# Mediation of Motivated Strategies for Learning for Thinking Maps Involvement Towards Metacognitive Awareness

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**Abstract**: This study emphasized the challenges involved in teaching and learning fundamentals of programming as a consequence of the lack of metacognitive awareness, which is associated with problem solving abilities. These abilities can be enhanced through the use of thinking maps, but they are typically used only in school and under the supervision of a teacher. Additionally, the practice is conducted in a typical manner, with no interesting features incorporated into the process, and it does not promote the development of metacognitive awareness. Thus, this study implementing the use of educational tool which embedding motivated strategies for learning theories including multimedia principles and elements called Motivated Strategies Thinking Maps Tool (MoSTMaT) and apply it experimentally in order to determine the tool's effectiveness towards guiding students in using thinking maps to solve fundamental programming problems. A total of 128 students participated in the quasi-experimental research. To compare the differences between groups, participants were given the Metacognitive Awareness Inventory (MAI) and the Motivated Strategies for Learning (MSLQ) questionnaires for pre- and post-testing. Appropriate analyses were performed to seek the relations among factors studied. The results indicated that motivated strategies for learning are indeed a mediating factor between the implementation of using thinking maps in learning and metacognitive awareness among computing students.

**Keywords**: Motivated strategies for learning, metacognitive awareness, thinking maps, multimedia, programming.

## 1. Introduction

In today's technology-driven world, virtually all people must deal with a vast amount of information from the internet and social media, which have drastically shaped their lifestyles and worldviews. Essentially, the development of websites and systems involves a variety of practitioners, such as designers, project managers, and, particularly, programmers, who write appropriate programs using codes to meet customers' needs. In this regard, programmers should be equipped with strong problem solving skills to solve complex and intricate problems.

Malaysian Qualification Agency (MQA) clarifies that programming skills and proficiency to learn other new programming languages is crucial in computing. Later, industrial training will cultivate student's maturity and gain experience in the working environment (MQA, 2015). These essential requirements in order to provide experts (in computing) to be marketable. The Malaysian government is eager to train

students starting at an early stage (primary and secondary school) to cultivate skills needed in the future. The Ministry of Education (MOE) of Malaysia has launched an ambitious education blueprint to raise the levels of quality of Malaysian students to be on par with those of developed nations by focusing on critical, creative, and innovative thinking skills (Ministry of Education, 2012).

This study highlights the issues in the teaching and learning of programming at the tertiary level that entail students to have good problem-solving skills. In particular, this study focuses on students' metacognitive awareness, motivated strategies for learning, and an instructional design strategy that involves the use of thinking maps to help students develop strong metacognitive awareness and intrinsic motivation [3][4]. Collectively, such factors can help students develop good metacognitive awareness that in turn help them learn programming more efficiently.

Fundamental courses on programming languages becoming essential at all levels of curriculum in education (Lawan, et al., 2019). In this regard, in the world of technology, facing 21st century education, programming skills are currently relevant (Abesadze & Nozadze, 2020). Thus, a proper understanding of programming languages is important that can only materialize when students have the essential cognitive ability to learn the subject matter efficiently (Ambrosio P. A., et al., 2014; Scherer, et al., 2021). Admittedly, most programming students find learning programming extremely challenging, which stems from a lack of essential learning ability and motivation as programming involves the understanding of coding concepts and procedures as well as creating, modifying and evaluating the code (Tondeur et al., 2019). Unresolved, students may eventually opt to quit learning the subject or perform poorly in the examination or dropout (Robins, 2019). In this regard, studies have been made to investigate the issues pertaining to the challenge confronted by students during the early phase of learning a programming subject.

Metacognitive awareness does have significant effects on the success of students in learning introductory programming courses in university and yet they still lack it (Rum & Ismail, 2016; Anthonysamy, et al., 2021). Moreover, metacognitive awareness have significance connection towards problem solving skills is agreed upon many researchers and it keeps on going to find suitable activities or tool to fit learners' condition (Guner & Erbay,2021; Mangaroska, et al., 2021).Indeed metacognitive awareness is crucial skills need to be acquired among computing students but then again these are the lack skills identified by many previous researches (Ismail, et al., 2006; Ismail, et al., 2010; Tseng & Weng, 2010 ; Hui & Omar, 2011; Rum & Ismail, 2016; Robins, 2019).

