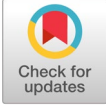


# UMT Education Review (UER)

Volume 8 Issue 2, Fall 2025

ISSN(P): 2616-9738, ISSN(E): 2616-9746

Homepage: <https://journals.umt.edu.pk/index.php/uer>



**Title:** Metacognitive Awareness and Academic Achievement: The Mediating Role of Students' Engagement

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**DOI:** <https://doi.org/10.32350/uer.82.03>

**History:** Received: July 27, 2025, Revised: October 10, 2025, Accepted: November 07, 2025,  
Published: December 02, 2025

**Citation:** Tsega, A., & Tefera, B. (2025). Metacognitive awareness and academic achievement: The mediating role of students' engagement. *UMT Education Review*, 8(2), 50–70. <https://doi.org/10.32350/uer.82.03>

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**Conflict of Interest:** Author(s) declared no conflict of interest



UMT

A publication of

Department of Education, School of Social Sciences and Humanities  
University of Management and Technology, Lahore, Pakistan

# Metacognitive Awareness and Academic Achievement: The Mediating Role of Students' Engagement

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## Abstract

Despite an ongoing reform and improvement of education in Ethiopia, quite a significant number of secondary students have been challenged by poor academic performance, which is often exhibited in low examination results and a higher school dropout rate. The purpose of this study was to examine the role of student engagement in the relationship between metacognitive awareness and academic achievement among secondary school students. The study utilized a correlational research design. Data were collected from 180 participants (male=79; female=101) selected through simple random sampling. Metacognitive awareness inventory and student engagement scale were used as a means of data collection. Descriptive analysis, correlation, stepwise multiple regression, and mediation analysis were carried out to respond to research questions. The results of the study showed that both metacognitive knowledge and regulation portrayed a statistically significant and positive correlation with academic achievement. This suggests that students with higher levels of metacognitive awareness (knowledge and regulation) tend to achieve higher academic success. The findings also indicated that metacognitive knowledge was significant and a main predictor of academic achievement among secondary school students. Moreover, findings from mediation analysis indicated that agency partially mediated the relationship between metacognitive knowledge and academic achievement. This implies that improving students' knowledge of cognition, connection with their school, and curiosity about their learning tasks can improve their academic achievement.

**Keywords:** academic achievement, awareness, metacognitive knowledge, secondary school students, student engagement

## Introduction

Secondary school education is needed to teach students the skills necessary for the adoption of new production methods and technologies, which cannot

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be achieved through primary school education (Teferra et al., [2018](#)). To this end, educators, parents, and even others who have a stake in education aspire to see students' academic success in schools. This success is mainly judged upon the educational attainment of students, taking their academic achievement score as a criterion. Academic achievement is an educational outcome that students scored based on their classroom performance in the subjects. Thus, it has been taken as a proven measure of success in schools (York et al., [2015](#)). However, the performance of the students mainly depends on cognitive-behavioral factors. More importantly, the influence of factors such as metacognition and engagement is more pronounced (Kim & Hargrove, [2013](#)).

According to Kuh ([2009](#)), student engagement is a nexuse of effort, time, and resources exerted by learners and their educational institutions to promote positive educational outcomes. It is also conceptualized as a cognitive, behavioral, and emotional reaction to achieve educational success (Günüş & Kuzu, [2014](#)). It is a vital part of academic success (Astin, [1993](#)). In support of this notion, research outcomes stressed that student engagement is a pivotal factor in explaining academic achievement and impacting several aspects of academic outcomes (Fredricks et al., [2016](#)). Likewise, a study carried out by Li and Lerner ([2011](#)) stated, students' academic engagement is critical for preventing school dropouts, and facilitates the academic success of learners. It happens when learners delve into learning activities and are emotionally and cognitively engaged in the learning materials (Reeve & Lee, [2014](#)).

