THE IMPACT OF MoSTMaT ON COMPUTING STUDENTS' MOTIVATED STRATEGIES FOR LEARNING AND METACOGNITIVE AWARENESS

NURUL NADIA BINTI HASSAN

UNIVERSITI PENDIDIKAN SULTAN IDRIS
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ABSTRACT

This study aims to develop and evaluate a learning tool: Motivated Strategies Thinking Map Tool (MoSTMaT) on motivated strategies for learning (MSL) and metacognitive awareness (MA) among computing students. The MoSTMaT tool was developed based on the principles of multimedia message design by combining multimedia elements and thinking maps. The research design consists of a survey and quasi-experimental study with pre-post test. The survey study sample involved 209 students, while 128 students from a public university were selected as participants in the experimental study using cluster random sampling. The experimental study involved three groups namely MoSTMaT group with 37 students, printed module group with 40 students, and control group with 51 students. Assessment was done using the Metacognitive Awareness Inventory (MAI) and the Motivated Strategies for Learning Questionnaire (MSLQ). The data were analyzed using descriptive statistics and inferential statistics including Pearson correlation test, Analysis of Covariance (ANCOVA), Analysis of Variance (ANOVA), and linear regression to answer the research questions. The findings of the survey study showed that the level of MA among students was high (M=5.11, SD= .61), while the level of MSL was moderate (M=5.10, SD=.68). The analysis of correlation between MA and MSL showed a strong and significant relationship, $r(209) = .81$, $p<.01$. Meanwhile, ANOVA and ANCOVA analyses for the experimental study indicated significant differences in MSL, $F(2,125)= 5.810$, $p< .05$ and in MA, $F(1,124) = 7.612$, $p<.05$. The linear regression analysis using Baron and Kenny's method showed that MSL mediate MA. In conclusion, the findings of the study indicate that the developed tool can have positive and significant impact on MSL and MA. The implications of the study suggest that the use of MoSTMaT, which includes interactive multimedia elements and thinking maps, can contribute positively to the mastery of learning motivation strategies and MA among computer students.

KESAN MoSTMaT TERHADAP STRATEGI MOTIVASI BELAJAR DAN KESEDARAN METAKOGNITIF PELAJAR KOMPUTERAN

ABSTRAK

Kajian ini bertujuan untuk menghasilkan dan menilai satu alat pembelajaran: *Motivated Strategies Thinking Map Tool* (MoSTMaT) terhadap strategi motivasi belajar dan kesedaran metakognitif dalam kalangan pelajar komputeran. MoSTMaT dibangunkan berpandukan pada prinsip rekabentuk mesej multimedia dengan menggabungkan elemen multimedia dan peta pemikiran. Rekabentuk kajian adalah berbentuk tinjauan dan kajian eksperimen kuasi dengan ujian pra-pos. Sampel kajian tinjauan melibatkan seramai 209 dan 128 pelajar universiti awam dipilih sebagai peserta dalam kajian eksperimen melalui kaedah rawak berkelompok. Kajian eksperimen dibahagikan kepada tiga kumpulan iaitu kumpulan MoSTMaT seramai 37 orang, kumpulan modul bercetak ialah 40 orang dan 51 orang dalam kumpulan kawalan. Penilaian dilakukan menggunakan soal selidik *Metacognitive Awareness Inventory (MAI) dan Motivated Strategies for Learning Questionnaire (MSLQ*). Data kajian dianalisis dengan menggunakan menggunakan statistik deskriptif dan statistik inferensi yang melibatkan ujian korelasi *Pearson*, ujian *Analysis of Covariance* (ANCOVA), ujian *Analysis of Variance* (ANOVA) dan regresi linear bagi menjawab persoalan kajian. Hasil kajian tinjauan mendapati tahap kesedaran metakognitif berada pada tahap tinggi (M=5.11, SP= .61) manakala tahap strategi motivasi belajar berada pada tahap sederhana (M=5.10, SP= .68). Korelasi antara kesedaran metakognitif dan strategi motivasi belajar menunjukkan kekuatan hubungan yang tinggi dan signifikan, $r(209) = .81$; $p< .01$. Manakala, analisis ANOVA dan ANCOVA kajian eksperimen pula menunjukkan terdapat perbezaan signifikan terhadap strategi motivasi belajar $F(2,125)= 5.810$, $p< .05$ dan kesedaran metakognitif $F(1,124) = 7.612$, $p<0.05$. Ujian regresi linear dengan kaedah Baron dan Kenny menunjukkan strategi motivasi belajar berperanan sebagai pengantara bagi kesedaran metakognitif. Kesimpulan, hasil kajian mendapati bahawa alat yang dibangunkan memberikan impak yang positif dan signifikan terhadap strategi motivasi belajar dan kesedaran metakognitif. Implikasi kajian menunjukkan penggunaan MoSTMaT yang mengandungi elemen multimedia interaktif dengan peta pemikiran dapat menyumbang secara positif kepada penguasaan strategi motivasi belajar dan kesedaran metakognitif pelajar.

