

# A Multimedia Approach towards Learning C Programming: A Discussion from Novice Learners' Perspective

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**Abstract—** This research paper presents the effectiveness of an interactive multimedia courseware called MAFPro which was employed in a C programming classroom from the perspectives of the novice learners. The courseware utilizes the elements of multimedia and graphical simulations that focus on enhancing learners' programming comprehension. This study was carried out in a survey design method with the participation of 30 undergraduates who are novice programmers. According to the quantitative results, the multimedia courseware that has been used in the C programming classroom has a significant difference on the undergraduates' programming comprehension. The students also perceived that the multimedia approach towards learning the C programming as motivating and engaging.

**Index Terms—** C Language; Novice Learners; Perceived Motivation; Programming Comprehension.

## I. INTRODUCTION

The learning and facilitation process of a programming language is a difficult task. C programming language is difficult for novices to learn on their own, as it is an intricate task which is perceived as hard and rigid by the undergraduates who have just started to learn to program. They differ in their ability to understand material which is very abstract and difficult to visualize. Usually, novices have different background knowledge before entering an introductory computer programming course, meaning that a class may contain students with a wide range of proficiency level.

It is claimed that by extending the prudent use of the multimedia in instructional technology that could serve as a useful learning supplement to promote learning and improve students' motivation, attitudes and interest [1]. Based on this agenda, a multimedia courseware called MAFPro was designed and developed to be implemented in the undergraduate programming classroom. It is an attempt to introduce a fun, engaging and motivating multimedia tutorial. This paper describes the perspective of novice learners on the implementation of MAFPro in their classroom.

## II. ISSUES OF LEARNING PROGRAMMING

Learning to program is intensely meticulous for novice undergraduates who do not have any background on computer programming [2]. During a preliminary analysis, the students perceived programming as rigid and hard. Although, each week, the students undertake computer-

based exercises, in lectures and practical classes, complemented discussion and online reading materials uploaded by the lecturer in the eLearning portal, students find the course frustrating and demotivating. As a result, the students performed poorly on the subject. The examination results for the course also indicated that most students obtained low scores in C programming due to their inability to fully grasp the programming concepts. A need analysis was done with the students, indicated that students were struggling with using the programming concepts, structural and program execution which are very abstract and difficult to visualize. This affects their efficiency in learning the new languages, and represented a serious impediment to their achievement of the learning goals of the course. An analysis of the questions asked to students revealed areas of misunderstanding that students were encountering at the beginning of the course that appeared to carry forward for the remainder of the course. This was one of the root causes of students' failing to achieve the learning goals. As such, learning constraints that include time and pace are barriers also confine them from going any further in developing their practical skills in the subject. The need analysis indicated that the students are unable to grasp the learning content when they are taught once in the classroom. Eventually, these accelerate their lack of engagement, motivation and interest.

These implications are resulted by the several challenges of executing of the course. According to Ousterhout [3], programming involves successive understanding of the programming language and scripting. To learn programming, students need to grasp valid basic concepts during their introductory computing courses as these forms a strong background for more advanced programming courses in their varsity curriculum. At the moment, current teaching is based on 'chalk and talk' method and textbooks and this does not always work well. Many students, who finish introductory classes, do not know what they are doing as they have no continuous enhancement on the programming concepts. Chansilp and Oliver [4] suggest that the graphic representations of algorithms used in most textbooks are abstract visualizations and are not sufficient for learners to develop the logical thinking required in programming courses. The students only depend on the lectures and the textbook to develop their programming comprehension. However, the lecturers only go through the lesson once. Hence, the students have no lesson repetition for them to learn and understand better. Students' problems with learning C programming are mostly based on a lack of

understanding of conceptual and mental models [5]. Consequently, the lack of approach for deep learning that incorporates students' higher order thinking skills to transfer and make connections, causes the students to convey disinterest and negative attitude to the programming subject [5][6].

The second drawback relates to retaining students' engagement in the programming subject. As beginners, the students believe that learning programming is cumbersome [6]. Therefore, a guided tutorial strategy should persuade them to deem otherwise. Although self-directed learning using notes and textbooks was previously implemented in the course, they would not actively participate or reflect their comprehension meaningfully as there is no approach that tackles students' interest. A study done previously indicated that the native digital students are drawn to visual media and creative task [7]. Therefore, the integration of multimedia as a reflection tool in learning is crucial in order to maintain students' motivation and engagement in the programming class.