Metacognition is the ability of learners to take control of what they know. From the learning perspective, the ability to take control of one's knowledge involves the ability to use a precise strategy in a correct situation, monitor learning, and replace the strategy with a new one if the former was ineffective or inefficient (Shraw & Dennison, 1994; Mitsea, et al., 2019). Metacognitive awareness also has close relations with problem solving skills. Guner and Erbay (2021), that metacognitive awareness does have significant impact towards students' problem solving effectiveness. Based on the findings of Schraw and Dennison study (1994), metacognitive awareness can influence cognitive performance by enhancing the strategy being used. Cognition relates as a process of thinking and metacognitive knowledge is a process of a person knowing the thinking process (Hamiddin & Saukah, 2020).

Thinking maps have been shown in prior studies to be one of the most effective tools for improving students' metacognitive awareness (Hyerle, 2011). Visualization tools have been proven to assist students in learning programming in a practical manner (Derus, et al., 2012; Elvina, et al., 2018). There are eight different types of thinking maps that have been used in the teaching and learning process to help students increase their metacognition and cognitive capacities. Because they provide an effective medium for thinking, listening, speaking, reading, writing, and problem- solving, thinking maps can help increase and change behavior through self-regulated learning (Hyerle, 2011; Harris et al., 2020).

Multimedia is delivered in an enthralling manner with the use of various presentations and the ability to give instructions through it. Metacognitive enables students to regulate, monitor, and assess their own learning (Shraw & Dennison, 1994). Previous research on the relationship between metacognition and multimedia (Antonietti & Colombo, 2014; Alamdari, Hossein, 2021) has shown that using multimedia in the classroom can help with metacognition in a variety of aspects, roles and performance (Schwonke, et al., 2013; Shakil, et al., 2020). With the prevalence of multimedia in the modern day, integration of dynamic multimedia (Moreno, 2005) that enables interactivity and feedback is necessary for integrating the component of cognitive, metacognitive, motivation (Sabjan, et al., 2020), and learners (Domagk, et al.,

2010; Sweller, 2010). Finally, the use of multimedia in the learning process demonstrates metacognitive improvement among learners (Antonietti, et al., 2015; Alemdag & Cagiltay, 2018; Mayer, 2009; Mayer, 2020).

## 2. Literature Review

### 2.1 Motivated Strategies in Learning

The researcher concentrated on motivated learning in this study, which is composed of two key components or constructs, namely motivational beliefs and self-regulation, both of which can be maintained or sustained by intrinsic factors (Pintrich, 1994). Motivational attitudes towards the appropriate use of learning tools can have a major impact on students' metacognition when they seek to solve complex problems (McDowell, 2019). In this study, we examined how participants' motivation to learn programming in a multimedia self-regulated learning environment is related to their incentive to learn. Pintrich (1994) identified three components of motivating beliefs: self- efficacy, intrinsic value, and anxiety. Studies have demonstrated that students' learning outcomes are significantly impacted by their motivational beliefs (self-efficacy, intrinsic value, and anxiety) (Gbollie & Keamu, 2017; Martin, Craigwel, Ramjarrie, 2022). Admittedly, conventional learning systems are ineffective at encouraging students to learn more enthusiastically because they are primarily exam-oriented, encouraging pupils to learn solely for the sake of achieving high grades.

According to the literature, self-efficacy is positively connected with cognitive methods and self-regulation, both of which influence students' academic achievement (Adesola, et al., 2018; Usan et al., 2022). Students with a high level of self-efficacy in self-regulation were able to employ appropriate cognitive strategies throughout learning, resulting in improved academic achievement. Self-regulated learning encourages learners to choose and employ suitable cognitive methods to aid them in sorting and organizing information in order to solve a specific task. Learners who are capable of self-observation, self-evaluation, self-reaction, self-efficacy and self-reflection will eventually promote self-regulated behavior (Ormrod, 2016; Lee, Watson, Watson, 2020).