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation and Evaluation Model
CTML	Cognitive Theory of Multimedia Learning
KoC	Knowledge of Cognition
MA	Metacognitive Awareness
MB	Motivational Beliefs
MoSTMaT	Motivated Strategies Thinking Maps Tool
MSL	Motivated Strategies for Learning
RoC	Regulation of Cognition
SPSS	*Statistical Package for the Social Science*
SRL	Self-Regulated Learning
TM	Thinking Maps
UiTM	Universiti Teknologi MARA

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In today's technology-driven world, virtually all people have to deal with a vast amount of information from the internet and social media, which have drastically shaped their lifestyles and worldviews. Over recent years, most people have been using a wide spectrum of information without knowing the process that creates it. Since 1940, many programming languages have been invented to provide the necessary commands to run computing machines to process and churn out the information needed by various sections of human societies (White, 2015), the process of which is called programming that enables every computing machine to understand and execute commands. For example, FORTRAN (*Formula Transition*) was the language used for computing machines to run engineering applications, while HTML (*Hypertext Markup Language*) is the scripting language used for website development.

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 general, virtually all programmers hold a bachelor's degree in Information Technology (IT), Software Engineering (SE), or Computer Science. Equipped with strong problem-solving skills, programmers will be able to develop effective programs to solve complex, intricate problems. Conversely, a lack of such skills can incapacitate a programmer to develop a reliable and efficient program.

Admittedly, for most people, acquiring such skills and knowledge is hardly easy let alone apply them in their works as there are many factors involved. Clearly, education and training play a critical role in helping students to acquire and develop sound problem-solving skills (Lawan, Abdi, Abuhassan, Khalid, 2019; Budak, Gecer & Topal, 2019). In particular, educators need to help students develop such skills, notably namely metacognitive awareness, to help them critically analyze and solve programming problems in the learning process. Many studies have shown that programming is one of the courses or subjects that most students have difficulty to learn and master (Alakeel, 2015; Baist & Pemungkas, 2017; Lawan, et al., 2019). To make matters worse, most students do not have a strong motivation to push them to work hard to learn the complex concepts of programming (Zainal, et al., 2012). As such, more efforts are needed to help students learn programming more effectively and enthusiastically, a subject matter that entails students to think critically, creatively, and analytically (Harimurti et al., 2019; Tseng & Weng, 2010).

Malaysian Qualification Agency (MQA) clarify that programming skills and proficient to learn other new programming languages is crucial in computing. Later, industrial training will cultivate student's maturity and gain experience in working environment (MQA, 2015). These essential requirements in order to provide experts (in computing) to be marketable. Malaysia government eager to train students starting 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). Specifically, this document focuses on future educational planning for primary and secondary school students to develop the essential skills to facilitate a smooth transition to higher learning at the tertiary level where such skills are a prerequisite for successful learning.

In higher education, developing students' critical thinking skills has become a major priority. Critical thinking abilities and problem solving as one of the qualities that students should develop during their tertiary education, according to the Ministry of Higher Education (MOHE) in Malaysia. Since 2015, critical thinking and problem solving has been incorporated into Malaysian higher education as required by MOHE. Therefore, it is important to increases students' problem solving skills accomplishment to support the principles of MOHE towards higher critical and problem solving skills among students (MOHE, 2015).

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 (motivational beliefs and self-regulation), and learning design tool strategy that involves the use of thinking maps and multimedia to help students develop strong metacognitive awareness and intrinsic motivation. Collectively, such factors can help students develop good metacognitive awareness that in turn help them learn programming more efficaciously.

1.2 Background of Research Study

Fundamental courses on programming languages becoming essential at all levels of curriculum in education (Lawan, et al., 2019). In this regards, in the world of technology and facing 21st century education, programming skills is currently relevant (Abesadze & Nozadze, 2020; Nelson, 2009). Programming languages are the communication language that need to transform structured plan into compatible languages to computers (Chowdhary,2020). In this regard, it is essential that programmers write effective, efficient codes to ensure computers can function as intended. Moreover, programming language described as complex structured grammatical rules presented in a creative and effective ways (Robins, 2019). 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 efficaciously (Ambrosio P. A., et al.,2014). Admittedly, most programming students find learning programming extremely challenging, which stems from a lack of essential learning ability and motivation. Unresolved, students may eventually opt to quit learning the subject or perform poorly in the examination or dropout (Robins, 2019).

In this regard, studies has been made to investigate the issues pertaining the challenge confronted by students during early phase of learning programming subject. Students found to have troubles in understanding fundamental concept in designing program including programming structure in order to solve problems (Derus & Mohamad Ali, 2012; Xinogalos, 2016). For this reason, there are study which identify the crucial skills that needed to learn introductory in programming which is problem solving skills (Tseng & Weng, 2010; Hui & Omar, 2011; Harimurti, et al., 2019).

Learning is a never-ending endeavour that affects all the people's lives, which they perform either consciously or unconsciously. The most important aspect of learning is the ability of individuals to manage the information that they have and apply it in various contexts, such as solving a problem. Effectively, it means that they need to have a full grasp of relevant information to make it purposely useful for them to perform their tasks effectively. Successful growth problem solving skills depending on the apt concept of programming skills (Harimurti, et al., 2019). Additionally, Harimurti and her colleagues (2019) also agreed that the services for implementation of computer-based obliges students to have problem solving skills other with designing skills, logical thinking skills and understanding how computer works.

In this respect, the capability of taking control when and where to use appropriate information creatively and critically is called metacognition or awareness of their own metacognitive. Metacognitive awareness do have significant effects on successfulness of students in learning introductory programming course in university (Rum & Ismail, 2016). 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).