### III. SOLUTION AND MOTIVATION

To improve the students' programming skill and engage them into the learning process, this study proposes an approach to incorporate multimedia as a tutorial and motivation tool in the programming subject. The motivation of this project originates from the advantages of multimedia reviewed in past literatures. There are increasing volumes of multimedia application that are utilized in higher education for teaching programming [7].

Multimedia applications are being used in the classrooms to compliment lectures on specific topics, enabling students to learn at their own pace rather than the pace of the course. This is to provide the students with a step-by-step tutorial of program execution in the programming language as a mean to enhance their understanding of programming structures and concepts.

In this study, the effectiveness of a multimedia courseware named MAFPro is being implemented in a C programming course. The content of MAFPro is delivered using the redundancy of multimedia elements in tutorial mode emphasizes on the programming language concepts. Jono et al. [8] stated that students who are provided with examples through multimedia produced better results as compared to those students who only experienced traditional instructional methods. MAFPro also becomes a self-help tool for the students to learn on their own will, pace and time. According to Keller [9], to improve confidence and motivate students in learning a particular lesson, they should be given the control over the lesson and the time required to complete lessons. The students should also be given full control and capacity to self-navigate throughout the lesson. The accessibility provided to them to navigate throughout the instructional material on their own will, and learn in their own time, is expected to provide them the confidence and keep them motivated throughout the lesson.

MAFPro provides a multi-genre tutorial space that engages and draws students into a different interaction with programming. It also appeals to multiple intelligences as it provides embedded mixture of visual (text) and audio (sound, music or voice) modalities that enables students to learn through their preferred modality. Students are able to learn programming while creating and integrating 'schema'

to understand better and freely at their own will. They may repeat the content as many times as they want for them to understand each step of programming better. The combinations of multimedia elements in MAFPro offer students a welcome change from routine lectures in the classroom and also arouse their interest in learning various types of modalities. The redundancy of multimedia in MAFPro also works together in improving the learning process.

The students this C programming course is novice and they have never done programming. Hence, these students might have difficulties in comprehending programming codes. The students' programming comprehension could be impaired because the students missed decoding the information from the source code, as they will allocate little or no cognitive capacity to construct and respond to the structure of the code. Thus, the students need to be approached with a self paced, attention-grabbing and effective learning mechanism that would gradually stimulate interest and concise understanding of the subject. The idea of a multimedia application that equipped with the aid of text, graphics, sound, animation, and video to innovate the learning programming language immensely suggests an alternative.

### IV. LITERATURE REVIEW

Programming is an important part of computer science. The effects of programming are widely experienced throughout society in a multitude of social, work-related, and leisure software applications [10]. Due to the importance and the broad influence of programming, the efficient and effective teaching of the subject is worthy of study and improvement. One of the most challenging aspects of this subject is to help students learn the concepts of computer programming [11]. Programming concepts are the broad ideas of programming. These include 1) the use of variables to store and retrieve data, 2) input to place data into the computer, 3) processing to organize data and make calculations, 4) output to report information, and 5) stored procedures to organize tasks [11]. The task involves many complexities, including skill development, different learning styles, helping students transition from a problem statement to algorithmic logic, developing programming code from that logic, debugging and resolving the program code to produce a working program that meets the problem requirements [11]. This learning process is even more challenging when students are novice and being introduced to a new programming language and development interface [8]. Under these circumstances, learning time is often at a premium and any approach that can assist a student obtain a quick start in learning the basics of the new language and its interface give the student an advantage and help avoid initial student confusion that can hamper achieving student learning goals [11]. However, the methods used to teach programming to students still relies on outdated teaching methods [11]. While the technology and the tools have changed, most are still introduced to programming by reading texts, listening to lectures and writing programs. Research findings indicate that programming students obtain their knowledge and skills from learning activities that are primarily outside the classroom, which led the educators to surmise that new approaches such as multimedia that are

more promising for achieving learning goals in programming [8].

The research literature has demonstrated many of the advantages of using multimedia based instructional material. In particular, results from Sankey, Birch, & Gardiner [12] indicated that students experienced improved comprehension, understanding, and retention of content when they learn using multimedia. This research is formulated to pursue those goals by examining the detailed usage of multimedia to address specific course problems in teaching computer programming, especially to provide their programming students a quick start path to learning and applying new programming languages in their coursework.