Metacognition is known as the ability of learners to take control of what they are learning and understand their own ability to learn. In this respect, metacognitive awareness is students' ability to select and use an effective method to monitor the learning process and adjust such a strategy if needed, subsequently obtaining the readiness of motivation to learn (Shraw & Dennison, 1994; Karatas, Arpaci, 2021). Therefore, the relationship between motivational beliefs and metacognitive awareness, in particular, can support students in comprehending and utilizing available information to accomplish desired goals. Such a skill is also known as 'knowing about knowing' that helps learners become aware of the most effective technique to handle a particular challenge. In other words, metacognition entails learners to have good self-regulation, planning, and monitoring skills that are necessary for self-directed learning (Pang, 2010; Sweller, Mawer, & Ward, 1983; Novick & Holyoak, 1991; Mustopa, Mustofa, Diella, 2020; McMillan & Moore, 2020; El-Adl & Alkharusi, 2020).

Self-regulated learning encourages learners to choose and employ suitable cognitive methods to facilitate them in sorting and organising information in order to solve a specific task. Learners who are capable of self-observation, self-evaluation, self-reaction, and self-reflection will eventually promote self-regulated behaviour (Ormrod, 2016). Additionally, Agarwal and colleagues (2021) it is recognised that students require a high level of self-motivation in order to engage in more engaging and meaningful learning.

In essence, self-regulated learning is a state of mind in which students' study and make choices based on their abilities. Effectively, such type of learning equips students with the ability to choose their own motivation, set learning goals, and monitor and control their own learning, all of which need a high level of metacognitive awareness and cognition. Self-regulation is a volitional process that entails goal formulation, planning, and monitoring (Roeser & Peck, 2009; Saraff, Biswal, Tripathi, 2020). Self-regulated learning was determined to be the most relevant mode of learning to explore in this research based on this criteria, as metacognitive strategies involving planning and comprehension of such tactics have a major impact on students' self- regulated learning.

### 2.2 The Influence of Thinking Maps towards Metacognitive Awareness

According to Hyerle (2011), thinking maps can assist students improve their metacognitive awareness across a wide variety of subjects and levels of age. Numerous novel learning aids have been developed in recent years to assist students in becoming more engaged and effective learners. Some discovered that using appropriate learning methods and instructions (McDowell, 2019; Conley, 2014) helped students raise their motivation (Abdelrahman, 2020) and metacognitive awareness, and metacognitive knowledge namely declarative, procedural, and conditional knowledge (Schraw and Moshman, 1995; Anthonysamy, 2021). Additionally, this study demonstrated that enhanced metacognitive awareness resulted in improved students' learning outcomes (Sindhwani, & Rakhi, 2019). Metacognitive experiences, in this context, are cognitive or affective experiences that involve any component of an intellectual endeavour.

To date, a number of strategies for promoting metacognition have been developed, including thinking aloud, thinking journals, thinking words (mnemonics), thinking maps, and thinking with reading. Each of these strategies can be used in the classroom and contributes to students' learning performance improvement (Kolencik & Hillwig, 2011; Chen, McDunn, 2022). According to Hyerle (2011), extensive research, thinking maps have numerous educational benefits, one of which is the promotion of metacognition in learning, which enhances students' cognitive growth. His study showed that the usage of thinking maps improved self-regulation during learning, implying that thinking maps could be a powerful tool for mediating thinking, listening, speaking, reading, writing, problem-solving, and obtaining new knowledge.

### 2.3 Motivated Strategies Thinking Maps Tools

The fundamental objective of the tool development is to assist students in grasping the concept of thinking maps, as well as how to effectively use each type of map for describing and explaining information structure. For this reason, once appropriate, the use of thinking maps may assist them in addressing challenges (on how to develop knowledge based on information stored in memory). By embedding multimedia principles and elements in the tool, it enables the creation of a variety of combination representations, including text and graphics, text and audio, and graphic and audio. To manage essential processing in multimedia, students should be able to manage the learning process at their own pace (Mayer, 2020). In other words, learners should be able to adjust the speed and how quickly they move through the lessons by using the "next" and "previous" buttons, as well as other aspects of the multimedia presentation's pace which contribute to their cognitive improvement (Othman, et al, 2021). In addition to texts, pictures, audio, and video, the tool includes multimedia components such as interactivity and feedback. Multimedia learning is associated with cognitive development, demonstrating how multimedia instructional materials can assist in the fast acquisition of knowledge (Rafiqa, et al., 2020). Effective text- and graphic-based learning occurs when learners select important images into visual working memory, organize them into pictorial models, and integrate them with prior knowledge (Vanichvasin, 2021). The following formats were used to present the content of thinking maps: written notes, examples, tutorials with help functions or hints for completing activities, and, finally, video representations.

