

# Programming Teaching and Learning: Issues and Challenges

Siti Noor Ahmad, Juzlinda Ghazali

*Fakulti Sains dan Teknologi Maklumat (FSTM)  
Kolej Universiti Islam Antarabangsa Selangor(KUIS)*

[sitinoor@kuis.edu.my](mailto:sitinoor@kuis.edu.my), [juzlinda@kuis.edu.my](mailto:juzlinda@kuis.edu.my)

**Abstract.** This paper reviews on literature focusing to programming teaching and learning by addressing issues and challenges in context of introductory programming at tertiary level. Learning programming is challenging and difficult especially at the beginning stage. Several papers were selected and reviewed to identify the issues and challenges faces by learners and lecturers. This paper proposes the categorization of programming challenges and highlights the keys issues in programming teaching and learning in higher education for further research and improvement.

**Keywords:** Computer programming, problem solving, programming teaching, mental model.

## INTRODUCTION

In Malaysia, programming subject is made compulsory core subject for Computer Science, Information Technology, Engineering and Mathematic (STEM) field. Most of the learners will undergo at least one or more programming subjects or Introductory subject in undergraduate level. Some will take up to several subjects to meet the requirement of the course standard.

Although there are many tools available, the difficulties of teaching and learning of programming remain unsolved. Higher failure rate among learners in Introductory level due to many reasons. Most of the learners had negative perception towards learning programming subject by thinking that the subject is difficult and known as killer subject. These negative perceptions have been passed down by their seniors, Lack of problem-solving skills among learners and ineffective textbook based teaching contribute more problem especially in programming competency.

Based on these scenarios, there are some questions to ponder. Is learning programming is difficult? Do the learners have inadequate knowledge background and skills? What are the challenges faced by the learners and educators? This paper will discuss the challenges in teaching and learning programming subjects by doing the initial literature reviewing related papers in this area.

## **RELATED LITERATURE**

Based on previous study, there are four categories in teaching and learning programming challenges. The first category and the most discussed is from learner's perspective (Cheah, 2020; Medeiros et al., 2019; Rahim et al., 2018; Salleh et al., 2013a; Shargabi et al., 2020). These includes (1) Problem-Solving Skill and Background Knowledge, (2) Programming Stage, and (3) Personal Trait and Motivation

### **Problem-Solving Skill and Background Knowledge**

The problem-solving skills need to be developed as strong base to write good programming. The most discussed challenges faced by learners is the ability to solve the problem or problem solving skill. (Cheah, 2020; Medeiros et al., 2019; Rahim et al., 2018) Learners need to master the skill prior learning programming to avoid problem like program design failure, confusion in selecting appropriate control structure and inappropriate mental model.

According to (Rahim et al., 2018), problem faced by the learners in problem solving skills is the difficulties to translate the answer of a given problem into programming language. The problem-solving skill is also associated with mathematical ability. (Medeiros et al., 2019).

### **Programming Stage**

Programming stage includes two phases: (1) Problem Formulation and (2) Implementation phases. (Cheah, 2020; Medeiros et al., 2019). Problem formulation is closely related to problem solving skill. The types of problem, steps in problem solving, concept of programming and data structure are introduced during the problem formulation phase. Good general solution or algorithmic reasoning and constructing leads to correct and complete programming code in implementation phase. The process of learning the programming effectively includes the understanding of syntax and the ability to comprehend the program. These include the ability to match the abstract to real life by identifying data variable, memory, control structure and data structure.

Program comprehension is the process of understanding program and a critical skill set in software development as programmers must understand the code before they can extend or maintain the software (Shargabi et al., 2020).

### **Personal Trait and Motivation.**

Learner's motivation and interest are key factors in learning programming successfully (Cheah, 2020; Medeiros et al., 2019; Rahim et al., 2018; Salleh et al., 2013b). The weak foundation of problem-solving skills and reasoning leads the difficulties in interpreting the problem. Reading, understanding, and learning from other's people coding examples is preferred. It is also depending on knowledge base regarding the general, domain and related programming languages. Learners engagement, perception, confident, poor time management, minimal work habit is contributing factors impacting the learner's motivation. If it is not use wisely, the plagiarism might occur especially when student feel

that the programming is difficult. It is necessary to ensure positive attitude and adab is cultivated at early stage to boost the motivation towards programming subject.

