Metacognitive Awareness Assessment and Introductory Computer Programming Course Achievement at University

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Abstract: *Computer programming is regarded as a difficult skill to learn both by researchers and often by learners themselves. Metacognition has been identified as an important factor to be a successful learner in learning computer programming. Metacognitive in educational psychology is generally described as monitoring and controlling activities of one's cognition. The researchers have examined the Metacognitive Awareness Inventory (MAI) to identify how it relates to student academic achievement at school and universities. In this research work, an empirical research is conducted using the MAI inventory with the objective to examine the correlation between the metacognitive awareness with the Grade Point Average (GPA) performance of the introductory programming course at Universities in Malaysia. The experiment result indicates a positive relationship between metacognitive awareness with the learning success of introductory programming course at Universities.*

Keywords: *Novice programmer, met cognitive, MAI, educational psychology, introductory computer programming.*

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1. Introduction

In educational psychology, "Metacognition" is a term used as a strong predictor of academic success for many decades, but what is metacognition? Without realizing it, we implied metacognitive activities almost every day. It has been identified as an important factor to be a successful learner as it has a relationship with intelligence [3, 8]. According to Flavell, metacognition is the control one has over their own cognition and learning [16]; whereas, Hart [19] defines metacognition as the systematic series of actions that enabled an individual to see, to reflect, or to experience his/her own cognitive series of actions. In the mid-1980's, Robert Sternberg combined these two definitions in his triarchic theory of human intelligence, and in his theory, he addresses the meta-components of metacognition [32]. Sternberg defines metacognition as the higher-order, executive processes used to direct and monitor cognition, and the meta-components to determine what to do, monitor what is being done, assess what is done, and interact with the performance components used to execute a task, while the knowledge acquisition components used to learn how to perform a task. This skill plays an integral part in successful learning, thus it is critically important to investigate the activity and the development of metacognition to determine how novices can be educated to be greater employ their cognitive sources through the control of metacognitive skills. Schoeffler [28] pointed out that, this skill can be developed through the use of direct lessons techniques through the discussion of both oral question and answer and written question, as well as oral and written responses. A study conducted by Flavell [15, 16] indicates that metacognition is composed of metacognitive Knowledge of Cognition (KC) and metacognitive regulation of cognition. The knowledge of metacognitive is referring to the reflective aspect of learning, this can be illustrated as what we are aware of and realize about our own cognitive process and it also refers to the knowledge that can be utilized to control cognitive processes. Schraw and Moshman [30] further divide metacognitive knowledge into three sub components, declarative, conditional and Procedural knowledge (P). Declarative knowledge (DL) has an influence on how we learn and it can be described as what we comprehend about how we acquire knowledge. P knowledge can be defined as knowledge about knowledge and memories or procedures that work best for us. Conditional knowledge (CDL) can be viewed as knowing why and when, by using the P knowledge and declarative. It allows learners allot their resources while constructing strategies. As a result, it allows strategy to become more effective. In contrast, metacognitive regulations can be defined as the actual activities in which we are employed in order to facilitate the progress of learning and memorizing [30]. The 'regulation' in metacongnition can be further broken down into three elements, Planning (PL), monitoring and evaluating. PL refers to the processes of selecting strategies that are appropriate to the cognitive tasks and the process of selecting suitable cognitive resources. Monitoring involves the assessment of strategy use or one's learning. While, evaluation involves the activity of assessing the knowledge acquired. A number of studies indicate that metacognition is an underlying predictor and factor of academic success as defined by Grade Point Average (GPA) at tertiary education [18, 25, 37]. From the given explanation on metacognition and its importance, if a learner has the opportunity to satisfactorily develop his or her metacognitive knowledge skills, the learning process can be more effective. This leads to the potential to excel academically.

2. Problem in Computer Programming

Generally, programming concept and data structure are the two key areas that novice programmers will first be exposed during teaching and learning activity. They being taught on how to examine and analyze problems, transform the problem solution into codes that are understood by programming language. The code then needs to be tested in order to produce the result accordingly. Computer programming is not about coding syntax using development setting. At core of it, computer programming is solving problem. To write a program, there are two-phase of processes that novice must go through; the problem-solving and the implementation. This requires them to possess analytic thinking as well as problem solving skills. The programming process is presented in Figure 1. From a general perspective, metacognition helps programmer to go through the steps involve in the problem-solving phase:

1. Analytical Study and Specification Determination: Recognized the problem to be solved and find solutions.
2. Conceptual Solution (Algorithm): Figure out the appropriate data types as well as the logical sequences of steps to solve the problem.
3. Confirmation/Verification: The logical steps are then executed, to see 'does it really solve the problem?'.