## 3. Methodology

Concerning the discussed problems related to computing students, a research question was formulated as guidance to the study; does motivated strategies for learning significantly mediate the relationship between the learning condition and metacognitive awareness? The purpose of this study is to investigate the effect of MoSTMaT on metacognitive awareness and the mediating effects of motivated strategies for learning on the relationship between different learning environments and metacognitive awareness. Similarly, the research hypotheses developed to address the research question are that motivated learning strategies significantly mediate the relationship between the learning condition and metacognitive awareness.

### 3.1 Variable and Participants

The variables examined in this study are learning conditions (independent variables), motivated learning strategies (mediating and dependent variables), and metacognitive awareness (dependent variable). The learning condition consists of two treatment groups and a control group. The first group was employing MoSTMaT by both learning about and applying the concept of thinking maps through exercises. The second treatment group used the thinking maps module, which incorporates static texts and graphics to assist students in comprehending how to use thinking maps. All three conditions were designed to evaluate the tool's effectiveness by examining the effect of metacognitive awareness on participants and in different learning environments.

The quasi-experimental study used a pre and post-test design and consisted of three groups: a control group and two experimental groups with different learning conditions. One of the treatment groups in the experiment used MoSTMaT (dynamic multimedia), another experiment group received a module on thinking maps that was written on paper (static multimedia). The control group (those who did not get treatment) was taught the topics, administered the evaluation without prior knowledge, and exposed to thinking maps.

The study sample was 128 students from a total population of 220 computing students, namely those enrolled in computing degree programs at a public university in Terengganu and aged between 19 and 21 years old. Participants chosen enrolled in computing courses, attending class of 'Fundamental of Information System Development' and were already gone through subject 'Fundamental of Programming', as the prior knowledge of programming subject. The researcher chose these students for this experimental study because they are learning programming, a course or subject that involves the greatest amount of metacognitive awareness and problem solving abilities. Following that, these students were clustered in random sampling assigned to three groups: control (51 respondents), using tool (37 respondents) and thinking maps module (40 respondent) ensuring a balanced representation for the future experiment.

### 3.2 Instruments and Implementation

The researcher will collect data for both survey and experimental research in this study solely through questionnaires with structured questions. Two questionnaires were used in the experiment research namely Motivated Strategies for Learning Questionnaire (MSLQ) and Schraw and Dennison's (1994) Metacognitive Awareness Indicator (MAI) questionnaire was used in this study since it met the requirements of the study. MAI surveys were administered to Malaysian students, notably those enrolled in public universities, and were used to assess programming students (Mohd Rum and Zolkepli, 2016; Ismail et al., 2010). Additionally, the MSLQ instrument has been used before by researchers to assess motivation and self-regulated learning in computer science students (Mustopa, Mustofa, & Diella, 2020) as well as other areas of learning (Lee, 2013; Batahong et al., 2017). The MAI and MSLQ instruments have been implemented to demonstrate that they are relevant and understandable to Malaysian public university students.

The Cronbach Alpha coefficients calculated for the questionnaire items related to MAI and MSLQ were high, registering values at 0.896 and 0.894 respectively. This shows that the reliability of these items are high because the values of the coefficients obtained are greater than the recommended value between 65 to.95 (Chua, 2020). For both experimental groups, a pre-test of the experiment was provided two weeks prior to the intervention of thinking maps training. After two weeks, the intervention between pre-test and training began, with respondents in the two treatment groups receiving training in thinking maps. Treatment groups received four weeks of training, which included the use of two different types of thinking maps each week. Every exercise given to respondents was focused on the subtopic that they had learned in class that week.