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; Caliskan & Sunbul, 2011; Mitsea, et al., 2019). Metacognitive awareness also has close relations with problem solving skills. In learning context, skills in problem solving depending on the how student are able to take control of their learning progress. Hence, growing metacognitive awareness is critical and crucial in learning programming as it relates on problem solving skills among students (Cakiroglu and Er, 2020; Pradhan and Das, 2021). A study by Caliskan and his colleague (2011) found that the use of proper learning strategies helped students increase their metacognitive awareness.

Metacognitive awareness is the belief that one has toward other agents of cognitive tasks, strategies, and the interactions between them, which will affect the outcome of any decision made (Flavell, 1979). Several studies have shown that metacognitive awareness would have a profound impact on students' learning achievement. Guner and Erbay (2021) agreed through their study, that metacognitive awareness do have significant impact towards students' problem solving effectiveness.

Based on the findings of Shraw and Dennison's (1994) study, metacognitive awareness can influence cognitive performance by enhancing the strategy being used. This means that students must be able to take charge of what they are learning by improvising learning strategies to overcome their learning problems. As such, it is important to design learning strategies that use appropriate learning tools that can help promote metacognitive awareness among students. Such learning strategies can help enhance the learning process, especially in the self-regulation mode.

Cognition relates as a process of thinking and metacognitive knowledge is a process of a person knowing the thinking process (Hamiddin & Saukah, 2020). Metacognitive knowledge, however also referred as metacognitive awareness as the process involves knowledge about cognition, as well as consciousness of knowledge in a person's action. In the opinion of Lai (2011), metacognitive knowledge is one of the fundamental component metacognition. Accordingly, cognition influencing metacognitive awareness in terms of changes of cognitive processing in mind and eventually the awareness of a person to control and regulate their own learning. Previous research by Pintrich (2002) showed that metacognitive awareness could be improved by metacognitive knowledge. Pintrich (2002) have implemented several strategies to improve metacognitive knowledge, such as rehearsal, elaboration, and organization. For example, Kauffman (2004) used feedback and self-monitoring in the learning process that helped improve self-efficacy and metacognitive processing.

One of the most important and essential and constantly discussed were the relations of metacognition and ability of students in self-regulate in learning. Self-regulation is defined as a combination of processes involving goal-setting, planning,

and monitoring (Roeser & Peck, 2009). As such, students who are unaware of the importance of what they need to learn may have difficulty to engage in self-regulated learning. Surely, learning in the self-learning mode requires students to have high self-motivation and strong self-efficacy to make judgments throughout the learning process. Thus, self-regulated learning can help students develop critical and creative thinking to enable them to solve problems more systematically. Admittedly, some students may not be able to perform problem-solving effectively as they do not know how to apply information or knowledge in a proper sequence. This is consistent with Hariri and his colleagues (2021) study, which discovered that the correlation between learning techniques and student motivation depends on that motivation, with learning techniques also being at a moderate level if the motivation is at a moderate level. Nonetheless, through proper training, students will be able to develop such an important skill needed in problem-solving.

Accordingly, metacognitive awareness able to increase by training, and the result can be seen through their achievement in academic performance (Ward and Darrell, 2019; Pradhan and Das, 2021). The exposure of learning tool to students continuously will give impact on their learning habits and process. Although it is depending on the learner's conditions and learning environment which can give different impact on the quality of their learning, eventually, with enough time of exposure to the training, the result will reveal positive outcome to learners. This situation also occurred with motivated strategies for learning. Motivation giving large impact on learning particularly when students need to learn in self-regulated mode (Stark, 2019).

As revealed in previous studies, one of the effective strategies to enhance students' metacognitive awareness is thinking maps (Hyerle, 2011). Derus and her colleagues (2012) also proposing a visualization tool as an aid to help students practically in learning programming. In principle, there are eight types of thinking maps, which have been used in the teaching and learning process to enhance the development of metacognition and cognitive abilities among students (Bunt, et al., 2022) and still being used nowadays. Thinking maps can also improve self-regulated learning because they provide an effective medium for thinking, listening, speaking, reading, writing, and problem-solving (Hyerle, 2011). Thinking maps can be used to improve the efficacy of the teaching and learning process; however, in the self-regulating mode, such a process can be challenging. Thus, such learning may entail effective learning strategies that use novel learning aids, such as a multimedia tool, to motivate students to learn more engagingly and meaningfully. Moreover, conventional classroom are less engaging compared to dynamic classroom (Borit and Lina, 2020). In this regard, motivation is required in self-regulated learning to ensure students can focus longer on the learning process, especially for science and technical courses or subjects, such as programming, which can be very challenging to some students (Roslina, et.al, 2011).

Throughout recent years, multimedia has been functioning as one of the interesting and successful learning aid also implemented in various areas of learning. Multimedia had proposed principles and comprehensive model by Mayer's cognitive theory in multimedia starting with general principles; students' learn more effectively when they use both words and graphic than using test alone in learning process (Mayer 2009). Previous literature discussion regarding relations between metacognitive and

multimedia (Antonietti & Colombo, 2014), proven that the use of multimedia in learning do supports metacognition in different aspects and roles (Schwonke, et al., 2013). Multimedia presented in fascinating way with combinations of multiple presentations, including ability to give instructions through it. Metacognitive enabling students to manage their own learning, monitoring and evaluate their own learning (Shraw & Dennison, 1994). With multimedia in present, integration of dynamic multimedia (Moreno, 2005) which allowing interactivity and giving feedback which connecting the component of cognitive, metacognitive, motivation and learners (Domagk, et al., 2010). Eventually, the learning process through involvement of multimedia demonstrate metacognitive progress among learners (Antonietti, et al., 2015; Alemdag & Cagiltay, 2018; Mayer, 2009; Mayer, 2020).