The second challenge in teaching and learning programming is from educator's perspective. (Cheah,2020; Medeiros et al, 2019). This reflect the role and responsibility of the educator for not only to deliver the content but also need to revisit the challenges faced by the learners. Effective communication and feedback will help to motivate the learners and increase learners' engagement. The selection of appropriate method and tools for teaching programming is also important. The learners and educator's ratio also contributing the difficulties in teaching programming. The number of learners in one class with different background and skill will be challenging to the educators as they need to use different approach with different learner. The selection of appropriate programming languages, teaching tools and teaching method are always challenging for educators.

The third challenge is teaching approach that comprises of teaching method and programming tool. The traditional approach by using textbook and traditional teaching method is no longer effective. Teaching by doing, by example, by demonstration, problem-based learning, active based learning, trace driven teaching app, pre- recorded and using live example are the common teaching method. As for novice programmer, the programming tool that can facilitate them in understand the program is really needed. Software simulation and visualization approach (Affandy, 2014) and gaming approach (Olsson et al., 2015; Zhao et al., 2018) will help learner more effectively especially in online learning. Programming tools using visualization is preferred by learners, and games elements makes learning programming more interesting. Some innovative programming tools include animation and online application. Various research in programming teaching and learning has been done typically focuses on teaching and learning technique, programming tool, and ability to understand the program (Salleh et al., 2013a).

The fourth challenge is the programming syllabus comprises pedagogy, syllabus content and education (Program Structure). Ineffective pedagogy refers to the usage of traditional methods and static material, teaching strategies and programming syllabus.

## **METHOD**

To get some input and ideas regarding issues and challenging in programming teaching and learning, several papers were reviewed. The papers were collected from established online database such as Springer, ACM, and IEEE to ensure that the literature searching follow the right steps to ensure quality and accurate information. Most of the reviewed papers found based on keyword "programming teaching and learning", "problem solving", "programming tool", "program comprehension" and "programming challenges by learners".

## DISCUSSION

The challenges faced by most of learner especially at the introductory level are the ability to understand the problem and to be able to solve the problem either the problem is given by their lecturer or otherwise. Problem solving skill is important and necessary for the learner to be able to identify, tackle and solve the problem and transform it into algorithmic solution. Lack with problem solving skill will turn down the learner's motivation in learning programming. Although some researchers associated the problem-solving skill with mathematic subject, more research need to be done to prove this. The question is whether more mathematic subjects should be offered in computing program to improve the problem-solving skills among programming learners or probably one mathematic subject such as Discrete Math is enough.

The programming concepts like variables, operations (mathematical and logical) and controls structure are vitals in programming subject. The strong understanding of these concept will help the learners to code the solution of the problem. The use of structured language like C or object-oriented language like C++ or Java as introductory programming language is still questionable but most of the times learners are struggling with understanding the syntax of the language. Ability to formulate the problem is related to problem solving skill and ability to comprehend the program by matching the abstraction to real life are another issue among learners. Some research rooted the problem to cognitive and critical thinking and mental model among learners. Beside to be able to formulate and comprehend the program other skills like debugging the code, tracing the code, rectifying syntax error and selecting appropriate control and data structure are important especially in solution expression and evaluation. This is also related to attitude of learner toward learning programming logic, syntax, and coding.

Most of researchers pointed out the personal trait, the perception and motivation towards learning programming is another challenge for learners. Learning programming by reading the example and other programmers' code help in improving the coding skill. However, it depends on the ability to comprehend, understand and to reuse the code. Failing to do so creates frustration and decrease the motivation. The negative perception of difficulty in learning programming has been passed down by the seniors and become mentally challenge for beginners. Poor time management, minimal work habit and learning capabilities contributes more. The high percentage of failures in certain Institute of Higher Learning (IHL) create worst perception and low motivation, this need to be solved. Learning programming should be more fun and interesting by integrating more activities or gamification techniques to increase learners confident and motivation.