### 3.3 Research Framework

The variables involved in the research are learning conditions (independent variables), motivated strategies for learning (mediating variable) and metacognitive awareness (dependent variable). The three groups consist of two treatment groups and one control group. One of the treatment groups was applying MoSTMaT and another applied thinking maps module to help students understand the use of thinking maps.

The control group consists of students going through the learning conventionally where they did the exercises on a paper and conducting references using textbooks or modules provided by lecturers during classes. In other words, they do their own exercises on their own preference. All groups were engaged in self-directed learning and exercise completion. A quasi-experimental research was conducted with pre and post-test design. In this experimental research, the mediating variable was motivated strategies for learning, between the relations of different learning conditions and metacognitive awareness (see **Fig 1**).

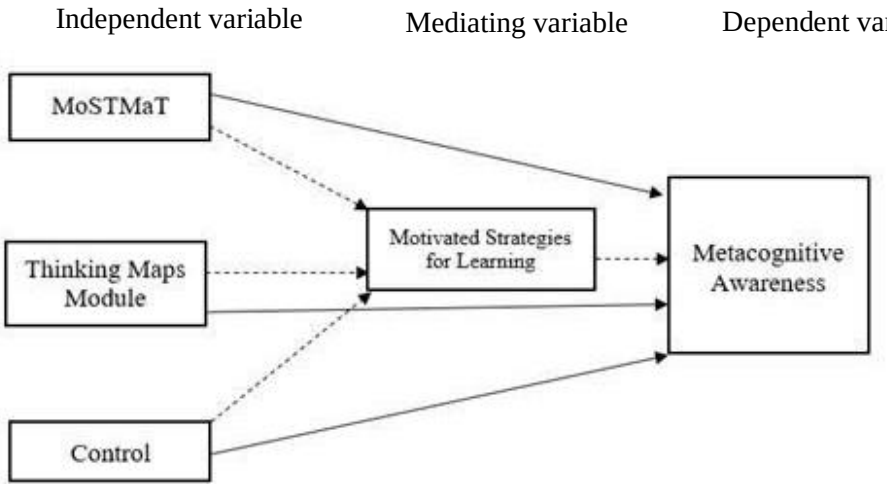


**Fig. 1** The research framework

## 4. Findings

The research question examines if there are significant relationships between motivated methods for learning and metacognitive knowledge of learning programming for students in this study. Based on a review of the research, the hypothesis is that there would be substantial relationships between motivated learning strategies and the interaction between different learning environments and metacognitive awareness.

$$(H1: \mu\ Tool \neq \mu\ Paper \neq \mu\ Conventional)$$

The research questions arise is to discover significant mediating variables of relations among distinct learning conditions which include learning using the respective tool (using thinking maps module and conventional learning environment) and metacognitive awareness. To identity the effects on mediating variable, method of Baron and Kenny (1986) was utilized which several conditions required to be meet based on the method as follows:

1) The independent variable (IV) must effects on dependent variable (DV); β1 must be significant;
2) The independent variable (IV) must effects on mediating variable (MV); β2 must be significant;
3) The mediating variable (MV) must effects on dependent variable (DV); β3 must be significant;
4) To state that predictor variables (MV) acting as fully mediating of the relationship between independent variables (IV) and dependent variables (DV), the impact of independent (IV) on dependent variables (DV) is nil or β4 is not significant. Whereas partial mediating occurs when β4 is significant but its value decreases.

Correlations between all variables indicate that they were significantly correlated at the p 0.01 level. Strong and substantial relationships were found between post-experimental motivated methods for learning and metacognitive awareness (r =.841, p 0.01). This finding demonstrates that motivated strategies for learning have an effect on students' metacognitive awareness while learning the fundamentals of programming. Correlations between three variables are shown in Table 1.