Over recent years, multimedia technology has been widely used to help motivate students to learn a variety of subjects by making learning an experience that is both engaging and meaningful. Thus, the design of learning strategies to enhance students' metacognitive awareness and motivation should consider the use of novel, innovative learning aids (Pintrich, 2002). Premised in this context, this study was carried out that aimed to improve secondary students' metacognitive awareness, motivation and self-regulated learning in learning with the use of multimedia. Self-regulation is a skills acquired when learner's are able to take control of their own learning, strategies and developing cognitive, motivational aspect (Pintrich, 1999a; Pintrich, 1999b; Zimmerman and Martinez Pons, 1986). Furthermore, Mustopa (2020) agreed that self-regulated learning does impact on learners' metacognitive awareness. With reference to a study by Yot-Domínguez and Marcelo (2017), one of digital technology has been applied in this study is the usage of multimedia to regulate university students' own

learning (self-regulation). Later, students sooner or later are capable enough to find their own resources without the help or any instructions from lecturers.

1.3 Problem Statement

In Malaysia's secondary educational curriculum, Computer Programming is one of the core and compulsory subjects that students majoring in Information Technology (IT) and Computer Science (CS). To efficaciously learn such a subject, students must first have the ability to understand the underlying concept of problem-solving before they can solve programming problems (Lawan, et al., 2019; Ismail et al., 2010 ; Tseng & Weng, 2010). However, learning this course has been very challenging for most students, especially novice computing students, which is primarily due to a lack of sufficient learning skills and confidence in learning such a subject. In terms of students' aspects, many of them lack problem solving abilities (Bosse & Gerosa, 2017; Gomes & Mendes, 2007; Robins, 2019) and lacking the skills in analysis of given tasks (Zaharin and Mariappan, 2018). Furthermore, most programming and problem solving in programming are acknowledged as difficult (Dobbyn and Chetwynd, 2014; Jenkins, 2002; Savage and Piwek, 2019).

Unmitigated, such a predicament can result in several repercussions, such as students becoming more frustrated or demotivated to learn, ultimately compelling them to quit learning the subject (Johan, et al., 2006, Robins, 2019). Admittedly, the early phase of learning programming will be extremely challenging as most novice students lack problem-solving skills and analytical thinking to understand a given problem (Hui

& Omar, 2011). This findings supported through a study by Lawan and his colleagues (2019) indicating that students do facing difficulties in learning programming due to deficient of problem solving abilities. Such skills are pre-requisite to the efficacious learning of programming, which are indispensable to programming students to help them become a highly successful programmer (Tseng & Weng, 2010; Hui & Omar, 2011; Derus & Mohamad Ali, 2012 ; Harimurti, et al., 2019).

There are several pedagogical and motivational factors that affect learning in programming, such as a lack of time to practice and a lack of confidence to perform tasks independently (Rahmat et al., 2011). More influentially, cognitive skills, such as problem-solving and metacognitive awareness, have profound impacts on learning programming, (Ifenthaler & Lehmann, 2012; Cakiroglu and Er, 2020; Pradhan and Das, 2021; Leutner & Leopold, 2003; Schiefele, 2005; Veenman, vab Hout-Woulters, 2006). Some scholars have suggested the use of visualization tools to help students learn complex learning concepts (Derus et al., 2012). While others have recommended novel learning aids to help students develop strong metacognitive awareness that enable them to solve problems more effectively such as embedding technology into learning aid. Several researches identified that multimedia-based learning activities is necessary at the early stage of learning programming subject (Kalelioglu & Gulbahar, 2014; Cegielski & Hall, 2006). Likewise, such learning tools can also help develop strong self-efficacy to facilitate self-regulated learning among students.

Arguably, students' inability to master programming stems from a lack of strong metacognitive awareness to help them learn to solve programming problems. Effectively, without such skills, students will have difficulty in processing information

that makes it useful for solving a given problem. To make matters worse, most students find it difficult to apply what they have learned from their lecturers to new problem-solving contexts. Put simply, they do not have sufficient metacognitive awareness to deal with a wide range of programming problems. A study was conducted by using mind mapping and cooperative approaches towards computer science students to promote problem solving skills and metacognitive (Ismail et al., 2010). However, integration of technology in learning materials through different learning environment depending on learners should be considered options on applying mind mapping.

Studies have shown that students with high metacognitive awareness and high motivation would perform better than those with low awareness and low motivation (Oz, 2016; Dedic, 2014). Furthermore, strong metacognitive awareness enables students to remain focused, as they are capable of monitoring and evaluating their learning. Equally important, such a skill allows students to become more strategic in planning their learning that enables them to effectively deal with problems. As acknowledged, students need strong self-motivation to help them learn more engagingly and meaningfully (Agarwal, 2021). In other words, they must have a strong intrinsic desire and motivation to learn programming (Fifueiredo and Garcia-Penalvo, 2020). Being motivationally driven, they will find learning to be an experience that is both educational and enjoyable. Thus, the focus of the research was on motivated strategies for learning to help enhance students' problem-solving skills yielding better metacognitive awareness and motivational beliefs to learn programming in self-regulated learning.