Multimedia have been defined in various ways. Mayer [13] defined multimedia as presentation of materials using both words and pictures. Multimedia can also be defined as an integration of multiple media elements (text, audio, video, graphics and animation) into one whole that brings more benefits for the end user than any one of the media elements can provide individually [14]. It is referred to as powerful, integrative educational technology that has great potentials as a pedagogical tool [14]. Multimedia is used to support essential teaching objectives, so as to clarify and illustrate complex subjects, adapt to individual learning styles, improve retention and aid recall [1]. Mayer [13] justified that individuals learn, retain, and transfer information better by using multimedia.

Multimedia technology allows instructors to use multiple modes and representations to construct new understanding and conceptual change of enhancing students' knowledge [4]. This is because by using multimedia in learning, it allows the students to use their own learning styles and modalities [1]. Researchers have also deduced that multimedia in learning help the students to have better retention [7], better attention [10], better understanding [4], and inference capabilities [13]. It was also revealed that multimedia provide more opportunities for the students to work at their own pace and in the learning style that they prefer [1]. This will correspondingly increase their learning engagement [15].

Studies done by many scholars stated that the use of multimedia approach was a successful complement to conventional programming teaching [4][7][8][16][17]. Their findings clearly demonstrated the advantages of using multimedia among student to provide them a step-to step representation of the programming topics to develop their understanding of the difficult programming concepts. The multimedia approach evidently enhances the learning process of the programming languages. Multimedia acts as an alternative way of learning programming besides lectures and textbook learning. At the same time, it also natures enthusiasm and motivation of the student to learn the programming languages [8][12][15][17]. It is concluded that the use of multimedia based instruction in facilitating and learning processes ensures same chance for students with different dominant senses by getting more information, deeper comprehension, better perception and more efficient memorizing.

## V. METHODOLOGY

### A. Sample

A sample of 30 undergraduate students was conveniently chosen from a programming classroom in a public

University in Malaysia. They are homogenous in terms of their average academic achievements, whereby they were novice learners who have no programming background.

### B. Instruments

The students were assigned to MAFPro, a tutorial-like multimedia courseware that is aimed to help the novice learners to learn basic of C programming. This courseware encompasses 7 chapters with distinctive scenarios that cover the fundamentals of computer programming such as variables, data type, arithmetic operators, comparison operators, and operator precedence. Every scenario is preceded with the learning objective. This courseware is built with a storyline, rules, challenges and a reward system. MAFPro was developed using Macromedia Flash with ActionScript 3.0. The lesson content for MAFPro was developed based on the syllabus provided by the faculty.

There were two research instruments used for this study:

(i) Six programming comprehension test (one for each chapter) (written and hands-on) to measure the students' programming comprehension. The test assessed the students': (1) general orientation, (2) programs execution, (3) notation, and (4) pragmatics. The duration to read and answer questions for each comprehension text is 30 minutes.

(ii) Instructional Material Motivational Scale (IMMS) developed by Keller (1993): to assess the motivational quality of MAFPro based on the principles of ARCS: Attention, Relevance, Confidence and Satisfaction. It comprised thirty-six (36) Likert-type statements that are based on opinion and attitude.

### C. Research Procedures

For the intervention, the students were assigned with the MAFPro individually, and they can only use it in the classroom. For each chapter, the students will take the duration of an hour to experience the learning content, and thirty minutes to answer the comprehension test. The experiment was conducted for six days. At the end of the experiment, the students were given the IMMS questionnaire used to measure their perceived motivation towards the instructional material.

## VI. FINDINGS

The analyses of the data were carried out through parametric statistical techniques.

The students experienced the MAFPro and answered six programming comprehension test (one for each chapter) (written and hands-on). The students were given pretests prior to the intervention and post-tests after the intervention. The scores are obtained to measure the students' programming comprehension. From the analysis, the mean of the post-test comprehension scores ( $\bar{X}_{\text{post}} = 78.48$ ), is relatively higher than pretest ( $\bar{X}_{\text{pre}} = 27.16$ ). The descriptive statistical analysis of the programming comprehension scores is depicted in Table 1.