**Table 1.** Intercorrelation between Different Environments Of Learning, Post-Test Of Motivated Strategies For Learning And Metacognitive Awareness

| | **1** | **2** | **3** |
|---|---|---|---|
| Learning condition | 1 | -.258** | -.239** |
| Motivated strategies for learning | -.258** | 1 | .841** |
| Metacognitive awareness | -.239** | .841** | 1 |

** Correlations are significant at the 0.01 level (2-tailed)

Significant relations refer to the motivated methods for learning as a mediator between the relationships of various learning environments and their metacognitive awareness. According to Baron and Kenny (1986), four conditions must be met in order for the mediating variable to act as a mediator or not in this study. The first requirement is that the independent variable (various learning contexts) must have an effect on the dependent variable (metacognitive awareness), and the effect must be statistically significant. Linear regression was used to determine the significant differences between the two variables.

Table 2 and 3 shows the ANOVA and regression analyses for the first condition, respectively, as well as the total impacts of each group. The data analysis demonstrates that the total effects between the different learning circumstances (IV) and the post-test of metacognitive awareness (DV) are statistically significant using coefficient regression ($\beta$ = - .24, $p < 0.05$). $R^2$ = .057 indicates that this factor (learning conditions) had a 5.7 percent effect on metacognitive awareness. As a result, the first condition is fulfilled.

**Table 2.** Summary model for different learning groups and metacognitive awareness

| **Model** | **R** | **R Square** | **Adjusted R Square** | **Std Error of Estimate** |
|---|---|---|---|---|
| 1 | .239 | .057 | .050 | .57361 |

**Table 3.** Regression analysis of different learning conditions and metacognitive awareness

| | **Unstandardized Coefficients** | | **Standardize Coefficients** | **t** | **Sig** |
|---|---|---|---|---|---|
| | **B** | **Std. Error** | **Beta** | | |
| Constant | 5.765 | 140 | | 41.286 | .000 |
| Group | -.171 | .062 | -.239 | -2.769 | .006 |

The second condition is the relationships between different learning conditions (IV) and motivated strategies for learning as a mediating variable. The results indicate that there is a significant relationship between these two variables ($p > 0.05$) with = - 0.26. The findings indicate that MSL had a 6.6 percent ($R^2$ =. 066) effect on the post test. As a result, it satisfies the second required requirement. The ANOVA and regression analyses for the second condition are shown in Tables 4 and Table 5.

**Table 4.** Model summary for different learning groups and motivated strategies for learning

| **Model** | **R** | **R SquareAdjusted R Square** | **Std Error of Estimate** |
|---|---|---|---|
| 1 | .258 | .066.059 | .56927 |

**Table 5.** Regression analysis of different learning and motivated strategies for learning

| **Unstandardized Coefficients** | | | **Standardize Coefficients** | **t** | **Sig** |
|---|---|---|---|---|---|
| | **B** | **Std. Error** | **Beta** | | |
| Constant | 5.789 | .139 | | 41.773 | .000 |
| Group | -.183 | .061 | -.258 | -2.993 | .003 |

The third condition concerns the link between MSL (the moderator variable) and the post-test of metacognitive awareness. The results in Table 6 and Table 7 indicate that there were significant relationships between those two variables, with $p < 0.01$ with $\beta = .841$, indicating that 70.4 percent of the factors impacting post metacognitive awareness results are contextual. As a result, the third condition is fulfilled as well.

**Table 6.** Model summary for motivated strategies for learning and metacognitive awareness

| Model | R | R Square | Adjusted R Square | Std Error of Estimate |
|---|---|---|---|---|
| 1 | .841 | .707 | .704 | .31993 |

**Table 7.** Regression analysis of motivated strategies for learning and metacognitive awareness

| **Unstandardized Coefficients** | | | **Standardize Coefficients** | **t** | **Sig** |
|---|---|---|---|---|---|
| | **B** | **Std. Error** | **Beta** | | |
| Constant | .850 | .263 | | 3.235 | .002 |
| Group | .843 | .048 | .841 | 17.426 | .000 |

Table 8 summarizes three from four of the conditions to meet the requirements for mediation according to Baron and Kenny (1986).