Studies have also shown that metacognition is positively related to self-regulated learning that can significantly change students' behaviors throughout the learning process (Ozcan, 2016). However, such studies did not address issues relating to internal motivation namely motivational beliefs. These factors or motivational beliefs are critical factors that can help students to go through cognitive changes that affect their way of thinking or learning strategies, which effectively can help them solve problems, especially in self-learning (McDowell, 2019).

Self-regulation and problem-solving process are a strategic combination that involves of metacognition (Ifenthaler, 2012), strategy use (Shraw & Dennison, 1994; Caliskan & Sunbul, 2011), and motivational learning strategies to help students perform difficult tasks, which leads to the development of strong learning skills. In principle, self-regulated learning involves two main aspects of learning, namely cognitive strategy use and self-regulation (Pintrich, 1991). Being self-regulated learners in higher education need students to necessarily capable for asking the correct questions to themselves. When they are asking the precise questions and trying to solve by finding the answer to the questions, then it will motivate them to try harder until the correct answer found. Therefore, in self-regulated learning, students need to have a strong motivation to remain persistent to learn independently and creatively.

For the teaching and learning process to be effective, knowledge has to be successfully transferred from the teacher to students, which can materialize if the latter have good problem-solving skills and metacognitive awareness (Ismail, et al., 2010). As acknowledged, most students find it difficult to manipulate knowledge or develop an effective strategy to solve a given problem. Specifically, students must have the

ability to transform tacit knowledge into explicit knowledge to achieve successful learning. Without successful knowledge transfer, students will not be able to learn effectively, which eventually can lead to low motivation and poor learning achievement (Fabbri, et al., 2013).

The use of innovative, novel learning tools or aids can help activate and enhance metacognition to guide students to select and use effective learning strategies that can enhance their metacognitive awareness and, thus, improve their learning performance. Surely, the process of improving metacognition may take time; but through persistent, continual training or learning, students will be able to improve their metacognitive awareness that can help change the way of their thinking. Furthermore, the use of learning tools or aids with proper design strategies can promote self-regulation and metacognitive awareness (Pintrich, 2002; Cho, 2004). Many researchers applying other than thinking maps, namely mind mapping (Malallah & Weese, 2020; Astriani et al., 2020; Ismail et al., 2010) and concept mapping (Cassata, E. Amy & French, Lucia, 2006; D'Antoni, 2009; Chevron, 2014) as learning tool and to be implemented in learning environment intentionally helping students to increase metacognitive awareness. Nevertheless, most studies implementing thinking maps in languages,science, medical areas but not in computing area of study in university (D'Antoni, 2009; Petrová, & Kozárová, 2018; Astriani et al., 2020).

Over recent years, many researchers have conducted several studies to determine the effectiveness of novel multimedia learning tools on metacognition (Clarebout, et al.,2013; Alemdag & Cagiltay 2018; Mayer, 2020). Lately, thinking maps have been widely studied in various learning disciplines, such as science,

technology, engineering, and mathematics (STEM), which have been widely used to stimulate critical thinking abilities among students of higher learning (Lim, 2014). In fact, the Ministry of Education of Malaysia has prescribed the use of such learning tools to improve problem-solving skills among students pursuing science and mathematics.

From the learning perspective, the combination of thinking maps and multimedia can not only help students to gain metacognitive awareness but also to make learning more interesting that motivates them to learn programming. In particular, the use of multimedia elements can help students to learn to use learning tools effectively. Studies have shown that there are significant relationships among self-efficacy, intrinsic value, motivation, cognitive strategy, and self-regulated learning (Jaafar, 2016). Learning environment plays important role in learning especially when learners need to do the task on their own (self-regulation). The presence of multimedia in the environment gives enjoyable experience and increasing motivation to learn specifically while doing problem-based learning (Liu et al., 2011). Learning motivation do derived through multi-level dynamic learning activity which eventually yielding improvement of learning effects (Meng et al.,2020). Other than that, multimedia also can offer independent learning experience by feedback, emoticons for example, giving the feel of enthusiasm to learners (So, et al., 2019). However, a tool which integrating motivated strategies multimedia and thinking maps is not available due to many research were focusing on developing the tool and many training on metacognitive awareness through traditional methods.

Effectively, this learning tool was developed to guide students to use several types of thinking maps that helped them solve programming problems. In this study,

students learned programming in the self-regulated mode with the use of such a tool. To ensure they would remain motivated and engaged, the learning design of the tool aimed at high interactivity and prompt feedback with the use of multimedia elements, such as video, graphics, and audio. Together, they helped transform the novel learning tool Motivated Strategies Thinking Maps Tool (MoSTMaT) into a potent learning tool to enable the students to learn programming more efficaciously and engagingly. Thus, the design of learning design strategy such factor in such elements to enhance self-regulated learning. Premised in this context, this study was carried out by focusing on these important factors.

1.4 Purpose of Study

The aim of this study was to design, develop and evaluate the impact of the Motivated Strategies Thinking Maps Tool (MoSTMaT) on computing students' motivated strategies for learning including their metacognitive awareness. In order to achieve this purpose of the study, an learning tool was developed with a survey and experimental research has been conducted.