Studies by Davidson *et al.* [12, 14], define problem solving as the progress of processes of transforming the problem's initial state into the desired one. Acquiring this knowledge has proven challenging for novice learners, and this has been indicated as a universal problem by researchers. Problem solving involves a reciprocal action of a person's experience with the task demands. Studies by Artz *et al.* [1, 36] state that those who possess well-developed metacognitive abilities are those who are persevere in problem solving, and who apply their intellectual skills consciously. Pointed out in the literature, several metacognitive regulatory skills important for problem solving, such as: PL and monitoring [24]. Metacognition is an integral part of the problem solving process and the term, metacognition, has a directing or monitoring connotation depending on the context in which it is used [21, 34]. Similar to other problem situations, problems in programming share the three important characteristics; the 'givens', 'a goal' and 'obstacles', the 'givens' happen during the initial state of problem situations that composed of elements, relations and conditions. The desired outcome of the problem is defined as 'a goal', whereby the obstacles in problems are defined as the difficulty of the problem solver to transform and to reach into the desired state.

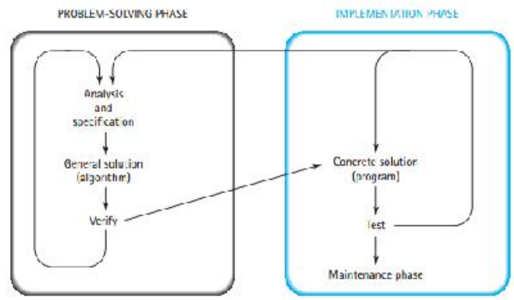

Figure 1. Programming process [35].

3. The Need for Metacognition Skills for Novice Programmers

Computer programming can be illustrated as the arrangement of schemas or plans, where the novices tend to use their lower level plans as they are lack of the ability to tackle and break down the problem into sub processes. According to Linn [23] for programmers' competency development, it is a something that compulsory for them to acquire good skills in solving problems. Elazhary [13] indicate that novice programmers have difficulties in learning, remembering and applying common programming languages especially to those who are not fluent in English. Yet these skills appear to be insufficient. Handerson [20] indicate that analytical thinking and problem solving are students' main weaknesses in a computer science course. Theoretically, programming fosters learners to assess their thinking solutions as well as their reflective process. This cognitive process allows the student to put the newly acquired problem solving skills towards novel problem situations. This state is difficult to be achieved by novices as they have difficulty in constructing programming syntax and the development environment appeared as additional problems. Brown [4] pointed out that novices have a problem with metacognitive deficiencies [5, 33] note that, "Metacognitive insufficiency is the novice's problem, without regards to the age; rather it is more of an inexperienced function in a new (and complex) problem situation". If novice programmers are taught metacognitive awareness, they tend to infer the strategy to new situations to be successful learners. Programming is a field area where it is necessary to build metacognitive strategies. [11] States that the fundamental of metacognitive strategies is composed of PL, monitoring and evaluating one’s thinking processes. Davidson [12] pointed out that metacognitive processes are strong contributors to the performance of problem-solving across diverse domains. Recent research has pointed out that those learners who own the awareness of their metacognitive are more strategic and perform better, which in turn allows individuals to directly improve their performance through PL, sequence and monitoring their learning [2]. Therefore, for novices to become lifelong learners and successful problem-solvers, metacognitive skills need to be developed in them. This study is conducted to see the effect of novice’s metacognitive awareness towards the learning success of introductory of computer programming at University.

4. Methods and Instruments: Metacognition Assessment

The relevancy of a pragmatic study of the metacognition measurement was emphasized by Garner and Alexander [17] where they proposed how these questions should be answered: how do we accurately measure the “knowledge about knowledge”?, How can the effectiveness of strategies used in training be measured? Many attempts have been made by researchers to answer these questions by developing instruments and methods. Those assessment instruments and methods are then examined by learners across domains that range from self-questionnaires, to verbal reports, where the learners are required to recall what they thought and what they did during their learning process experience. Table 1 presents the brief information of most general techniques for metacognition measurement and the limitation of each.

Table 1. Common techniques applied in the measurement of metacognition.

