INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 13, Issue 4, (2024) E-ISSN: 2226-6348

# Programming Challenges Experience by Primary School Students: A Systematic Literature Review

Salmiah Salleh Hudin[1] & Amirah Adil[2]

Faculty of Technical and Vocational Education, Universiti Tun Hussien Onn Malaysia 86400 Parit Raja, Batu Pahat, Johor, Malaysia

Corresponding Author Email: myasumitra@gmail.com

**To Link this Article:** http://dx.doi.org/10.6007/IJARPED/v13-i4/23238 DOI:10.6007/IJARPED/v13-i4/23238

***Published Online:*** 31 October 2024

**Abstract**

The emergence of the Industrial Revolution 4.0 has changed many sectors including education field. In this age of digital, programming education is currently being integrated into primary school curriculum worldwide. The study adopted Systematic Literature Review (SLR) method. This SLR study identify the programming challenge faced by primary school students and find solutions to overcome these challenges. The selection of 20 articles needed is based on the PRISMA guidelines. A comprehensive analysis of 20 relevant articles was done through few databases such as Google Scholar, Science Direct, and ERIC. The articles that have been chosen for this SLR study were published between the year of 2019 to 2024. Findings indicate that key factors contributing to programming challenges among primary school students are categorized into cognitive, digital skills, metacognitive challenges, programming language and issues related to students' readiness. Also, limited access to good infrastructural and resources will further hinder effective programming education. Ultimately, this SLR research hopefully can guide the teachers and policymakers on the challenges faced by the primary students so that they will enhance programming education to ensure students learn well and better prepared for future.

**Keywords**: Programming in Primary School, Problem-Solving Skills, Programming Challenges, Digital Literacy, Cognitive, Metacognitive.

## Introduction

The Industrial Revolution 4.0 has brought changes in many aspects of our daily life. It started in 2016 in developed countries such as Germany and the United States; before expanding to Asian countries such as South Korea, China, Singapore and Malaysia (Lai & Aziz, 2019). Accordingly, the education curriculum also experiences changes globally. Badrulhisham et al. (2019), emphasized that the Industrial Revolution 4.0 give a great challenge to the education field. Previously, programming was only studied at the university level. However, the changes caused by the Industrial Revolution 4.0 have led to a renewed interest in primary school programming education on global scale in recent years. As a result, worldwide curriculum modifications for schools are developing quickly in order to adapt to the digital age (Starkey, 2016).

In the "Computing our Future: Computer Programming and Coding" document through the European Schoolnet report (2015), many countries have added programming topics into their national curricula. Mannova (2022), stated that in developing countries the trend of implementing programming education at the primary school level has begun since 2014. Hussein's (2017a), also support this finding by stating that the large countries like England have established computer programming as a compulsory topic area for all grade levels in schools since September 2014.

Next, Nelson (2016), adds that developing nations like the United States and Japan have introduced programming education at elementary school level. This statement is further strengthened by the findings of Predrag (2021), study indicate that computer programming has become a mandatory topic in primary education in countries such as Finland, England, Estonia, Sweden, New South Wales in Australia, Japan, the United Kingdom, Slovakia, Poland, France, Ireland and Croatia. In addition, the study of Sáez López et al (2016), also stated that programming has been actively taught in schools in the United Kingdom, Finland and Estonia. According to Heintz et al (2016), the field of programming has been introduced at the primary school level around the world through Computer Science subjects. The aforementioned statements prove that many nations have been updating their curricula for many years, by require the field of programming a skill that needs to be mastered by students starting at the primary school level. Computer programming is a skill-based practical-oriented course that requires a lot of real-world examples for students (Apeanti & Essel, 2021).

To maintain a balance between education and the demand for workers in the future, education should keep pace with the industry's development. According to Adıgüzel et al. (2023), learning programming gets more and more important today due to the high demand for programming skills in the labour market, the increasing automation of jobs, the potential for innovation, the development of problem-solving and creativity skills, and the need for enhanced digital literacy. Kadar et al (2021), support this statement by mention that in this modern age, to meet industry demand in the field of Information and Communications Technology (ICT) such as software programming, database, software engineering, computer networking and creative multimedia, one must possess knowledge of computer technology and programming in various fields of work.