**Table 8.** Summary of regression analysis predictor requirements

| | B | SEB | β | S |
|---|---|---|---|---|
| 1st condition<br>Learning conditions – Metacognitive awareness ($R^2$ = .057) | -.171 | .062 | -.239 | .006 |
| 2nd condition<br>Learning conditions – Motivated strategies for learning<br>($R^2$ = .066) | -.183 | .061 | -.258 | .003 |
| 3rd condition<br>Motivated strategies for learning – Metacognitive awareness<br>($R^2$ = .707) | .843 | .048 | .841 | .000 |

Throughout these analyses, it is established that different learning environments do have an effect on students' motivated learning strategies and metacognitive awareness. Additionally, the data demonstrate that motivated strategies for learning do have an influence on post-test performance. These findings could be explained by the mediation effects of motivated learning strategies and metacognitive awareness.

The findings demonstrate that direct relationships exist between different learning environments and their metacognitive awareness. Thus, in order to determine the effects of the mediating variable, a final test must be conducted using multiple linear regression with different learning conditions and motivated

strategies for learning as the independent variable, as well as a post-test of metacognitive awareness as the dependent variable, in order to ascertain the effects of the mediating variable in this research. Table 9 and Table 10 shows the model summary and multiple linear regression for different groups, metacognitive awareness and motivated strategies for learning.

**Table 9.** Model summary for different learning groups, motivated strategies for learning and metacognitive awareness

| Model | R | R Square | Adjusted R Square | Std Error of Estimate |
|---|---|---|---|---|
| 1 | .841 | .707 | .703 | .32090 |

**Table 10.** Regression analysis of different learning conditions, motivated strategies for learning and metacognitive awareness

| Unstandardized Coefficients | | | Standardize Coefficients | t | Sig |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| Constant | .922 | .301 | | 3.061 | .003 |
| Group | -.017 | .036 | -.025 | -.489 | .625 |
| MSL | .837 | .050 | .834 | 16.661 | .000 |

The test consists of two steps. First, the study demonstrates that different learning conditions have an effect on students' metacognitive awareness. While in the second step, the mediating variable was included as an independent variable in the analysis of multiple linear regression. The integration of the MSL score in the second step resulted in an insignificant ($p > 0.05$) value for the regression value ($\beta$) independent variable, learning conditions, as shown in Table IX, indicating that motivated strategies for learning are indeed a complete mediator between the relationship between various learning conditions and metacognitive awareness. Additionally, $R^2 = 0.703$ when motivated strategies for learning are included, demonstrating that it does influence 70.3 percent of students' metacognitive awareness, as shown in Table 9. As a result, it is argued that motivated learning techniques are a significant mediator of the relationships between various learning situations and metacognitive awareness among the students in the study. To summarize, the null hypothesis is rejected. As a result, the regression model extracted from the analysis is shown in **Fig 2**.

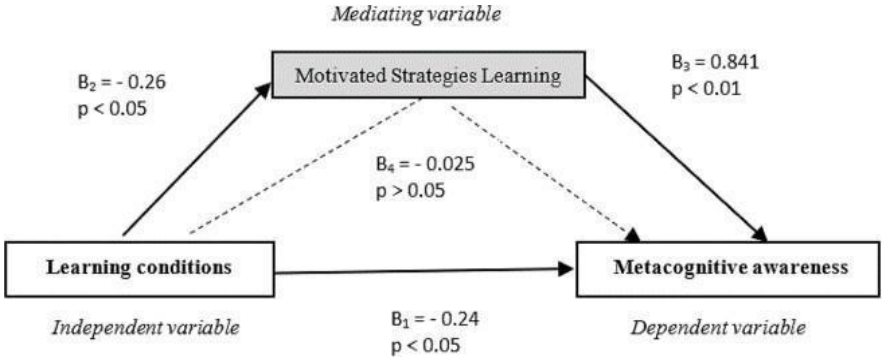


**Fig. 2** Motivated strategies for learning as mediating variable

## 5. Discussions

The research hypothesis and objective reflect on the potential that the presence of motivated strategies for learning has an effect on metacognitive awareness when students are exposed to different of conditions in their learning environment while studying the respective subject. The analysis results support the research hypothesis that motivated strategies for learning do have an effect on these particular students' metacognitive awareness while learning programming in the classroom. The results indicate that the learning condition does have a 5.7 percent ($R^2$ = .057) influence on the development of metacognitive awareness in these students. Though the presence of motivated strategies for learning and thinking maps was demonstrated through a post-test of metacognitive awareness, 70.7 percent ($R^2$ =.707) gained metacognitive awareness.