1.5 Research Objectives

The main purpose of this study was to develop and test the effectiveness of a novel learning tool called *MoSTMaT* on the development of participants' metacognitive awareness that would help improve their metacognitive awareness and learning

performance in programming subjects. Specifically, this study was carried out to address the research objectives as follows:

1. To identify the level of metacognitive awareness and motivated strategies for learning among novice computing students.
2. To investigate the relationship between motivated strategies for learning and metacognitive awareness among novice computing students.
3. To determine the acceptance of computing students towards MoSTMaT.
4. To design and develop a learning tool called Motivated Strategies Thinking Maps Tool (*MoSTMaT).*
5. To determine the participants' motivated strategies for learning and metacognitive awareness among computing students after using *MoSTMaT*.
6. To determine the effectiveness of MoSTMaT on motivated strategies for learning among computing students in different learning conditions.
7. To determine the effectiveness of MoSTMaT on metacognitive awareness among computing students in different learning conditions.
8. To determine the mediating effects of motivated strategies for learning on the relationship between different learning condition and metacognitive awareness.

1.6 Research Questions

Seven research questions were formulated to guide the study as follows:

1. What are the level of metacognitive awareness and motivated strategies for learning among novice computing students?
2. Is there any significant relationship between motivated strategies for learning and metacognitive awareness among novice computing students?
3. What are the acceptance of computing students towards MoSTMaT?
4. Do participants' motivated strategies for learning and metacognitive awareness improve after using MoSTMaT?
5. Is there any significant difference in motivated strategies for learning between participants who received treatment using MoSTMaT, paper based module and conventionally?
6. Is there any significant difference in metacognitive awareness between participants who received treatment using MoSTMaT, paper based module and conventionally?
7. Does motivated strategies for learning significantly mediate the relationship between the learning condition and metacognitive awareness?

1.7 Research Hypotheses

Correspondingly, five (5) research hypotheses were formulated to answer the research questions as follows:

H_1: There will be significant differences between relationship participants' metacognitive awareness and motivated strategies for learning among computing students.

H_2: There will be significant differences in participants' motivated strategies for learning and metacognitive awareness after using the Motivated Strategies Thinking Maps Tool (MoSTMaT).

H_3: The difference in motivated strategies for learning between participants' who received treatment using MoSTMaT, thinking maps module and control group is significant.

H_4: The difference in metacognitive awareness between participants' who received treatment using MoSTMaT, thinking maps module and control group is significant.

H_5: Motivated strategies for learning significantly mediates the relationship between the learning condition and metacognitive awareness.

1.8 Significance of Study

The findings from the conducted research were provided numerous advantages from several perspectives; to the body of knowledge in education, information technology, multimedia field, multimedia learning tool design and development in higher learning both to educators and students. Studies have shown that students have difficulties in learning programming courses or subjects starting at the early stage (analysing the problem) of the subject due to their lack of strong metacognitive awareness and problem-solving skills (Ismail, Ngah, & Umar, 2006; Tseng & Weng, 2010; Hui & Omar, 2011; Harimurti, et al., 2019). Furthermore, the study support MOHE's recommendations in educating students with critical-thinking and problem-solving

skills succeed especially in higher education. Students must have these skills to help them learn the complex concepts, syntaxes, and algorithms of a programming language right from the beginning.

Without these essential skills, they will surely find learning the subject matter extremely challenging, which can lead to poor learning performance. Research conducted by Ismail and his colleague in 2010 shows that students are not afford to gain understanding because deficiency of metacognitive awareness and problem solving skills. Problem and creative thinking skills are crucial to master the subject. The problems arise when students are not capable to create the ability to gain metacognitive awareness thus metacognitive awareness by themselves, or not using proper stimulus such as a tool. Thus, it is vital to develop and provide students learning tools or aids that can effectively and efficiently help students to learn the subject matter. Such learning tools must be not only effective but also appealing to help students learn with greater engagement and enthusiasm.

In this study, the researcher developed a novel learning tool called *MoSTMaT* consisting of several types of thinking maps. Since 2012, the use of thinking maps has been given strong emphasis by *Agensi Inovatif Malaysia* (AIM) through the *iThink* program conducted throughout Malaysian schools to help students develop strong problem solving skills including critical and creative thinking. As the thinking maps tool developed especially for in self-learning mode, it can be used in classroom as self-learning process to enhance metacognitive awareness in the subject matter. Improvement of metacognitive awareness will produce problem solver, critical and creative students, as well as exposing students to technology in learning process. As the

developed tool applied in self-regulated learning, it will contribute to the self-regulated field as the technology applied to the theory. Mostly students will do their revision and learning by themselves so that they can understand and remember the information to be used when they need them.

Other than that, findings from a study by Mohd Rum & Zolkepli (2018) indicating that students who claimed that programming subjects were difficult seems demotivated to learn through programming subject. As for the study intended to embedding the motivation through using the developed tool, it is essential to create a platform and environment to help students to keep engage with the tool during learning session. The results of the effects of multimedia in self learning mode might help students in learning process which can contribute to multimedia field. Thus, thinking maps were used in the development of *MoSTMaT* with several multimedia elements to provide the participants with multiple representations of learning concepts. Such use of these elements would help them to learn the programming subject more engagingly and meaningfully (Schwonke, 2015). In addition, this novel learning tool helped the participants to learn independently without supervision in the self-regulated learning mode.

