are more self-efficacious.

This finding is consistent with previous studies by Ngwira (2017), Safranj (2019), Cerezo et al. (2019), Roick and Ringeises (2017), and Sen and Yilmaz (2016). Thus, a higher frequency of metacognitive strategies is linked to higher academic self-efficacy. Moreover, Tian et al. (2023) and Liu et al. (2019) found that negative achievement emotions negatively impact students' academic self-efficacy in learning science. Elevated negative emotions can lead to poor classroom performance. However, de Lima et al. (2023) found that students who enjoy science learning and experience hope and pride are more self-efficacious.

Table 5: Influence of Metacognitive Strategies and Achievement Emotions on Academic Self-Efficacy

Independent Variable	Unstandardized Coefficients		Standardized Coefficients	t	p-value	Remarks
	B	Std. Error	Beta			
(Constant)	2.900	0.179	-	16.174	0.000	
Metacognitive Strategies	0.338	0.038	0.417	8.838	0.000	Significant
Achievement Emotions	-0.283	0.037	-0.356	-7.559	0.000	Significant
R = 0.511;	R square = 0.261;		F = 59.837;	p = 0.000		

Table 5 shows that metacognitive strategies significantly predict students' academic self-efficacy in learning science, while achievement emotions negatively predict it. Metacognitive strategies increase academic self-efficacy by 0.338 for every unit increase in strategies, while achievement emotions decrease it by 0.283 for every unit increase in emotions. These two variables account for 26.1% of the observed variation in students' academic self-efficacy in science learning, as indicated by the R square value of 0.261. The results highlight the importance of metacognitive strategies and achievement emotions in shaping students' academic self-efficacy in learning science.

The study by Cengiz-Istanbullo and Sakiz (2022) found that metacognitive strategies positively impact students' academic self-efficacy. The same results were found in Soltani and Askarizadeh (2021) and Ali and Karim (2019). Students who effectively adopt metacognitive strategies believe they can learn and complete their academic tasks. Students with higher academic self-efficacy take advantage of these strategies. On the other hand, Positive and negative emotions significantly

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predict students' academic self-efficacy, especially in science. Studies by Acedo et al. (2021) and Yang et al. (2021) show that increased positive emotions lead to belief in learning specific content, while negative emotions are more common when students don't feel capable of learning. Therefore, positive emotions positively impact academic self-efficacy, while negative emotions negatively affect it.

Recommendations

Students should prioritize improving metacognitive strategy use and maintaining positive emotions in order to increase their self-efficacy when learning science. Teachers can also play an important role in creating a supportive environment, guiding the use of metacognitive strategies, and providing positive feedback. Parents should actively participate by offering additional emotional support and encouragement. Furthermore, school administrators are encouraged to support activities that foster metacognitive strategies and positive emotions. Deputies can help develop interventions that address negative emotions and underutilized strategies in science education. Future research should focus on identifying additional variables that influence academic self-efficacy in STEM education.

Conclusions

The study's conclusions can be summarized as follows: Firstly, the level of metacognitive strategies is high; therefore, metacognitive strategies are often observed among students. Secondly, the extent of achievement emotions is moderate; therefore, achievement emotions are slightly manifested. Thirdly, students have a moderate level of academic self-efficacy in science learning; thus, students possess an average level of academic self-efficacy. Furthermore, metacognitive strategies significantly correlated to students' academic self-efficacy in learning science. In contrast, achievement emotions negatively correlated significantly with students' academic self-efficacy in learning science. Lastly, metacognitive strategies and achievement emotions significantly predict students' academic self-efficacy in learning science.

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