The findings of this study demonstrated that the combination of different learning environments and motivated strategies embedded in the developed tool had an effect on these students' metacognitive awareness of their learning. As discussed in the literature review chapter, motivated strategies for learning are composed of two components namely motivational beliefs and self-regulated learning. Both above-mentioned constructs are critical for the development of metacognitive awareness during the learning process. Apart from that, it may help increase focus and engagement with the tool, as well as provide a better understanding of thinking maps.

Outcomes from data analysis reveals motivated strategies for learning indeed has to be implemented into learning to help enhance metacognitive awareness among students especially to study subjects that involve critical and problem solving skills. These findings were also supported by a study conducted by Reed (2015) which revealed an increase in metacognitive awareness among students who actively interact during learning specifically with those who employ cognitive strategies subcomponents such as rehearsal, elaboration and organization. Moreover, this group of students also increases their academic accomplishments in that particular subject (Reed, 2015).

As everyone goes through the process of learning, there are some aspects that motivate them to continue until they achieve or are content with the outcome. This aspect is referred to as intrinsic motivation. There are external reasons such as a desire to be appreciated, to earn extra marks, and so forth. However, more significant is the acceptance of one's own selves through performing things not for the sake of others, but for the sake of one's own passions and enjoyment of the outcome. Maintaining engagement in learning is difficult, but motivations will encourage learners to persevere until the task or challenge is completed. Pintrich (1994) puts a focus on the development of self-efficacy, intrinsic worth, and anxiety in order to boost learning capacity, particularly in disciplines that require critical thinking. Moreover, independence in learning will create and increase self-efficacy of students while empowering critical thinking skills (Sulistyanto, H., et al., 2023).

Learning with multimedia tools can be a pleasurable or challenging experience for some due to the variety of representations available to convey the content to the user, especially when used in self-learning mode. It can only be successful through influence and the application of appropriate strategies with users to encourage learners to use all information or guidance provided, including all representations provided in the tool, consistently and repeatedly, until self-regulation is achieved through the ability to conduct self-monitoring and regulate one's own learning. Self- regulated learning necessitates those learners be able to actively engage in the following tasks during learning (selecting, organizing, and regulating), as well as selecting materials or other media that can assist them in acquiring information to aid in their learning (Azevedo,2014; Abdelrahman, 2020). Additionally, it is considered that self-regulation is associated with cognitive regulation and is related to the ability to organize future learning activities (Azevedo, 2014; Dunlosky & Metcalfe , 2008; Veenam et. al, 2006).

Both components (motivational beliefs and self-regulated learning) are interconnected and critical for supporting learning, particularly in difficult subjects. Once it integrates tactics for being motivated, it reflects on strategies for increasing learners' metacognitive awareness. As noted in a study on the impacts of motivated strategies for learning on metacognitive abilities, the existence of MSL is unquestionably a factor in the enhancement of metacognitive awareness in learning; indeed, they refer to MSL as a 'learning facilitator' (Tabatabaei, et al., 2017). Nonetheless, the exposure to thinking maps into the learning process, and the method of problem solving assigned to them has an effect on their ability to think critically about assignments in a particular area, fundamentals of programming.

The role and combination of thinking maps and motivated methods has a beneficial effect on metacognitive awareness improvement. Motivation and self-regulation were required in the majority of situations, especially when considering potential solutions to difficulties. When pupils are obliged to learn in self-regulated mode, motivation has a substantial impact on learning. (Stark, 2019). With the presence of MSL as a mediator in the learning process of programming with the aid of thinking maps, it helps to improve the metacognitive awareness of students, where it continues to have a positive effect on improving student performance through better self- learning and also how to organise information, and select an effective strategy (Azavedo, 2014) for overcoming a problem in the programming subject.

## 6. Co-Author Contribution

The authors affirmed that there is no conflict of interest in this article. Author 2 carried out the fieldwork, verified the statistical analysis and overlooked the writeup of the whole article. Author 1 carried out the literature review, statistical analysis and interpretation of the results. Author 3,4,5 wrote the research methodology and did the data entry.

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