Another psychological factor is metacognition which predicts academic achievement, and is often attributed to Flavell ([1979](#)) who conceptualized it as knowledge about one's own cognitive process. It primarily involves knowing, understanding, monitoring, and controlling one's own thinking. Metacognition is among the top 10 skills needed in 21st-century learning (Scott, [2015](#)). It plays a critical role in students' learning to develop other skills required in 21st-century education (Damayanti et al., [2021](#)). Metacognition facilitates critical thinking, self-regulation, and independent lifelong learning among students (Ewing, [2020](#); Horvathova, [2021](#)).

Scholars defined metacontion in different but related ways. They defined it as knowledge of cognitive process, (Al-Jarrah et al., [2018](#)), thinking about thinking (Woolfolk & Kapur, [2019](#)), or knowledge about

knowledge (Schunk, [2017](#)). In the same vein, metacognitive awareness is the ability to know and monitor one's own cognitive process and is interchangeably used with metacognition (Schraw & Dennison, [1994](#); Hughes, [2017](#)). Metacognitive awareness includes two dimensions: metacognitive knowledge and regulation (Hughes, [2017](#); Scott & Berman, [2013](#)).

As a dimension of metacognition, metacognitive knowledge refers to one's own understanding of cognition (Kisac & Budak, [2014](#)). It involves cognitive strategies and skills that affect learning and memory. The second dimension, metacognitive regulation, indicates the ability that involves planning, organizing, and evaluating a series of cognitive tasks (Scott & Berman, [2013](#)). Metacognition has a fundamental role in the development of critical thinking (Rivas et al., [2022](#)). It relates to the way cognition operates with knowledge and strategy that has been acquired (Dangin, [2020](#)), leading to altered, and ideally more productive behavior during learning (Levchyk et al., [2022](#)).

There is a positive association between metacognitive awareness and academic achievement among secondary school students (Zhao & Mo, [2016](#)). This means students who employed metacognitive techniques outperform those who failed to use them (Eskandari et al., [2020](#)). They are aware of their strengths and weaknesses in learning tasks and make the necessary adjustments to maximize their learning outcome (Molenberghs et al., [2016](#)). However, students who failed to identify what they knew from what they didn't, may not be engaged in higher order cognitive strategies, such as evaluating their own learning, and employing more efficient learning strategies.

To the knowledge of the researchers, no study has been carried out on the mediating role of students' engagement in metacognitive awareness and academic achievement among secondary school students in Addis Ababa, Ethiopia. However, some studies have been carried out on student engagement and academic achievement in relation to other variables (Getachew, [2018](#); Geleta, [2017](#); Ibrahim et al., [2019](#); Tadesse & Edo, [2021](#); Tessema & Rao, [2018](#)).

Despite these investigations, there remains a notable gap in studies examining the role of metacognitive awareness on academic achievement of secondary school students in Ethiopia, particularly considering student

engagement as a mediating variable. Therefore, this study was conducted to address this gap by answering the following research questions:

- What is the status of metacognitive awareness, student engagement, and academic achievement of secondary school students?
- What is the relationship among metacognitive awareness, students' engagement, and academic achievement among secondary school students?
- To what extent does metacognitive awareness explain the change in academic achievement?
- Does student engagement significantly mediate the relationship between metacognitive awareness and academic achievement?

### **Research Methodology**

#### **Research Design**

In this study, a correlational research design was employed to examine the mediating role of students' engagement in the relationship between metacognitive awareness and academic achievement among secondary school students. Since it helps to assess the relationship between the study variables among participants simultaneously, choosing this research design is appropriate for the current study (Stangor, [2011](#)).

#### **Participants**

The participants of the study were secondary school students at Bole Addis secondary school in Addis Ababa, Ethiopia. Carrying out this study among secondary school students in Addis Ababa is justified at least by some reasons. Since it is a capital city and metropolitan area of the country, Addis Ababa represents the hub of social, cultural, and educational landscape. The city also has higher concentration of schools, qualified teachers, and educational resources compared to other cities in the country. Therefore, the context gives a vital setting to examine the mediating role of student engagement in the relationship between metacognition and academic achievement among secondary school participants. Moreover, the diverse socio-demographic attributes of participants may provide a valuable strand of data on how predicting factors influence academic achievement as a dependent variable in a multi-cultural context. The results of the current study are expected to contribute some information to educational policy and general understanding of variables in the area.