Technique	Description	Advantages	Limitation
Concurrent Think-Aloud	Learner expresses out loud everything that across his/her mind while performing a task	Rich data can be extracted from the process that is invisible to other techniques	Automated processes remain inaccessible; Verbalizations might be a problem to some targeted subject; Extensive analysis of data needed;
Post Performance Interviews	Interview learner past learning experience	Provides data from responses to specific, direct probes.	Cognitive events that happened during the time of processing and reporting are always failing to remember; lack of Verbal fluency.
Cross-Age Tutoring	Conduct tutoring session to observe which strategies and behaviors are most encouraged in solving a problem	non-verbal data; Avoid targeted subject from speculating what the investigator desired to hear and answering accordingly.	Beneficial in investigate to ascertain specific strategies (e.g., Awareness of usefulness of text re-examination strategy).
Self-Report Inventory	Self-questionnaire typically using formats like Likert scale, forced choice or true-false	Structured and convenient: ease of use	Answers given by respondents may just give pleasant to the investigator; Answer about partially automated processes are difficult to gain

5. The MAI Inventory

In this study, the technique employed is through the use of self-report inventory for assessing novices’ metacognitive awareness in learning the introductory computer programming. The inventory named Metacognitive Awareness Inventory (MAI) was invented by Schraw and Sperling [31]. This technique is used as it consumes less time and effort which was considered as significant in this study. The Self-questionnaire in MAI is well structured, convenient, easy to use and secure. It has well devised statement and well-validated inventory. MAI is also, domain general inventory for assessing individual’s KC and regulation of cognition. It consists of 52-item self-report tapping into two components of metacognitions; the metacognitive knowledge and metacognitive regulation. Their study reveals that knowledge cognition factor and the regulation of cognition factor have the strong support of each other. The questionnaire survey includes items regarding knowledge and regulation of cognition and divided into eight component processes [31]. Knowledge about Cognition (KC) composed of three subcomponents processes that ease the aspect of reflective in metacognition; DK (i.e., knowledge about self and strategies), P knowledge (i.e., knowledge about how to use strategies’), CDL (i.e., knowledge about when and why use strategies). Regulation about cognition component putting the aspect of learning that includes PL, information management strategies, comprehension monitoring, Debugging (DBG) strategies and evaluation [31]. The decomposition of MAI is illustrated in Figure 2.

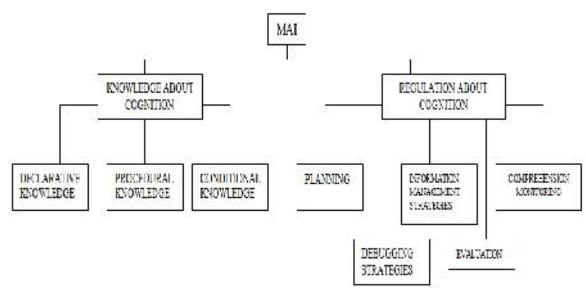

Figure 2. The decomposition of MAI

6. Metacognitive Assessments and Introductory Programming Course Achievement

Researchers investigate metacognition knowledge and awareness and how it correlates to measure academic success. In these researches, metacognition knowledge are gauged from the perspective of metacognitive regulations and metacognitive knowledge. Given the discovery, thus far regarding academic achievement was measured and MAI, the primary goal of this research work was exploratory in nature. This research is interested to find a correlation between the MAI and grade point of the introductory computer programming course. The following questions were highlighted and put forward in this research work:

1. Do metacognitive skills have an effect on students' learning success in an introductory computer programming course at university?.
2. Which subcomponents of metacognitive have strong predictors towards learning success in introductory computer programming course at university?.

This study is conducted using the descriptive research model. The sampling is based on convenience sampling that is a non-probability sampling that consumed less time and effort which is considered as a great significance in this study. This sampling method is based on the respondents voluntary act to the instrument distribution that is uncontrollable i.e., a questionnaire [29]. The online survey is set up using Google doc's application. Google doc's application allows researchers to design an online survey form and invite a group of people to respond via email or the URL created can be posted on Facebook. All responses are assembled automatically into a Google Docs spreadsheet. The participations are invited through email and group on Facebook. With the permission given by the academic affairs departments of universities, student email is obtained from the student database system.