The findings of this study will provide all the stakeholders with greater insights into the understanding of the issues confronting the teaching and learning of the programming subject in Malaysian secondary schools. For example, teachers and instructors lacking teaching sufficient time can use such a learning tool to help complement their teaching by enabling students to learn the programming subject outside the normal classroom hours independently. Students, on the other hand, can use

such a learning tool to develop their metacognitive awareness and problem-solving skills as they learn to solve programming problems, which effectively can lead to improved learning performance of the subject matters. Additionally, learning tool designers can learn about the effectiveness of thinking maps as a cognitive tool to help students visualize programming steps to facilitate problem-solving in the programming subject.

In terms of methodology, this study contributed to the process of designing and developing of MoSTMaT based on ADDIE learning tool design. The tool was designed based on motivated strategies for learning theory together with combination of multimedia elements and principles. This research also contributing to the methodology of experimental research implemented in this study.

1.9 Operational Definitions

The following definitions are for the purpose of this study intentionally to explain the terms used as important context through the thesis.

1. *Metacognitive Awareness (MA)*

The consciousness of students in being aware of their own thinking, assigning strategies and self-reflecting during learning process as an effort understanding and improving them (Shraw and Dennison, 1994).

2. *Motivated strategies for learning (MSL)*

Consist of strategies in learning by the combination of motivational beliefs and self-regulation that engender stimulating and motivating learning experiences (Pintrich and De Groot, 1990).

3. *Motivational Beliefs*

A set of propositions stemming from the inner-self consisting of self-efficacy beliefs, intrinsic value, and anxiety (Pintrich and De Groot, 1990).

4. *Self-Regulated Learning*

A type of learning where students take control, monitor, regulate, and evaluate their learning activities (Pintrich and De Groot, 1990).

5. *Multimedia learning tool*

A tool developed based on learning theories through the combination of multimedia elements, such as graphic, text, audio, video, and animation that supports interactive human-computer interaction for educational purposes (Mayer, 2005).

6. *Thinking maps*

A thinking map consisting of eight (8) types of diagrams to help students to visualize programming steps in solving programming problems (Hyerle, 2011).

9. Multimedia

A set of multimedia consists of words and pictures combined with instruction with intention to promote learning understanding through presented material. Furthermore,

multimedia instructional messages can be presented using technology-centered or technology-centered approaches (Mayer, 2020).

10. Dynamic and Static multimedia

Combination of textual and graphic including illustrations, graphs, diagrams, maps or photos representations of the material without any movement of the medium (still) (Mayer, 2005)

11. Dynamic multimedia

Combination of media including videos, animation, audio, animation which involves movement in a representation of a content (Moreno, 2005).

12. Interactive learning environment

Interactive learning environment is a characteristics of multidirectional or two-way action of communication between learners and learning tool. It relates to responsiveness during the learning process (Mayer, 2005).

13. Non- interactive learning environment

Non-interactive learning environment only involves text and illustrations without implies any multi-directional communication during learning process (Rasch, 2009).

1.10 Scope and Limitation of Study

The scope of the survey study was limited to a study sample consisting of undergraduates who enrolled in a computing course in a public university in the state of Kuala Terengganu in Malaysia. On the other hand, the scope of the experimental study was limited to students in several intact classes who were read a computing course where the training has been conducted. The population of the study defined as the students from one public university in Kuala Terengganu, Malaysia that studying in Degree in Information Technology and Degree in Business Computing aged between 19-21 years old.

As for survey study, variables involved and being reviewed limited to students' metacognitive awareness (knowledge of cognition and regulation of cognition) and motivated strategies for learning (consists of motivational beliefs and self-regulated learning). As for experimental research, variables that being investigated was the impact of three different learning conditions (MoSTMaT, thinking maps module, control) towards metacognitive awareness and motivated strategies for learning. Furthermore, motivated strategies for learning also investigated as a mediator.

1.11 The Conceptual Framework

This research consists of two types of studies, namely a survey study and an experimental study. The prior aimed to investigate the levels of metacognitive awareness and motivated strategies for learning among students. Additionally, the

survey was conducted to examine their relationship between these two factors. The latter was conducted to determine the effectiveness of a novel learning tool called Motivated Strategies Thinking Maps Tool (MoSTMaT) on students' motivated strategies for learning as well as their metacognitive awareness. MoSTMaT was designed based on motivated strategies for learning theory along with cognitive theory of multimedia learning principle (CTML). Principles incorporated in this tool were coherence, signalling, redundancy, spatial and temporal contiguity principles (details in Chapter 4). This CTML also use multimedia elements namely text, images, audio, video and animation (Vaughan, 2014).

The conceptual framework was developed based on related findings and literature review that discussed detailed in further chapter. The framework consists of two researches: a survey study and an experimental study. The result from the study was examined by taking into account the relations of students' motivated strategies for learning towards metacognitive awareness.

On the other hand, the experimental study was conducted to evaluate the effectiveness of a tool called MoSTMaT in order to gain metacognitive awareness and to enhance students' motivated strategies for learning. The tool was used thinking maps, which was proven improving students' metacognition that will lead to better critical thinking and problem solving of students. This ability to engage in critical thinking and problem solving is highly needed in learning introduction to programming (Hyerle,2011). The elements of dynamic multimedia elements (which contain text, audio, graphics, video, interactivity) embedded into the tool as enhancement to students' ability to motivate strategies and self-regulate in learning (Erhan, et al., 2014).