## Sample Size Determination

Krejcie and Morgan's (1970) sample size determination formula was applied to set the total sample size required for the study. Therefore, 213 total participants were selected through stratified random sampling techniques, taking gender and grade levels as stratification criteria. Data from 180 (male=79; female=101) were analyzed and compiled in the report of the study, while cases from 22 participants were found to be incomplete and discarded during manual inspection of the data.

## Instruments

In the present investigation, data were collected using Amharic version self-reported questionnaire rated by the respondents independently. The questionnaire had three parts. Part one contained socio-demographic questions (Gender, age, grade level, and semester grade point average). The second and third parts of the questionnaire were the metacognitive awareness and the students' engagement scale, respectively. These scales were adopted from the original developer and translated into Amharic language, which is the mother tongue of the participants.

### *Metacognitive Awareness Inventory*

For this study, metacognitive inventory (MCAI-52) developed and validated by Schraw and Dennison (1994) was adapted and utilized. The original scale has 52 items and dimensions: metacognitive knowledge (items, 1-17) and regulation (items, 18-52) respectively. Items were rated on five points Likert scale ranging from (1) strongly disagree to (5) *strongly agree*.

### *Students Engagement Scale*

Student's engagement scale (SES-20) developed by Veiga (2016) was adapted and employed in the current study. The original scale has 20 items rated on six points Likert type scale ranging from (1) *very strongly disagree* to (6) *very strongly agree*. The scale contains four sub-scales: cognitive sub-scale (items, 1,2,3,4 and 5), behavioral sub-scale (items, 6, 7, 8, 9, and 10), affective sub-scale (items, 11, 12, 13, 14, and 15), and agency sub-scale (items, 16,17,18,19, and 20).

## Validation of Instruments

The instrument validation process begins with reviewing and critically

evaluating the content of the instruments in line with the research objectives, operational definition, and prior applicability in the local context. Then, both the metacognitive awareness inventory with 52 items, and student's engagement scale with 20 items were checked and translated into Amharic by the researcher. Both the translated and Amharic version instruments were given to two educational psychology candidates to check the relevance of their content. The feedback was taken to improve the content and construct validity of scales.

At last, the authors and translated versions of the scales were cross-checked and made ready for the pilot study. To this end, the final Amharic version questionnaire (52 metacognitive inventories (MCAI) and 20-item students' engagement scale (SES) were administered to 25 randomly selected students. Finally, the responses were scored and analyzed using SPSS Version 25. The results of the Cronbach's alpha coefficient ( $n=25$ ) was .923 & .941 for both metacognitive knowledge and metacognitive regulation respectively.

Regarding the dimension of the student engagement scale (SES), the Cronbach's alpha coefficients were ( $n= 25$ , .702, .765, .885, and .771) for cognitive, affective, behavioural, and agency dimensions, respectively. From the behavioural sub-scale, the one item '*I am distracted in the classroom*' was deleted to increase the scales' reliability from .685 to .885. To sum up, 52 items for metacognitive awareness inventory and 19 items for students' engagement scale were employed during the main data collection process. The scales' reliability is shown below in Table 1.

**Table 1**

*Reliability of Metacognitive Awareness and Students' Engagement Scales*

Indicators	Items	Cronbach's Alpha
Metacognitive Awareness Scale	52	.948
Knowledge	17	.923
Regulation	35	.941
Students Engagement	19	.762
Cognitive	5	.702
Affective	5	.765
Behavioral	4	.885
Agency	5	.771

## Procedure

First, before administering data collection instruments, a letter of support was obtained from Addis Ababa University School of Psychology to get the permission and support of the school where the data were collected. Second, the researcher discussed the aim of the study with the school principals and teachers; sampling procedures, time of data collection, and adherence to ethical principles followed before the main data collection.