The questionnaire is divided into two sections. First section is to elicit respondents' personal information and educational background. The second section consists of 52 self-reports in which students are required to rate as True or False. The MAI will be given 1 (one) point for each TRUE on the chart and for each question with a False answer, 0 (zero) point will be given towards the score. The second section is actually tapping into two components of knowledge discussed above; KC and regulation of cognition. The KC component involves questions number 3, 14, 27 and 33 that is related to P knowledge of novice programmers, questions 5, 10, 12, 16, 17, 20, 32 and 46 are related to DK while question no 15, 18, 26, 29 and 35 are to extract the CDL of novices. There are 35 of questions that relate to the KC factor. The scores are calculated by adding the total scores from each factor. Higher total scores of each factor correspond to greater metacognitive knowledge and greater metacognitive regulation. Table 2 shows the aggregation of MAI subcomponents. The performance of computer programming subject of a student is according to the GPA range; a student with excellence performance is indicated with range GPA between 3.5 and 4 points and a student with a good GPA is within the range 3 to 3.49 points, a student with an average GPA is within the range 2.5 and 2.99 points, while a student with a low GPA range is within 2.00 and 2.49 points and below. In this research work, we have defined the 'successful learner' as some one who has earning GPA between 3.00 and 4.00 points in computer programming subject.

Table 2. Subcomponets of MAI.

Instrument MAI Subscales	No of Items
P Knowledge	4
DL	8
CDL	5
PL	7
Comprehension Monitoring (CM)	7
Evaluation (EVL)	6
DBG	5
Information Management Strategies (IMS)	10
Total	52

- Participants: The participants of this study are 164 undergraduate students of computer science (102 females, 62 males) from several selected universities in Malaysia. All the selected universities in this study provide the introductory computer programming for their first year students in the Diploma and Bachelor Degree in Computer Science regardless the programming languages used. Table 3 demonstrates the detail information about the course at each university. The target sample of this study is 200 and the response rate is 82%. Table 4 presents the distribution of respondents by University. Table 5 presents the distribution of respondents by GPA.

Table 3. The introductory computer programming at universities.

Course Code	Course Title	Course Description	Program	University
CSC 1101	Structured Programming Language	This course focus on the fundamentals of structured programming with C++. Students are taught the art of problem solving in programming, the techniques, architectures, the design issues and fundamental about class and object. This course is designed to prepare a student to be familiar with software development process.	Bachelor of Computer Science (BCS)	International Islamic University Malaysia
SC128	Fundamentals of Computer Problem Solving	This is a fundamental to problem solving course using computers via structured programming. The focus will be on various aspects of problem solving rather than syntactical aspect of the chain programming language, mainly consisting of the problem domain, phases of problem solving and basic techniques in designing solutions.	Diploma of Computer Science (CS110)	UiTM Kedah, UiTM of Kelantan, UiTM of Perlis, UiTM of Sarawak, UiTM of Segamat Johor, UiTM of Sri Iskandar Perak, UiTM of Terengganu, UiTM of Pahang, UiTM of Melaka, Kolej PolyTech MARA Kuala Lumpur
WXES1116	Programming I	This course is a basic to Object Oriented Programming using JAVA. It defines the concepts of Object Oriented programming with flowchart and pseudocode. The student will learn about how to write and develop programs using the appropriate semantic and syntactic.	Bachelor of Computer Science (AI) (MC00)	University of Malaya (UM)
SCJ1013	Programming Techniques I	This course equips the students with theory and practice on problem solving techniques by using the structured approach. Students are required to develop programs using C++ programming language	Bachelor of Computer Science (SCJ)	Universiti Teknologi Malaysia (UTM)
CPT111/3	Principles of Programming	In this course, the student is equipped with the principle of Programming. They are taught how to analyze and examine problems, transform the problem solution into codes that are understood by programming language	Bachelor of Computer Science	Universiti Sains Malaysia (USM)

Table 4. Distribution of respondents by university.

Universities	%
International Islamic University Malaysia (IIUM)	12
Kolej PolyTech MARA Kuala Lumpur	2
UiTM of Kedah	2
UiTM of Kelantan	4
UiTM of Perlis	5
UiTM of Sarawak	11
UiTM of Segamat Johor	21
UiTM of Sri Iskandar Perak	11
UiTM of Terengganu	10
UiTM of Pahang	5
UiTM of Melaka	10
University of Malaya (UM)	4
Universiti Teknologi Malaysia (UTM)	1
Universiti Sains Malaysia (USM)	2

Table 5. Distribution of respondents by GPA.

GPA	Frequency	%
2.0-2.99	44	26.83
2.5-2.99	56	34.15
3.0-3.49	40	24.39
3.5- 4.0	24	14.63
Total	164	100

- Procedure: The MAI survey is set up using Google Docs application for respondents to access as shown in Figure 3. Google doc's application allows researchers to design an online survey form and invite a group of people to respond via email. The other flexibility feature of google docs; it is easy to use and convenient where the URL of the online survey form can be posted to the Facebook to survey invitation. This present study makes use of this feature for data gathering. Figure 4 shows the survey invitation using Facebook and Figure 5 present one of the targeted Facebook group of this study. All responses are assembled automatically into Google docs spreadsheet. The URL of online survey was sent out through the student group and individual email. The URL was also posted on the Faculty of Computer Science Facebook from different groups or universities.