However, writing a computer programming is not an easy task. It is complicated and brings a huge challenge to many students (Kadar et al., 2021). The programming challenges faced by primary school students were examined and analysed based on related previous studies or research that have been reported. The methodology of Structured Literature Review (SLR) was applied to explore the study area help to measure the major contributing factors influencing the programming challenges among primary school students. Hence, SLR can guide researchers to find related information from the articles systematically and extensively in line with the objectives of the research framework.

Therefore, this systematic literature review aims to:

1) identify the factors that lead to difficulties and challenges in learning computer programming by novice students.

## Methodology

This study was conducted using the analyst matrix approach and followed in-depth literature review format. As defined by Xiao and Watson's (2019), a systematic literature review is a well-organised study that explores and analyses pertinent literature in-depth. It can also be repeated in a subsequent process which could enhance the quality, validity, and reliability of the current review that was conducted. Thus, this technique is used by the researcher as part of research methodology.

## Article Search Strategy

To collect all related publications and articles that fit the pre-defined inclusion criteria to answer the specific research question, Systematic Literature Review (SLR) approach was employ in this study. It uses explicit and systematic procedures to minimize the existence of bias during searching, identification, synthesis, analysis, and summary of studies. SLR can provide a summary of the state of knowledge in any field needed. For this study, SLR approach was applied to trace articles reporting research about programming challenges for primary school students. The articles were derived from few databases such as Science Direct, Google Scholar, and Eric. In a systematic review, the use of several databases will give accurate results and retrieved more articles compared to using one database to summarize the results of related research studies.

## Article Selection Criteria

The keywords used were “Programming challenges for primary school students”, “Programming in primary school and the challenges” and “Challenges to programming education in primary schools”. While searching for the related articles, the limitation of the articles’ published year has been set up. Only articles that published during 2018 to 2024 are chosen. There are as many as 1413 articles retrieved from all the databases. The large number of items derived during the search. However, after applying filters such as year range, sample studies, and specific terms of this study, only 20 articles have been chosen to fulfil the requirement for this article review paper. Therefore, all the articles that are not relevant to the research questions and goals will be excluded. Table 1 show the distribution of the articles derived from 3 databases.

Table 1
*Total of article derived from each database*

| Keywords | Science Direct | Google Scholar | Eric |
|---|---|---|---|
| Programming challenges for primary school students | 131 | 123 | 180 |
| Programming in primary school and the challenges | 213 | 334 | 221 |
| Challenges to programming education in primary schools | 92 | 14 | 105 |

## Article Selection and Exclusion Process

To refine the search results, the researcher applied several different criteria. One way to limit the search results is to show just publications that were published between 2018 and 2024, as shown in Table 2. Only articles are allowed for the document type, and only journals are

allowed for the source type. Furthermore, most of the items that need to be searched are written in English.

Table 2
*Article inclusion and exclusion criteria*

| Criteria | Inclusion | Exclusion |
|---|---|---|
| Language | English language | Other language |
| Reviewed | Peer-reviewed | No peer-reviewed |
| Year of publish | 2018 until 2024 | Before 2018 |
| Types of references | Journal articles | Personal blog/websites |
| Journal Article Review Title | In the title of the programming challenges for primary school students | Apart from the topic of the programming challenges for primary school students |

By applied all the criteria, researcher found the suitable articles needed. The articles need to be downloaded and then be imported into the Mendeley Desktop application. The Mendeley Desktop was designed to make the process of filtering and organizing data easier. It also has the capability to identify documents that are repeatedly (duplication). Furthermore, it can also link all PDF document files to the document title that is given in the software.

**Data Collection and Analysis**

The data gathering process of twenty articles related to this study is based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines to select papers by Moher et al., 2009; updated 2020. These articles were retrieved from several prominent databases including Science Direct, Google Scholar, and ERIC. The article selection must include profiles of scholars who submit their research findings and references. Figure 1 displays the PRISMA Flowchart for the Systematic Literature Review for this study. To compile these data, a table was created by using the Microsoft Office Excel 2021 software to gather the information.