Third, the total number of questionnaires were printed and checked for clarity and organization. The day, time, and place of data administration were decided with the school principal and unit leaders. Fourth, the participants were asked about their willingness to participate in the study and informed about the purpose of the study, and finally, questionnaires were administered to participants with the help of school leaders, classroom teachers, and data collectors. After 45 minutes of operation, the data was collected back, checked, counted, and handed over to the researcher for further data clearance, management, and subsequent analysis.

## Data Analysis

After all preliminary tests of statistical assumptions were checked, descriptive statistics such as frequency, percentage, mean, and standard deviation were used to see the levels of study variables. Pearson product-moment correlation and stepwise regression were also conducted to see the association between predictors and criterion variables and the contribution of each predictor to the criterion variable, respectively. At last, path analysis was tested to assess the role of mediating variable (students' engagement) in determining direct, indirect, and total effects of predictors on outcome variable using standardized coefficients.

## Results

As presented in the methods section of the study, out of the total sample size of 213 participants who participated voluntarily in the study, 180 participants had completed the administered questionnaires fully. The remaining 22 questionnaires were found to be incomplete and genuinely excluded from further data clearance and analysis in the study. Therefore, the response rate of this study is 84.5% of those who participated in the study. This part of the study presents major findings and discussions of the study as per the stated research questions.

## Demographic Attributes of Participants

Results of descriptive analysis showed that, out of 180 total participants, 101(56.1%) were females while the remaining 79(43.9%) were male participants. When we look at the age of participants, 93(51.7%) were females whose ages ranged from 13 to 16 years. The remaining 87 (48.3%) were males with a range of 17-20 years of age. In relation to grade level of participants, 96 (53.3%) were from grade nine and the rest, 84(46.7%), were grade ten students. Detailed information on demographic characteristics of participants is presented here in Table 2 below.

**Table 2**

*Demographic Attributes of Participants*

Variable	Label	Frequency	%
Gender	Male	79	43.9
	Female	101	56.1
Age	13 – 16	93	51.7
	17 – 20	87	48.3
Grade level	9 <sup>th</sup>	84	46.7
	10 <sup>th</sup>	96	53.3
Total		180	100%

## Metacognition, Student Engagement, and Academic Achievement Status of Students

A descriptive analysis was computed to assess the status of secondary school students' metacognitive awareness, students' engagement, and academic achievement. The findings of the study indicated that the participants obtained a mean of ( $M=63.45\pm 11.31$ ) for metacognitive knowledge (MCK) and ( $M=122\pm 22.78$ ) for regulation (MCR) dimensions, respectively. This indicates participants have moderate to high levels of metacognitive awareness on metacognitive measures.

Regarding dimensions of student engagement, participants obtained above the expected mean value on cognitive ( $M=18.01\pm 5.09$ ), affective ( $M=16.55\pm 4.84$ ), and agency dimensions ( $M=14.68\pm 5.29$ ) as indicated in table 3 below. This implies that students who were cognitively, behaviorally, and emotionally involved in their learning tasks, have a better sense of autonomy and control in academic activities. Moreover, participants obtained a mean of ( $M=70.87\pm 11.12$ ), that was above the cutoff

score. This means that, on average, students have performed academically well above the expected GPA score.

**Table 3**  
*Descriptive Analysis of Study Variables*

Variables	Items	Minimum	Maximum	Mean	SD
MCK	17	25.00	85.00	63.45	11.31
MCR	35	50.00	167.00	122.00	22.78
Cognitive	5	5.00	29.00	18.01	5.09
Affective	5	5.00	26.00	16.55	4.84
Behavioral	4	4.00	24.00	8.72	5.36
Agency	5	5.00	28.00	14.68	5.29
GPA	-	42.60	95.45	70.87	11.12

### Correlation among Variables

As presented in Table 4 below, correlation analysis was computed to assess the relationship among study variables: metacognitive awareness (metacognitive knowledge & metacognitive regulation) as a predictor, student engagement (cognitive, affective, behavioral, and agency) as a mediator, and academic achievement as a dependent variable.