Figure 3. The MAI survey is set up using Google docs application.

Figure 4. Survey invitation through Facebook.

Figure 5. The IIUM bachelor of computer science Facebook group.

7. Result

Correlation between MAI and measures of learning success in Introductory Computer Programming of the 164 respondents, the score of mean MAI was 36.51, the mean score for the KC factor was 11.76 and Regulations of Cognition factor (RC) was 24.75 respectively. Table 6 presents the descriptive statistics for all variables

Table 6. Mean, mode, standard deviations, skewness and Coefficient Variations (CV) of all variables.

Variables	Mean	Mode	Std Dev	Skewness	CV
GPA	2.88	2.745	0.50916	0.299	17.68%
MAI	36.51	48	10.660	-0.568	29.20%
KC	11.76	17	3.507	-0.150	29.82%
RC	24.75	10	7.592	-0.762	30.67%
P	3.02	3	0.913	-0.587	30.23%
DL	4.94	6	2.033	-0.027	41.15%
CDL	3.76	5	1.224	-0.619	32.55%
PL	4.67	6	2.025	-0.588	43.36%
IMS	7.38	9	1.973	-0.296	26.73%
CM	4.74	7	2.047	-0.660	43.18%
DBG	3.93	5	1.389	-1.243	35.34%
EVL	4.01	5	1.488	-0.350	37.10%

Figures 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 show the data distribution frequency of MAI score and other individual MAI's subcomponents scores. These frequency polygon diagrams are provided to understand the shapes of distribution for each variable. The black line superimposes on each of the histograms in Figures 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 represent the bell-shaped "normal" curve. All diagrams (Figures 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15) represent each variable (GPA, MAI, P, DL, CDL, PL, IMS, CM, DBG and EVL) are normally distributed, where the mean and median almost the same. Examining the CV result, most of the CVs are approximately at 30%, this implies that the data are stable which indicates that standard deviation as compared to the mean is acceptable. Therefore, both non-parametric and parametric statistics can be applied for further analysis. However, in this study, the non-parametric statistic is used. The Spearman's Rho a non-parametric correlation analysis was conducted to prove the existence of the relationship between the KC and the regulation of cognitive factors, correlation between the MAI and GPA of introductory computer programming course as well as the relationship between the subcomponents. Spearman rank's. Symbolized as r in Correlation coefficient is a numerical summary of a linear relationship varies from -1.00 to +1.00. Positive r showing a positive relationship between two measured variables whereby negative or indicates inverse or indirect relationship. Here, is a scale provided by Chung and Salkin [9]. If the value of r is between 0.8-1.0, this indicate that the relationship is very strong, for r between 0.6 to 0.8 give an indication to a strong relationship, for r between 0.4-0.6 indicate that the relationship is moderate, for r between 0.2-0.4, indicate that the relationship is weak. There is no relationship if the value of r is between 0.0-0.2.

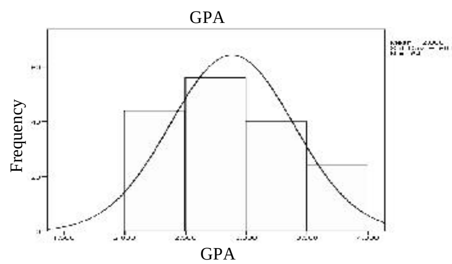

Figure 6. Frequency polygon for GPA.

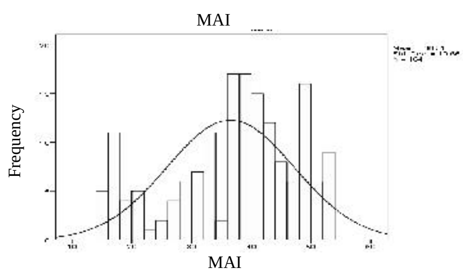

Figure 7. Frequency polygon for MAI score.

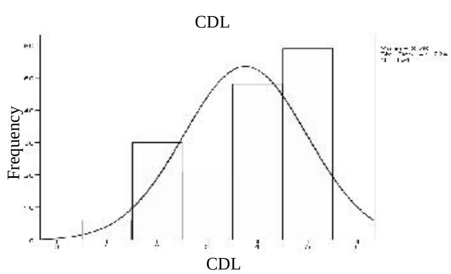

Figure 8. Frequency polygon for CDL score.

