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A Preliminary Study of Difficulties in Learning Java Programming for Secondary School

Mazliah Majalin[1], Aslina Baharum[1], Rozita Ismail[2], Ismassabah Ismail[3], Ervin Gubin Moung[1], Noorsidi Aizuddin Mat Noor[4]

[1]UXRL, Faculty of Computing and Informatics, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah
[2]College of Computing and Informatics, Universiti Tenaga Nasional, Putrajaya Campus, Malaysia
[3]Centre of Foundation Studies, UiTM Cawangan Selangor, Kampus Dengkil, 43800 Dengkil, Selangor
[4]UTM CRES, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, Johor Bahru, Johor, Malaysia
aslina@ums.edu.my

ABSTRACT

Coding is being part of the curriculum study for Malaysian primary and secondary school since 2017. The introduction of Computer Science subject was to expose the young to digital technology and groom them to become digital makers. The programming field is very challenging especially to those who still triggering what programming is all about. One of the problems is students have difficulty in certain subtopics of programming. Coding to a specific task by using much complex algorithm is not an easy task as student needs to understand and know how to use it to solve a problem. For a beginner who does not have a background in a programming language, some might experience it hard to grasp the concept at the beginning of the learning process. This paper is to identify secondary school student's problems in the subject. Based on the study conducted using an online survey with 37 respondents, results indicated that they faced difficulties in various subtopics of programming from an easy to complex concept based on the scope of learning content they have learned. From the process of computational thinking techniques, algorithm concepts, declaring constant and variable, control structures, search and sorting approach, and several more, these subtopics of programming were hard for some of the respondents. The results showed the subtopic of function and procedure was difficult for most of the respondents, regardless kind of programming languages they learned.

Keywords: Classroom, Computer Science, Education, Marker-Based, STEM.

1. INTRODUCTION

Programming is the process of designing and building an executable computer program to accomplish a specific computing task. A programming language is a set of Malaysian curriculum has exposed students to the world of programming. A new approach to teaching and learning how to program is vital to the education industry. The evolution of high-performance electronics is now ubiquitous and offers great and continuously improving resources ready to support us in ordinary tasks. Besides, Augmented Reality (AR) is a breakthrough technology that could considerably ease the execution of complex operations.

In the education field, the process of teaching and learning about a topic can be made more interesting with the usage of AR. At this point, AR has been today's one of the most popular perspectives to improve the effectiveness of the e-learning on courses including abstract or technical subjects to be learned. It can be expressed that the AR can improve learning processes in such courses, by using its effectiveness on affecting students' multi senses and enabling them to experience the learning approach, which is enhanced with real-world based practices, explorations and discoveries [1]. Thus, AR also can be used for Computer Science (CS) subjects like coding.

Students that have no motivation in learning is one of crucial aspect towards the subject. Based on the conducted study of Strengths, Weaknesses, Opportunities and Threats (SWOT) by Helyawati et al. [2], they had outlined the problem as one of the main weaknesses from the students' perspective towards the subject. Moreover, student interest in the Science, Technology, Engineering and Mathematics (STEM) subject is decreasing yearly. The dropout of interest is an issue addressed by the Ministry of Education as stated via The Star Online, a local media newspaper highlighted on Sunday, 17 Mar 2019 [3].

Thus, this paper is aim to identify a problem in learning Java programming subject among secondary school. Results may give better instruction of teaching and learning activities in the programming concept of function and procedure. Thus, it may help the students to capture a better understanding of the content and having fun on learning styles to enhance

motivation, interest and boost to better academic achievement.

2. RELATED WORK

Student's motivation is one of the important keys in helping them to learn effectively to retain useful information about knowledge and enhance their willingness to participate actively in classroom learning processes. The conducive learning environment will help to gain students' interest and ability to motivate them intrinsically or extrinsically. Motivation refers to the source of energy to energy to respond to why learners decide to build an effort, the period they are keen to uphold to an activity, how tough they tail it and linked their sense to the activity [4]. Khan et al. [4] highlighted that a lack of motivation will bring a difficulty to learner accomplishment, emphasizing the significance of creating and supporting motivation. The research focused on intrinsic motivation theory to explain motivation in the context of learning by applying attention, relevance, confidence, and satisfaction (ARCS) model to understand the impact of AR application on students' motivation (figure 1). The Instructional Materials Motivation Survey (IMMS) was used to intend on motivation study instrument [5].
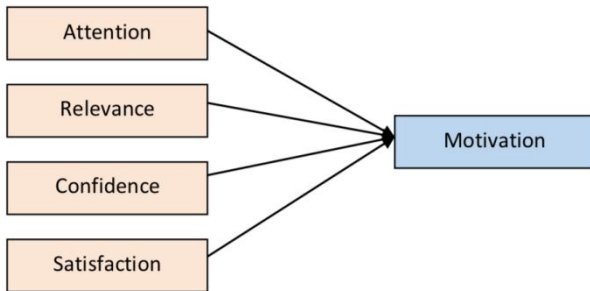