The results indicate both dimensions of metacognitive awareness, metacognitive knowledge ( $r=.597, p<0.001$ ) and metacognitive regulation ( $r=.366, p<.001$ ), showed significant positive correlations with academic achievement. This implies that higher levels of metacognitive awareness are positively related to higher academic achievement of students. Likewise, academic achievement (GPA) also has a statistically significant and positive correlation with domains of student engagement subscales: cognitive ( $r=.187, p <.05$ ) and agency ( $r=.265, p < .001$ ), respectively. This implies that students who are more engaged in cognitive activities and exhibit a sense of control and autonomy in their learning tend to perform better academically.

**Table 4**  
*The Correlation of Predictors and Dependent Variable*

Variable	1	2	3	4	5	6
1. GPA	-					
2. Metacognitive knowledge	.597**	-				
3. Metacognitive regulation	.366**	.704**	-			
4. Cognitive	.187*	.300**	.475**	-		

Variable	1	2	3	4	5	6
5. Affective	-.033	-.040	.033	.065	-	
6. Behavior	-.128	-.193**	-.244**	-.297**	.334**	-
7. Agency	.265**	.162*	.196**	.378**	.047	.046

*Note.* \*  $p < .05$ . \*\*  $p < .01$ .

### The Contributions of Predictors to Academic Achievement

To investigate the extent to which metacognitive awareness and students' engagement predicted academic achievement, stepwise regression analysis was conducted. The results indicate 36.2% of the change in the dependent variable was explained by metacognitive awareness. Regarding dimensions of metacognitive awareness, metacognitive knowledge ( $\beta = .639$ ) significantly predicted academic achievement, while metacognitive regulation ( $\beta = -.096$ ) was not a significant predictor. This implies that being aware of one's own cognitive activities plays a vital role in improving academic performance, while the ability to control or direct those might not be directly linked with it.

At the second stage of the model, adding dimensions of the second variable, student engagement, explained an additional 4.3% ( $\Delta R^2 = .043$ ) of variation in academic achievement score (GPA). The model was statistically significant at  $F(4,170) = 3.1$ ,  $p < .05$ . From the dimensions of student engagement, student agency was the only significant predictor of academic contribution ( $\beta = .202$ ) when the effect of other factors was controlled.

**Table 5**

*Summary of Regression Analysis Taking GPA as Dependent Variable*

Stages	<i>R</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$	Beta	<i>SE</i>	$\beta$	<i>t</i>
Stage 1	.602 <sup>a</sup>	.362	.362***				
MCK				.662	.083	.639	7.85***
MCR				-.053	.041	.096	-1.15
Stage 2	.637 <sup>b</sup>	.385	.043**				
Cognitive				-.134	.162	.061	-1.82
Behavioral				-.243	.142	.115	-1.71
Affective				.074	.147	.032	.50
Agency				.425	.134	.202	3.17**

*Note.* \*\*  $p < .01$ . \*\*\*  $p < .001$ . MCK=metacognitive knowledge, MCR=metacognitive regulation

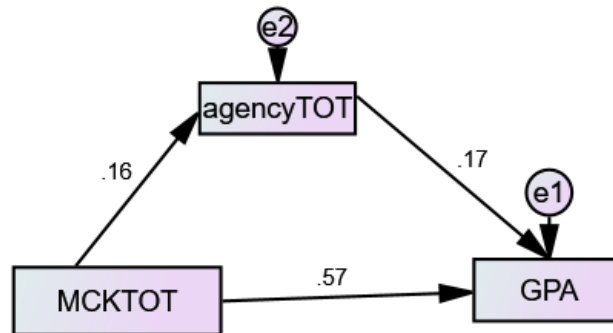
## The Mediating Role of Students' Engagement

To assess the mediating role of student engagement in the relationship between metacognitive awareness and academic achievement, mediation analysis was computed. The aim was to assess the indirect effect of the predictor variable on the dependent variable. Assumptions were checked based on the guidelines outlined by Baron and Kenny (1986). The following figure (1) depicted the model of the study variables.