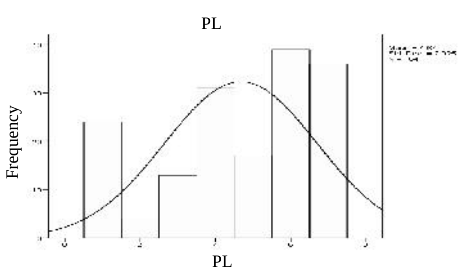

Figure 9. Frequency polygon for PL score.

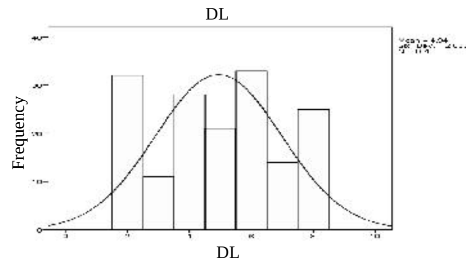

Figure 10. Frequency for DL score.

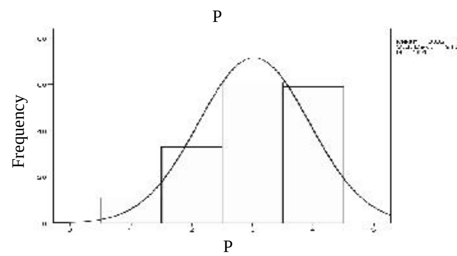

Figure 11. Frequency polygon for P knowledge score.

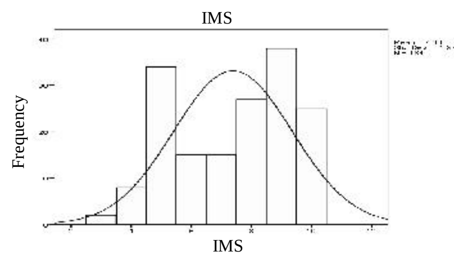

Figure 12. Frequency polygon for information management strategies score.

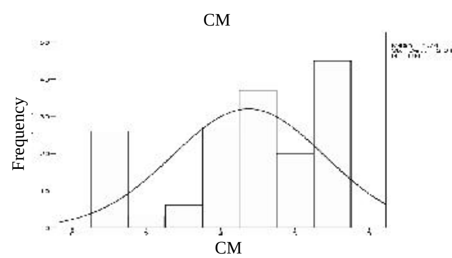

Figure 13. Frequency polygon for comprehension monitoring score.

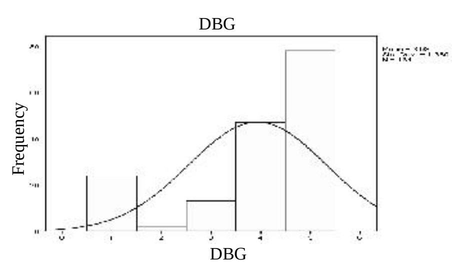

Figure 14. Frequency polygon for DBG strategies score.

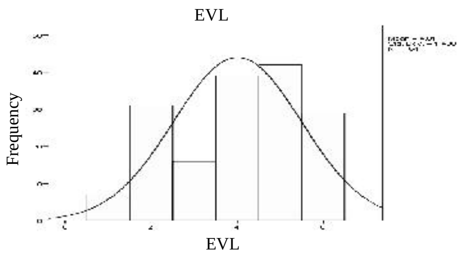

Figure 15. Frequency polygon for evaluation score.

The correlation coefficient result is presented in Table 7. The result indicates a positive linear correlation between GPA and MAI score with the correlation coefficient of r=0.8226 and significant at the 1% level. The findings confirmed that metacognitive has a positive effect on students learning success in introductory computer programming course at university. The result suggests that, as the MAI scores go up, the GPA tends to increase as well and vice versa. The variations in the MAI are explained at 67.67% of the variation in GPA (r^2=0.6767 with n=164), indicating the there is a possibility of 32% of other factors influences are affecting student learning success in introductory computer programming at University. The result also showed, the DL, PL and CM are the three main subcomponents that strongly contribute to the MAI score with the average of r is 0.8. The main subcomponents of MAI that strongly contributed to the score of KC is the DL where r is 0.9, whereby PL is the key components that. The results also tell us, a strong correlation exists between the GPA and KC with r=0.7483, GPA with RC with r=0.8224, GPA and P Knowledge with r=0.4387, GPA and DL Knowledge r=0.7358, GPA and CDL with r=0.6134, GPA and PL with r=0.7061, GPA and IMS with r=0.6882, GPA and CM with r=0.7025 and strong relationship also existes between GPA with DBG with r=0.6023 and all are significant at the 1 % level. This implies that each of the subcomponent processes of the KC and regulation of cognition has influence towards the academic achievement in introductory computer programming course at the University.