The tool was used by students intended to increase their metacognitive awareness and motivated strategies for learning. The effectiveness of the tool was analyzed to determine its impact on the two factors namely metacognitive awareness and motivated strategies for learning. Metacognitive expansion determined by the pre (2 weeks earlier) and post-test after 4-weeks training using thinking maps as a tool to sharpen their ability in controlling information gained through learning the subject. The drill should encourage students to be more critically thinking and helping themselves in self-controlled in order to create solutions for any coming problems. Figure 1.1 shows the conceptual framework of survey and experimental research.

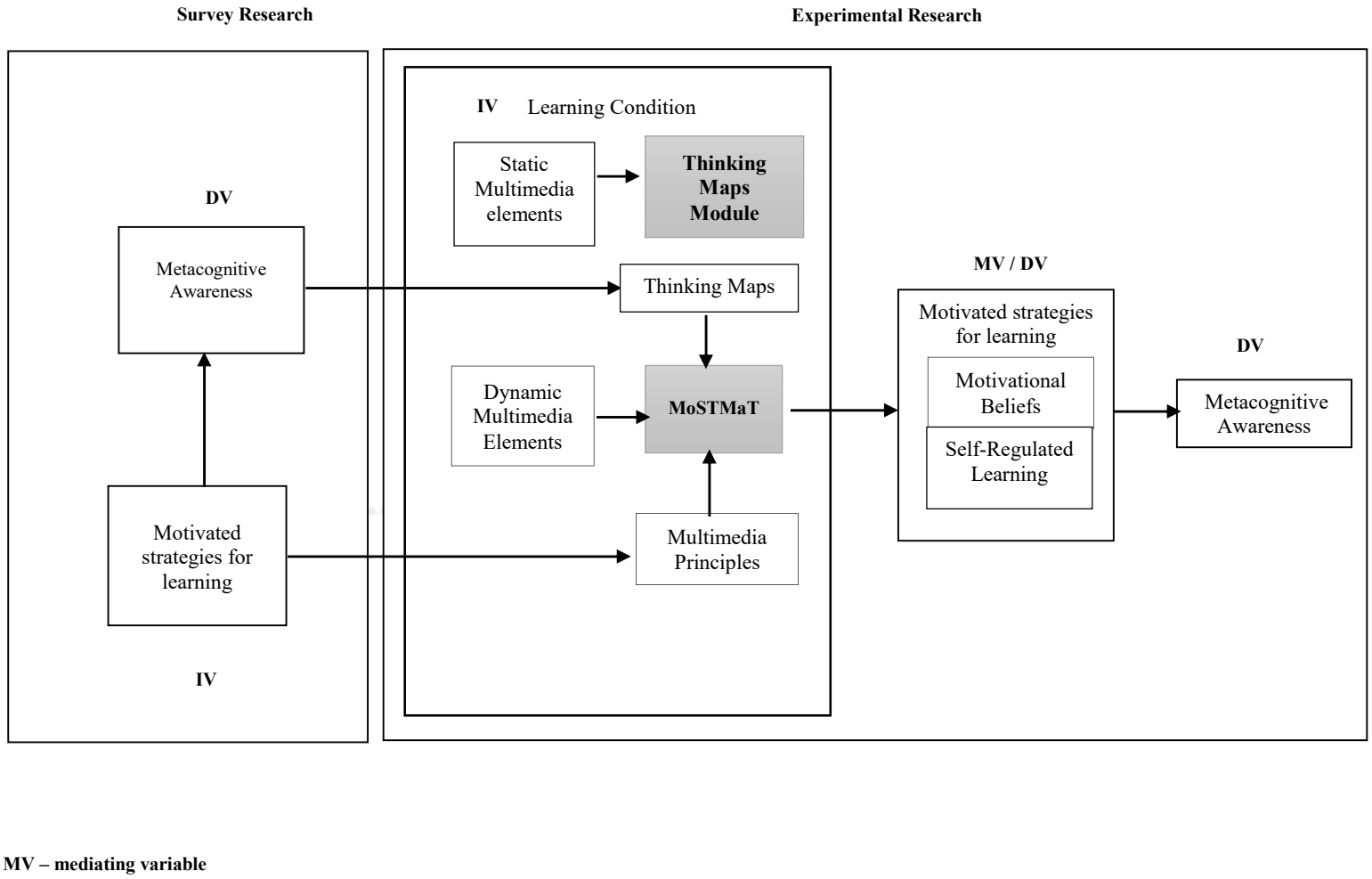

Figure 1.1. The conceptual framework of survey and experimental research

1.12 Summary

A critical review of previous studies in the current literature helped reveal prevailing issues and problems in the teaching and learning of programming subjects or courses among computing students. Specifically, most students have been found to be struggling to understand and learn programming due to a lack of problem solving skills and low metacognitive awareness, which have resulted in low learning motivation. In this regard, a novel learning tool called MoSTMaT (combination of eight types of thinking maps, design strategies based on motivated strategies for learning theory , the use of learning design tool and embedment of multimedia principles and elements) was developed and used to help nurturing participants' motivated strategies for learning (motivational beliefs and self-regulated learning) including metacognitive awareness as they learned to solve programming problems through the developed tool in self-regulated learning environment.