Figure 1: Keller's ARCS model of motivational design

STEM education is gaining huge attention in the Malaysian educational field [6]. The introduction of computational thinking and CS is one of the initiatives to strengthen and increasing student's interest in STEM education as outlined in the Malaysia Education Blueprint 2013 – 2025 [7]. These skills have been integrated into the primary and secondary school curriculum since 2017. The content of the CS has been designed to be part of Standard Curriculum for Primary School (KSSR) at Year 6 and the Standard Curriculum for Secondary School (KSSM) from Form 1 until Form 5. In other words, students who are taking the subject have to be prepared in the world of coding. Various programming languages and application software such as Scratch, Python, Java, HTML, JavaScript, Microsoft Access, MySQL,

XAMPP and Notepad were being exposed to the students by phase based on their education level.

Java programming is known as a high-level language, a general-purpose computer programming language that is concurrent, class-based, and object-oriented by enabling programmers to write computer instructions using English-based commands instead of having to write in numeric codes. Based on Computer Science Curriculum and Assessment Standard Form 4 [8], function and procedure have been embedded as one of the subtopics to be covered by the students. Function and Procedure in Java programming are being taught to the Form 4 student as a main language framework in the textbook to conceptualize both function and procedure as a modular programming approach. Modular programming is the process of subdividing a computer program into separate sub-programs.

The use of AR in CS has been conducted by several types of research. Based on the study conducted by Kosea, Koca and Yucesoy [9], the software system using AR to support learning experience in CS for 200 students in different faculty and universities showed an effective and successful performance in improving learning experiences and been accepted as better and more enjoyable way compared to other e-learning approaches.

Another study has been conducted by Del Bosquea, Martinezb and Torresc [10], the result showed that the failure rate has decreased by 50% in the subject of structured programming with the augmented reality tool. Myers [11] claims in his study that Pop-up java has the potential to be a very effective tool both in the classroom and at home. Significantly, AR can be used in the computer science field for abstract concept learning [12]. The participants found mobile AR to be the most enjoyable technology and ease of use [13]. This is proven that AR technology has had a dominant impact on the programming subject by making it more dynamic and help the student to grasp the logic of programming.

Sommerauer and Müller [14] have proposed AR learning framework adaptable through the mobile application by combining three-phase layers. The framework design is illustrated in Figure 2. These three layers are composed to develop a sequence of learning activities in any AR application.
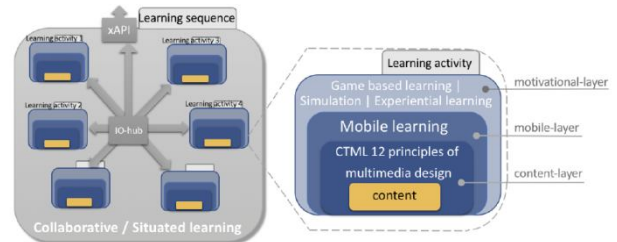

Figure 2: An Effective Design Framework of AR for Teaching and Learning

On the other hand, students with lower problem-solving abilities encounter significant difficulties while learning and might be able to master it [15]. Moreover, the deficiency result obtained by the students and the difficulty of developing algorithms from the management of control structures, loops, functions, the use of parameters and the scope of the variables in the object-oriented programming were outlined as problems to the students [16]. Therefore, the programming field needs an effective learning approach and activities to minimize the arising issues.

3. METHODOLOGY

Exploratory via literature search, reading and review are done to have a clear direction of the research. A preliminary survey was conducted to strengthen the need for the study. It has been conducted via an online survey using the Google form to clarify the problem and students' perceptions relating to the core focus of this study. Respondents were among Form 4 Computer Science students in rural secondary schools located at Kota Marudu. There are 37 respondents from the chosen secondary school who answered the questions and collected. It is not restricted to any level of education form.