In this model, metacognitive knowledge (MCKTOT), agency (agencyTOT), and academic achievement (GPA) were predictor, mediating, and dependent variables, respectively.

**Figure 1**

*Tested Mediation Model*



The findings indicated as agency partially mediated the relationship between metacognitive knowledge (MCK) and academic achievement (GPA). Each path, from MCK to agency and agency to GPA, was statistically significant ( $\beta=.162$ ) and ( $\beta=.173$ ), respectively. The effect of metacognitive knowledge through agency was ( $\beta=.028$ ). This means that agency partially explained the relationship between metacognitive knowledge (MCK) and academic achievement (GPA) as it visualized by their statistically significant chain relationship (MCK→agency→GPA) in the mediation model (Figure 1).

This indicates that an enhanced level of agency is linked with higher academic achievement or GPA. Thus, improving students' agency through making them to take an active initiative in their learning process can possibly boost their academic achievement in schools. Regarding the direct

effect of metacognitive knowledge (MCK), it has a statistically significant direct effect ( $\beta=.570$ ) on academic achievement(GPA).The statistically significant direct effect of MCK on GPA implies a higher level of MCK is often linked with a better academic outcome of students. Therefore, knowing, reflecting, and actively involving oneself in one’s own learning processes are vital for academic success.

**Table 6**  
*Mediation Analysis*

Path	$\beta$	<i>S.E.</i>	<i>p</i> -value
MCK → Agency (Path a)	.162	SE	.028
Agency → GPA (Path b)	.173	.035	.004
MCK → GPA (Direct)	.570	.125	<.001
MCK → Agency → GPA(Indirect)	.028	.058	-
MCK → GPA (Total)	.597		<.001

*Note.* MCK=metacognitive knowledge

### Discussion

The main purpose of this study was to examine the role of metacognitive awareness in predicting academic achievement among grade nine and ten students, taking students' engagement as a mediating variable. Accordingly, secondary school students scored above the mean on metacognitive awareness and students' engagement (affective, agency, and cognitive), and academic achievement. The findings also revealed that from predictor variables, both dimensions of metacognitive awareness were positively and significantly correlated with the academic achievement of grade nine and ten students.

These findings are supported by previous investigation carried out by Mwangi et al. (2024) who studied metacognition as a correlates of academic achievement of secondary school students in Kenya. The result indicated that the two variables are positively correlated. This means that learners with a higher level of metacognition scored higher in their school achievement. The study also assured that both dimensions of metacognition significantly contributed to an enhanced level of academic achievement. This means improving one's ability to know and control one's own thinking and strategies of using it possibly results in an associated increment in the level of students achievement.

Another investigation carried out by Abidin et al. (2025) on the association between metacognition and academic achievement showed a strong positive association between metacognition and students' academic achievement. The study also implied that students who are better in their exam results are believed to have better scores in their metacognition measures. Higher score on metacognitive awareness is linked with more strategic and optimal learning behavior and enhanced academic outcomes (Xie et al., 2024).

Furthermore, a study by Owo and Ikwut (2015) assessed the relation between metacognition, attitude, and academic achievement of high school students in river state, Nigeria. Results supported the existence of positive association among variables. Moreover, another study carried out by Wara et al. (2018) on the relationship between emotional engagement and academic achievement of secondary school students in Kenya revealed that there was moderate positive association between emotional engagement and academic achievement of secondary school students. It also implied that an increment in emotional engagement was linked with an increase in the level of overall academic achievement.

Similarly, Ohamobi et al. (2018) carried out a study on student engagement as correlates of academic achievement of high school students in Nigeria, and the findings revealed a significant positive relationship between behavioral, cognitive, and emotional dimensions of student engagement with overall students' academic achievement. Contrary to the current study, a research carried out by Wang and Eccles (2012) noted that behavioral, cognitive, and emotional engagements were associated with a decline in students' academic performance.