Table 1  
Descriptive Statistics for Programming Comprehension Scores

Mode	Chapters	Number of students	Mean	Std. Deviation
Pretest	1	30	26.23	11.097
	2		26.76	10.679
	3		23.86	11.057
	4		28.03	12.598
	5		29.17	11.528
	6		28.90	8.523
	Total		27.16	4.336
Post-test	1	30	78.10	13.847
	2		81.30	11.818
	3		77.10	10.986
	4		80.33	11.008
	5		76.20	11.105
	6		77.86	10.095
	Total		78.48	5.635

Figure 1 illustrates the linear graph for the descriptive statistics for pre-test and post-test mean scores across the treatment mode. The graph depicts that there is an increase in the mean scores of post-test that measures the programming comprehension scores, indicating that the students are able to comprehend the learning lesson better when they used MAFPro.

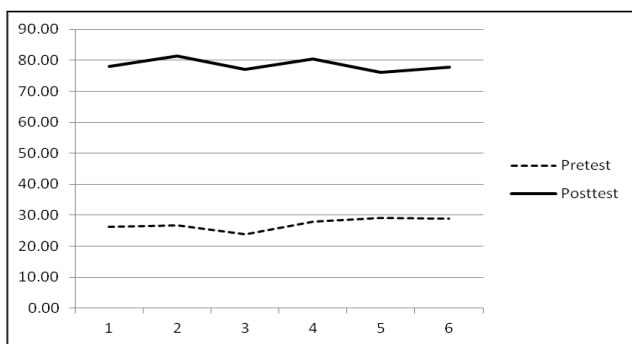


Figure 1: Descriptive Illustration for Pretest and Posttest Mean Score

Statistical analyses were also conducted to measure the students' perceived motivation toward MAFPro courseware using Keller's Instructional Material Motivational Scale (1993). This survey questionnaire had 36 items with response scale ranges. This means that the minimum score on the 36-item survey is 36 and the maximum score is 180. The minimums and maximums for each subscale vary because they do not all have the same number of items. However, for this study, an alternate scoring method was used to find the average mean score for each subscale and the total scale instead of using sums. This converts the totals into a score ranging from 1 to 5 and makes it easier to compare performance on each of the subscales. The descriptive statistical analysis results of the students' perceived motivation scores are presented in Table 2.

The statistical analysis findings for students' perceived motivation showed that the MAFPro is regarded as motivating ( $X_{IMMS} = 4.441$ ). In each of the individual subscales; attention, relevance, confidence and satisfaction, the findings showed that the mean scores are more than four ( $X_{Attention} = 4.400$ ,  $X_{Relevance} = 4.455$ ,  $X_{Confidence} = 4.422$ ,  $X_{Satisfaction} = 4.488$ ), indicating that MAFPro is a motivating

instructional aide to learn C programming language learning. Overall, the findings showed that the novice undergraduate students opined MAFPro as engaging, motivating and usable in their programming language environment.

Table 2  
Descriptive Statistics of Students' Perceived Motivation

Mode	Dimensions	*n	Mean	Std. Deviation
MAFPro	Attention	30	4.400	.184
	Relevance		4.455	.234
	Confidence		4.422	.272
	Satisfaction		4.488	.327
	Total IMMS		4.441	.177

\*n denotes number of students

## VII. DISCUSSION

Students encountering the programming paradigm for the first time often have problems to understand the abstract concepts and applying them to the software design. The ultimate goal of this research is to bring a multimedia approach into the curriculum of basic programming to help the novice students who had difficulties with learning programming. The data gathered from this study indicated that using multimedia approach to facilitate and learn C programming can bring benefits. It helped the novice students to conceptualize and apply the abstract concepts of programming in a problem-solving context. When the students are able to understand the abstract concepts, they will comprehend the programming language better and will be motivated to learn the programming language as it ensures same chances for the students with different dominant senses with getting more information, deeper comprehension, and better perception using the multimedia approach towards learning programming. It also supported the lecturer, with the aid of the multimedia elements, to teach the abstract concepts of C programming which were difficult to explain verbally.

## VIII. CONCLUSION

The multimedia courseware evidently enhances the learning process of the C programming language. The courseware acts as an alternative way of learning C programming besides lectures and textbook learning. It enables the students to learn at their own pace. This allows them to understand the learning content better. Through the multimedia courseware, the novice students' comprehension and interest in the C Programming language will be cultivated efficiently. At the same time, it should also nurture enthusiasm and motivation to further improve the literacy of C programming language among the novice students who has no or little background in C programming.

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