4. RESULT AND DISCUSSION

4.1 Result and Discussion on Question 1

Question 1: What is the programming language that you learn? Tick one or option below.
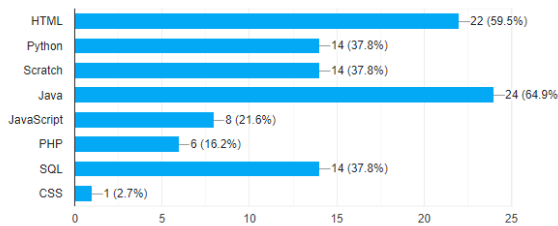

Figure 3: Type of Programming Languages Learned by the Respondents

Based on the result shown in Figure 3, students have learned various types of programming languages in Secondary School. Normally, lower secondary students started to learn HTML, Scratch and Python. Meanwhile, the rest of the programming languages will be covered in the upper level of students. Most importantly, these programming languages are opened to be explored either in formal or informal education as students are exposed to many learning sources and contents online. Based on the finding, 24 (64.9%) students have learned Java, 22 (59.5%) students learned HTML, 14 (37.8%) students learned for Python and also for Scratch and SQL. JavaScript, PHP and CSS by distinctively learned by eight (21.6%), six (16.2%) and one (2.7%) of respondents. This result upholds the use of Java programming.

4.2 Result and Discussion on Question 2

Question 2: Is the topic of programming difficult for you to learn and apply in a classroom setting?

Table 1: Level of Difficulties of Learning Programming in a Classroom Setting

	1	2	3	4	5	Total
Total in number	0	1	30	6	0	37
Percentage	0%	2.7%	81.1%	16.2%	0%	100%

* Note: 1. Totally not difficult, 2. Not difficult,
3. Moderate, 4. Difficult, 5. Very Difficult

Based on the result shown in Table 1, the majority, 30 (81.1%) of the respondents preferred that learning programming in a classroom setting is at a moderate level. Six (16.2%) respondents found the learning processes is difficult and one (2.7%) respondents indicated that it is not hard to implement in a classroom setting. Thus, it is considered that with the existence of teacher and learning material or equipment as well as the use of appropriate pedagogical strategies in teaching and learning, the process of programming is not that difficult but not even too easy to be learned. This finding leads to the possibility that the use of technology such as augmented reality in a classroom setting is a suitable approach to be introduced to enhance student's level of understanding in programming as it will promote active involvement of students through the collaborative and cooperative learning environment.

4.3 Result and Discussion on Question 3

Question 3: Please choose the subtopics of programming that difficult for you. You can tick more than one option as listed below.

Table 2: Difficulties in Subtopics of Programming

	1	2	3	4	5	6	7	8	9	10	11	12	13
Total in number	9	6	6	7	7	12	9	12	17	9	7	1	6
Percentage	24.3%	16.2%	16.2%	18.9%	18.9%	32.4%	24.3%	32.4%	45.9%	24.3%	18.9%	2.7%	16.2%

* Note: 1. Computational thinking, 2. Concept of algorithm, 3. Variable, constant and data types, 4. Linear control structure, 5. Selection control structure, 6. Iteration control structure, 7. Types of error, 8. Array, 9. Function and procedure, 10. Linear and binary search algorithm for form 3, 11. Bubble and bucket sort algorithm for form 3, 12. Bubble and selection search for form 5, 13. Binary search algorithm, max, min, mean, count, queue for form 5

There are 13 major subtopics of programming implemented in the secondary school syllabus at a different level as shown in Table 2. Based on the result, all respondents experienced at least one or more difficulties in the subtopic of programming. There is only one respondent who indicated that bubble and selection sort at Form 5 level is difficult. This might conclude that the concept of the topic is well grasped among Form 5 students who took the online survey. Most respondents chose function and procedure is difficult for them with a total of 17 respondents (45.9%) of the result. Informal education, this subtopic is introduced to Form 3 students through Python programming and carried forward to Form 4 and Form 5 students via Java and JavaScript. This result justified function and procedure as the main preference topic to be covered in learning contents.

5. CONCLUSION

In conclusion, the preliminary survey findings help to identify and clarify the problem, focus and need of this study. At this point, the learning content of Java function and procedure will be designed to meet the constructivist learning approach within a classroom setting in the development phase. The result of primary research in this study has proved that this modular programming is one of the subtopics that hard for most respondents. The ability to code differs on students' capabilities to solve a problem. Programming ability required high problem-solving abilities; therefore the problem-solving activities can be practiced. This study will contribute and help in enhancing students' motivation to code by capturing their interest, thus improving the student academic achievement of function and procedure coding through the learning environment. The finding of the study could be a ground-breaking approach that will change the way teachers teach programming, especially for an abstract and concrete difficult concept to be conveyed via the conventional method of teaching. The greater demand for students to have a good basic of programming justifies the need for effective and life-changing teaching and learning approach. Thus, schools that apply the recommended approach derived from the result of this study will be able to train students better. Administrators will be guided on what should be emphasized by teachers in the school curriculum to improve students' performance not only in Computer Science but broaden to various disciplines in education. For researchers, this study will help them to uncover more potential and critical areas in the educational process to be able to explore and applying augmented reality techniques. Future works will help to promote the use of technology such as augmented reality for Malaysian secondary school in a classroom setting or as an independent learning platform at home. Thus, this will help to increase and nurturing students' interest in a STEM subject, especially in programming.