- Further Analysis: Table 8 presents the multiple linear regression result. The result shows that DL and IMS are the two strong subcomponents of MAI that significantly contribute towards the effect of a student's learning success in an introductory computer programming course at the University at the 1 % level. The CDL Knowledge is another subcomponent of MAI that has significant contribution towards the learning success at the 5% level.

Table 7. Correlation coefficient between variables.

Y	X	r	r^2	t	Pr(>|t|)
GPA	MAI	0.8226	0.6767	18.4136	0.0000
GPA	P	0.4387	0.1925	6.2140	0.0000
GPA	DL	0.7358	0.5413	13.8274	0.0000
GPA	CDL	0.6134	0.3762	9.8843	0.0000
GPA	PL	0.7061	0.4986	12.6917	0.0000
GPA	IMS	0.6882	0.4737	12.0747	0.0000
GPA	CM	0.7025	0.4935	12.5629	0.0000
GPA	DBG	0.6023	0.3627	9.6027	0.0000
GPA	EVL	0.5679	0.3225	8.7816	0.0000
GPA	KC	0.7483	0.5599	14.3562	0.0000
GPA	RC	0.8224	0.6763	18.3987	0.0000
MAI	P	0.6186	0.3827	10.0207	0.0000
MAI	DL	0.8638	0.7462	21.8251	0.0000
MAI	CDL	0.7519	0.5654	14.5175	0.0000
MAI	PL	0.8469	0.7172	20.2709	0.0000
MAI	IMS	0.7848	0.6159	16.1173	0.0000
MAI	CM	0.8639	0.7463	21.8309	0.0000
MAI	DBG	0.6545	0.4283	11.0177	0.0000
MAI	EVL	0.7317	0.5354	13.6633	0.0000
MAI	KC	0.9257	0.8570	31.1568	0.0000
MAI	RC	0.9764	0.9534	57.5703	0.0000
P	DL	0.4464	0.1993	6.3503	0.0000
P	CDL	0.4717	0.2225	6.8085	0.0000
P	PL	0.4368	0.1908	6.1811	0.0000
P	IMS	0.4024	0.1619	5.5945	0.0000
P	CM	0.5232	0.2737	7.8140	0.0000
P	DBG	0.4059	0.1647	5.6521	0.0000
P	EVL	0.3645	0.1329	4.9825	0.0000
P	KC	0.6698	0.4486	11.4797	0.0000
P	RC	0.5523	0.3051	8.4328	0.0000
DL	CDL	0.6192	0.3834	10.0363	0.0000
DL	PL	0.7193	0.5174	13.1786	0.0000
DL	IMS	0.5926	0.3511	9.3628	0.0000
DL	CM	0.7939	0.6303	16.6180	0.0000
DL	DBG	0.4806	0.2310	6.9761	0.0000
DL	EVL	0.5728	0.3281	8.8934	0.0000
DL	KC	0.9071	0.8228	27.4249	0.0000
DL	RC	0.7878	0.6206	16.2789	0.0000
CDL	PL	0.6276	0.3938	10.2591	0.0000
CDL	IMS	0.5709	0.3259	8.8508	0.0000
CDL	CM	0.5649	0.3191	8.7130	0.0000
CDL	DBG	0.4589	0.2106	6.5732	0.0000
CDL	EVL	0.4760	0.2266	6.8886	0.0000
CDL	KC	0.8289	0.6870	18.8584	0.0000
CDL	RC	0.6815	0.4644	11.8528	0.0000
PL	IMS	0.5884	0.3462	9.2618	0.0000
PL	CM	0.7752	0.6010	15.6212	0.0000
PL	DBG	0.5579	0.3112	8.5562	0.0000
PL	EVL	0.5663	0.3207	8.7459	0.0000
PL	KC	0.7347	0.5398	13.7840	0.0000
PL	RC	0.8615	0.7423	21.6000	0.0000
IMS	CM	0.5442	0.2961	8.2553	0.0000
IMS	DBG	0.5533	0.3061	8.4541	0.0000
IMS	EVL	0.5896	0.3477	9.2918	0.0000
IMS	KC	0.6548	0.4288	11.0268	0.0000
IMS	RC	0.8199	0.6723	18.2308	0.0000
CM	DBG	0.5071	0.2572	7.4888	0.0000
CM	EVL	0.5277	0.2785	7.9076	0.0000
CM	KC	0.7810	0.6099	15.9145	0.0000
CM	RC	0.8521	0.7262	20.7263	0.0000
DBG	EVL	0.4684	0.2194	6.7472	0.0000
DBG	KC	0.5446	0.2966	8.2648	0.0000
DBG	RC	0.6866	0.4714	12.0204	0.0000
EVL	KC	0.6087	0.3705	9.7643	0.0000
EVL	RC	0.7451	0.5551	14.2175	0.0000
KC	RC	0.8347	0.6967	19.2897	0.0000

Table 8. Multiple linear regression result.