Challenge faced by educators/lecturers and faculty is to boost the motivation and engagement of learners in programming subjects. Besides teaching the logic and syntax, the important role of educators is to motivate the learners through effective communication and always give feedback to them. Creativity in delivering the content can be done by introducing various programming tools like visualization or simulation to helps learners understand the program better.

There was various teaching approach can be implemented such as teaching by doing, using appropriate example, demonstration, live examples, and trace driven teaching approach. Prerecorded teaching approach and new online learning method such as blended learning and flipped classroom due to current situation should replace traditional teaching approach using slide and textbook. This creates new challenge to educators and new appropriate teaching tool is required. Educators also need to deal with learner's different knowledge background, and this will be tougher to handle in large scale of learners.

## **CONCLUSION**

There are four main challenges in programing teaching and learning that need further study (1) Learner, (2) Educator, (3) Syllabus and (4) Teaching approach. Out of the four areas most research covered on combination of learners and teaching approach whereas the least research covered learners and syllabus. The most research covered a combination of learners and teaching approach perspective. The less research covered a combination of learners and Syllabus approach. The issues and challenges in teaching and learning programming research direction will focuses on improving learners knowledge background, learners problem solving understanding and characterization, learners cognitive and critical thinking, tool and methods for problem formulation, program comprehension, solution expression and learners motivation.

## REFERENCES

1. Affandy. (2014). *Algorithm-Program Visualization Model: An Integrated Software Visualization To Support Novice Programming Comprehension* (pp. 97–118).
2. Cheah, C. S. (2020). Factors Contributing to the Difficulties in Teaching and Learning of Computer Programming: A Literature Review. *Contemporary Educational Technology*, 12(2), ep272. <https://doi.org/10.30935/cedtech/8247>
3. Medeiros, R. P., Ramalho, G. L., & Falcao, T. P. (2019). A Systematic Literature Review on Teaching and Learning Introductory Programming in Higher Education. *IEEE Transactions on Education*, 62(2), 77–90. <https://doi.org/10.1109/TE.2018.2864133>
4. Olsson, M., Mozelius, P., & Collin, J. (2015). Visualisation and gamification of e-Learning and programming education. *Electronic Journal of E-Learning*.
5. Rahim, H., Zaman, H. B., Ahmad, A., Ali, N. M., Teknologi, J., Tuanku, P., & Sirajuddin, S. (2018). *Student 's Difficulties in Learning Programming*. 2(3), 40–43. <https://doi.org/10.26666/rmp.ajtve.2018.3.7>
6. Salleh, S. M., Shukur, Z., & Judi, H. M. (2013a). Analysis of Research in Programming Teaching Tools: An Initial Review. *Procedia - Social and Behavioral Sciences*, 103(May 2015), 127–135. <https://doi.org/10.1016/j.sbspro.2013.10.317>
7. Salleh, S. M., Shukur, Z., & Judi, H. M. (2013b). Analysis of Research in Programming Teaching Tools: An Initial Review. In *Procedia - Social and Behavioral Sciences* (Vol. 103, pp. 127–135). <https://doi.org/10.1016/j.sbspro.2013.10.317>
8. Shargabi, A. A., Aljunid, S. A., Annamalai, M., & Zin, A. M. (2020). Performing tasks can improve program comprehension mental model of novice developers an empirical approach. *IEEE International Conference on Program Comprehension*, 263–273. <https://doi.org/10.1145/3387904.3389277>
9. Zhao, D., Chis, A., Muntean, G.-M., & Muntean, C. H. (2018). a Large-Scale Pilot Study on Game-Based Learning and Blended Learning Methodologies in Undergraduate Programming Courses. *EDULEARN18 Proceedings*, 1, 3716–3724. <https://doi.org/10.21125/edulearn.2018.0948>