REFERENCES

1. A. Baharum, N.H. Nazlan, N.A.M. Noor, R. Hanapi, I. Ismail, and N.A.M. Noh. **Information Visualization For Food Mobile Application: Hangri 2.0**. *International Journal of Advanced Trends in Computer Science and Engineering*, Vol. 8, No. 1.3, pp. 306-314. 2019. ISSN 2278-3091. https://doi.org/10.30534/ijatcse/2019/5781.32019

2. B. Helyawati, M.S. Shakirah, and F.A. Asuhaimi. **Cabaran Dan Isu Dalam Penawaran Subjek Sains Komputer Di Sekolah Menengah**. *International Research Management & Innovation Conference 2018*, pp. 1–6. August 2018.

3. The Star Online. *Interest in Science Continues to Drop*. March 2019. Retrieved from https://www.thestar.com.my/news/education/2019/03/17/interest-in-science-continues-to-drop

4. T. Khan, K. Johnston, and J. Ophoff. **The Impact of an Augmented Reality Application on Learning Motivation of Students**. *Advances in Human-Computer Interaction.* 2019. https://doi.org/10.1155/2019/7208494

5. N. Loorbach, O. Peters, J. Karreman, and M. Steehouder. **Validation of the Instructional Materials Motivation Survey (IMMS) in a self-directed instructional setting aimed at working with technology**. *British Journal of Educational Technology*, vol. 46, no. 1, pp. 204–218. 2015. https://doi.org/10.1111/bjet.12138

6. L.P. Jack, N. Khamis, C. Salimun, D.M. Nizam, Z. Haslinda, and A. Baharum. **Learn programming framework for Malaysian preschoolers**. *International Journal of Advanced Trends in Computer Science and Engineering,* vol. 8, no. 1.6, pp. 431 - 436. 2019. https://doi.org/10.30534/ijatcse/2019/6281.62019

7. Malaysia Education Blueprint Malaysia. **Malaysia Education Blueprint 2013 - 2025**. *Education*, vol.

27, no.1, pp. 1–268. 2013. https://doi.org/10.1016/j.tate.2010.08.007

8. Bahagian Pembangunan Kurikulum. *DSKP Sains Komputer Tingkatan 4*. 60. 2015.

9. U. Kose, D. Koc, and S.A. Yucesoy. **An augmented reality based mobile software to support learning experiences in computer science courses**. *Procedia Computer Science*, vol. *25*, pp. 370–374. 2013. https://doi.org/10.1016/j.procs.2013.11.045

10. L. Del Bosque, R. Martinez, and J.L. Torres. **Decreasing Failure in Programming Subject with Augmented Reality Tool.***Procedia Computer Science*, vol. *75*(Vare), pp. 221–225. 2015. https://doi.org/10.1016/j.procs.2015.12.241

11. R. Myers. *Pop-up Java: An Augmented Reality Mobile Game to Teach Java.* pp. 14–15. 2017.

12. T. Patel. *Learning Object Oriented Programming Using Augmented Reality A Case Study with Elementary School Students*. 2017. https://doi.org/10.1016/j.jenvman.2018.01.013

13. N. Dass, J. Kim, S. Ford, S. Agarwal, and D.H.P. Chau. **Augmenting Coding: Augmented reality for learning programming**. *ACM International Conference Proceeding Series*, pp. 156–159. 2018. https://doi.org/10.1145/3202667.3202695

14. P. Sommerauer, and O. Müller. **Augmented reality for teaching and learning - A literature review on theoretical and empirical foundations**. *26th European Conference on Information Systems: Beyond Digitization - Facets of Socio-Technical Change, ECIS 2018*. 2018.

15. M. Mladenović, D. Krpan, and S. Mladenovi. **Learning programming from scratch**. *Turkish Online Journal of Educational Technology*, *2017* (November Special Issue INTE), pp. 419–427. 2018.

16. M.D.G. Rios, and M.P. Velasco. **Augmented reality as a methodology to development of learning in programming**. *Communications in Computer and Information Science*, vol. 895, pp. 327–340. 2019. https://doi.org/10.1007/978-3-030-05532-5_24