Attribute	Coef.	std	t(155)	p-value
Intercept	1.435311	0.111444	12.879183	0.000000
P	0.018408	0.030892	0.595889	0.552118
DL	0.062143	0.021997	2.825044	0.005350
CDL	0.053789	0.028191	1.907979	0.058243
PL	0.019846	0.025259	0.785687	0.433250
IMS	0.064113	0.017725	3.617059	0.000403
CM	0.030684	0.025590	1.199069	0.232331
DBG	0.025224	0.028729	0.877980	0.381313
EVL	0.017236	0.022784	0.756505	0.450495

8. Discussion

The present work examines the relationship between metacognition and student achievement in introductory computer programming course at the University. It is realized that metacognitive awareness has a significant effect on the successful learning of introductory computer programming at universities. The conducted experiment has answered the following questions:

1. Do metacognitive skills have an effect on students' learning success in introductory computer programming course at university?.

2. Which subcomponents of metacognitive have strong predictors towards learning success in introductory computer programming course at university?.

The findings of the present study indicate that metacognitive has a positive effect on students' achievement GPA in an Introductory Programming course at university. The results show that almost all subcomponents of MAI have a positive contributor towards the learning success. The experiments show that KC and RC are related. This suggests that the way learners plan, strategize, monitor, correcting errors and evaluate their learning is impacted by what learners know about their conceptual knowledge and vice versa. Consistent with studies done by Eysenck *et al.* [14, 23, 32] the finding supports the claimed that the higher the degree of metacognitive awareness possessed by novice programmer the greater the learning success in Introductory Computer Programming at university. Study by Coutinho [10] states that, students that own good metacognition, possesses mastery goal and be better learners than students with performance goals. In the present study, the findings indicate that DL and IMS are the two subcomponents of MAI identified as a strong knowledge factor towards the learning success. Consistent with previous studies, the finding of the present study is similar to the results of some studies done by other researchers. Basato *et al*. [6, 7] in their research work as an example stated that "Students with given of appropriate or favourable time or occasion to think metacognitively and clearly expressed their thought of metacognitive strategies are more likely to be affected positively in their academic achievement." Also, reported in several studies, computer programming requires a higher level of knowledge and strategic knowledge. This is the knowledge of "when and why" which requires metacognitive skills which are apparently being lacking among the novices [20, 21, 22, 26]. In conclusion, this research supports metacognition as a significant role in learning the introductory computer programming at University. Findings from this research encourage the use of metacognitive strategies in programming problem-solving.

9. Future Works

In the present study, the non-probability type of statistics is used for the data analysis process where the sampling is based on convenience sampling. This method was used as it consumes less time and effort which was considered as significant in this study. But the disadvantages of convenience sampling are; it does not produce representative results. We suggest for the improvement of this research work, the probability sampling is used to produce the result. With the probabilistic sampling, the confidence intervals of the statistics are easy to estimate. In comparison to nonprobability sampling, the random sampling or probabilistic is more accurate and rigorous. In this study, student's GPA was captured using the ordinal data, where the GPA was grouped into four interval scales which were then coded as 3.75 for (4.0-3.5), 3.245 for GPA between 3.49-3.0, 2.745 for GPA between 2.99-2.5 and 2.245 for GPA between 2.49-2.0. The prediction of the effect of metacognitive towards the learning success of introductory computer programming was based on the GPA performance, perhaps to give the best result and to get a more accurate result; the exact value of GPA is captured. There are a lot of factors that influence the process of learning such as intellectual ability [27], personality, motivation and learning style [6]. Motivation for example is influenced by the emotional states of an individual and role of emotion is interrelated with these two concepts, motivation and metacognition. Self-evaluation is a core component of metacognition that are inherently laden with emotions. Thus, the best to understand the learning success is to view and measure all factors and organized them into set of principles rather than single test measurement factor. This is the possibility of further investigation of how factors other than metacognitive skill of an individual influence the learning success.

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