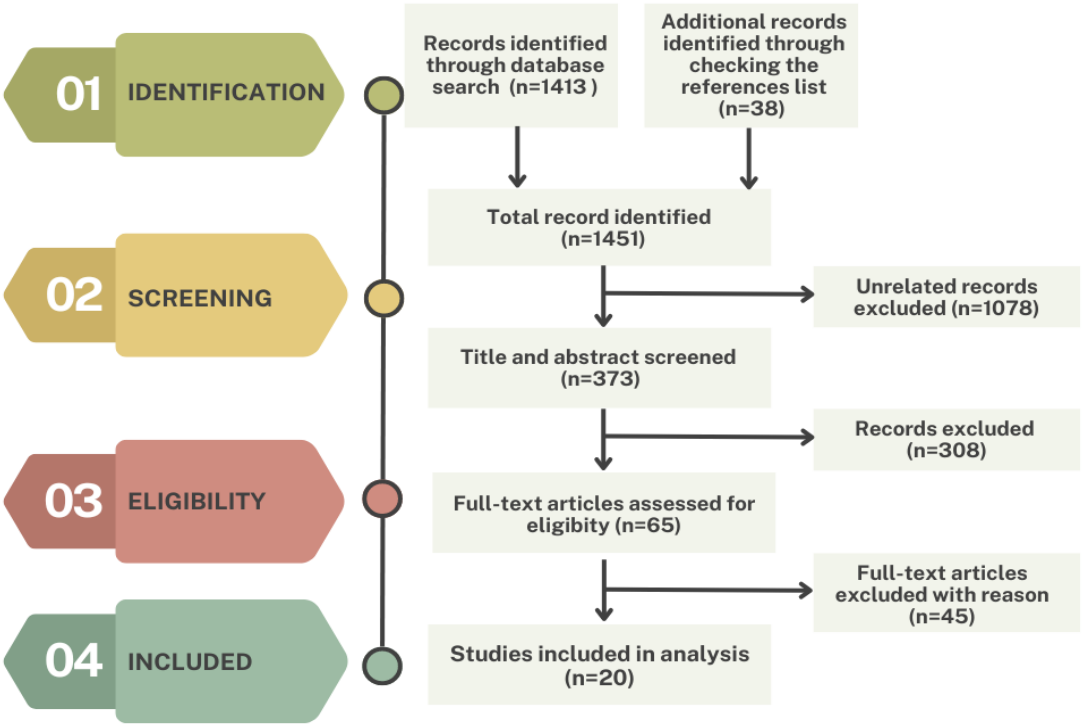


Fig 1 PRISMA Flowchart for the Systematic Literature Review (SLR)

The table consist of the name of author, the year of publish, the title of the research, the purpose of the study and the challenges faced by primary school students in learning programming. The list of past research articles used in this SLR study as shown in Table 3. The inclusion and exclusion criteria that have been established are included in each of these chosen publications.

Table 3

*List of past research articles*

| Num. | Authors / Year | Research Topic |
|---|---|---|
| 1 | Elsawah, W. & Hill, C. (2023) | Barriers to Programming Education in UAE Primary Schools: A Qualitative Review from ICT Teachers' Perspectives. |
| 2 | Napalit, F., Tanyag, B., So, C. L., Sy, C., & San Pedro, J. R. (2023) | Examining Student Experiences: Challenges and Perception in Computer Programming. |
| 3 | Arslan, S. and Çelik, Y. (2022). | Primary School Teachers' and Students' View about Robotic Coding Course. |
| 4 | Landman, M., Futschek, G., Unkovic, S. & Voboril, F. (2022). | Initial Learning of Textual Programming at School: Evolution of Outreach Activities. |
| 5 | Mannova, B. (2022). | Teaching Coding in School. |
| 6 | Olipas, C. N. (2022). | A Phenomenological Study on the Feelings, Challenges and Difficulties Experienced by Information Technology Students in Learning Computer Programming. |
| 7 | Saha, B. & Thakur, M. G. S. (2022). | Learning To Program: Hurdles and Remedies. |