More importantly, another study by Günüç (2014) highlighted that cognitive, behavioral, and emotional engagement had a strong relationship with academic achievement. A study carried out by Dogan (2015) found that cognitive academic engagement positively predicted academic engagement. A similar investigation run by Chase et al. (2014) and Lei et al. (2018) confirmed that there was an existence of a positive relationship between cognitive, emotional, and behavioral dimensions of students' engagement and academic achievement.

Furthermore, a study by Muturi et al. (2025) confirmed the link between academic achievement with behavioral and cognitive engagement of

students. This implied that the more students are cognitively, behaviourally, and emotionally engaged, the better they would perform in their educational outcomes. Regarding the predictive role of variables, metacognitive awareness dimensions were significant predictors of academic achievement score above and beyond other predictor variables, with 43% of the variance in the criterion variables. The path analysis result also portrayed that agency partially explains the relationship between metacognitive knowledge and academic achievement. Metacognitive knowledge has a significant standardized direct effect on secondary school students' academic achievement.

To support this finding, a research conducted by Sarawer and Govil (2017) on metacognitive awareness as a predictor of academic achievement indicated that metacognitive awareness was a statistically significant predictor of academic achievement among secondary school students. Another investigation done by Gaylo and Dales (2017) on the effect of metacognitive strategies on academic achievement and engagement showed that metacognition was a significant predictor of academic achievement. Furthermore, a study conducted by Amerstorfer and Kistner (2021) on metacognitive awareness and academic achievement of students in Pakistan indicated a strong relationship between metacognition awareness and academic achievement.

The study also concluded that metacognitive awareness was a strong predictor of the academic achievement of students. This implies that secondary school students who have higher metacognition are predicted to have higher academic achievement scores. A study carried out by Günüş and Kuzu (2014) on the role of socio-demographic characteristics on academic achievement indicated 54.5% of the change in academic performance is attributed to the nexus of independent variables. Among the four dimensions of the student engagement, agency was a significant predictor of academic achievement. In line with the present study, research conducted by Rodgers and Ghosh (2001) indicated that student engagement was significant in determining performance. This means a change in students' academic engagement domains combined, predicted academic achievement (Iqbal et al., 2019).

## Conclusion

Despite, substantial direct effect of metacognitive knowledge on the

academic achievement, the findings of this study revealed the relationship between two variables is also partially mediated by a student engagement dimension; agency. Substantial direct effect of metacognitive knowledge (MCK) indicates that the indirect effect of MCK on academic achievement may be better explained by additional or other mediation pathways above and beyond agency. Thus, enhancing metacognition through empowering students to actively monitor their learning activities improves academic outcomes. Through integrating metacognitive strategies, which enhance metacognitive skills and active involvement of learners, educators can stimulate learning activities and achieve optimal learning outcomes. To conclude, the study finding may contribute to the existing literature by providing additional evidence on the pivotal relationship among the variables of the study.

### **Limitations**

The study underlines the impact of metacognitive awareness on students' academic achievement. The study was not conducted without some limitations. First, since the study was conducted in a purposefully selected government secondary school in Addis Ababa, the findings of the study are generalized to the government schools samples only. Second, the study employed correlational research design which used cross-sectional data. Therefore, future researchers shall consider carrying out mixed methods study including participants from private schools possibly to deepen our understanding of the area.

### **Author Contribution**

**Asfaw Tsega:** conceptualization, data curation, formal analysis, investigation, methodology, resources software, validation, visualization, writing original draft, writing – review & editing. **Belay Tefera:** conceptualization, data duration, investigation, methodology, supervision, validation, writing – review & editing.

### **Conflict of Interest**

The authors have no conflict of interest related to this manuscript.

### **Data availability Statement**

Data of this study will be provided by the corresponding author upon formal request.

### **Funding Details**

No funding has been received for this study

### **Generative AI Disclosure Statement**

The authors did not use any type of generative artificial intelligence software for this research.

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