| | | |
|---|---|---|
| 8 | Singh, S. (2022) | Identifying Learning Challenges Faced by Novice/ Beginner Computer Programming Students: An Action Research Approach. |
| 9 | Apeanti, O. W., & Essel, D. (2021) | Learning Computer Programming Using Project-Based Collaborative Learning: Students' Experiences, Challenges, and Outcomes. |
| 10 | Greifenstein,L., Graßl, I., & Fraser, G. (2021) | Challenging but Full of Opportunities: Teachers' Perspectives on Programming in Primary Schools. |
| 11 | Kadar, R., Wahab, N. A., Othman, J., Shamsuddin, M., & Mahlan, S. B. (2021). | A Study of Difficulties in Teaching and Learning Programming: A Systematic Literature Review. |
| 12 | Macrides, E., Miliou, O., & Angeli, C. (2021). | Programming In Early Childhood Education: A Systematic Review. |
| 13 | Muhamad Yusof, M., Ab Jalil, H., & Perumal, T. (2021). | Exploring Teachers' Practices in Teaching Robotics Programming in Primary School. |
| 14 | Predrag, O. (2021). | Prospective Teachers' Opinion on Computer Programming in Primary Education. |
| 15 | Tengler, K., Kastner-Hauler, O., & Sabitzer, B. (2020) | Programming in Primary Schools-Challenges & opportunities. |
| 16 | Amanullah, K. (2019). | Teaching Programming to School Children using Elementary Patterns. |
| 17 | Brannon, M. & Novak, E. (2019). | Coding Success through Math Intervention in an Elementary School in Rural Amish Country. |
| 18 | Islam, N., & Sheikh, G. S., & Fatima, R., & Alvi, F. J. (2019). | A Study of Difficulties of Students in Learning Programming. |
| 19 | Mason, S. L., & Rich, P. J. (2019). | Preparing Elementary School Teachers to Teach Computing, Coding, And Computational Thinking. |
| 20 | Chalmers, C. (2018). | Robotics And Computational Thinking in Primary School. |

**Finding and Discussion of Study**

There are many challenges that occur while learning programming for the primary school students. The findings from all the research articles involved, it can be concluded that the challenges can be categorized into cognitive, digital skills, meta-cognitive, programming language, and students' readiness to learn programming. Another factor that influences the difficulties of students in learning programming subjects in primary schools include inadequate infrastructure and resources such as internet connectivity, and shortages of ICT-friendly classrooms and outdated equipment.

The challenges that faced by primary school students when learning programming are primarily related to cognitive and metacognitive issues (Greifenstein et al., 2021). Cognitive issues are associated with a lack of digital literacy among young learners. Primary school

students might be cognitively overwhelmed and might have insufficient prior knowledge regarding digital literacy. According to Brannon and Novak (2019), the challenges faced by young learners while learning programming are that they are not familiar with the use of technology because they are still being newly introduced to the concepts of computer science and programming languages. Rafi et al (2019), reinforce this statement by stating that there are inadequate digital competences among the primary school students.

Greifenstein et al (2021), in the study pointed out that the most frequent cognitive issues of a lack of digital literacy are younger students find it challenging to grasp and implement many instructions in programming because they are often still learning fundamental computer skills like how to use a mouse. Conversely, some programming procedures and concepts are too abstract for young learners. The programming language and mediation language are two examples. Young learners will face difficulty in understanding the abstract during programming lessons. Gary et al (2017), highlighted that primary schools have indicated the following major concerns, such as the lack of coding interest of the students. The fact is, students in primary school are still weak in digital literacy. It is difficult for students to understand and execute many instructions in programming because they are still learning basic computer skills. Elsawah & Hill (2023), emphasized that it is vital for students to master the principles of computing at an early age before try to write the program.

Other than that, cognitive issues in the field of programming also related to the thinking skills. Programming education requires a lot of problem-solving skills. Napalit et al. (2023), recognized computer programming as a creative activity which promotes problem-solving and innovation related to algorithms. Saha and Thakur (2022), in their study mention that many of novice programming earners lack of problem-solving skill. Another research by Yagci (2016), explained that Higher Order Thinking Skills (HOTS) and problem-solving skills are the essential for computer programming and these elements pose significant challenges for young learners. In order to complete a programming task, students need to think critically and creatively. One needs to possess problem-solving skills because the ultimate goal of programming is to write the solutions to the task given (Olipas, 2022). He also added that in writing programs, one must think logically to solve the problem.

Muhamad Yusof et al (2021), in their research study highlighted that students' computational thinking skills are generally low. Lack of problem-solving skill and limited surface knowledge of programs is among the main factors that lead to difficulties in learning computer programming (Kadar et al., 2021). Furthermore, young learners also lack fully developed reasoning skills, logical thinking, and inferential skills. Olipas (2022), in his study found that students with a weak logic and problem-solving foundation may view programming as difficult task. Amanullah (2019), further notes that another challenge faced by young learners while learning programming is the lack of progression in skills even after many years of using block-based programming languages.

There are previous studies that focus on the issue of students' ability to master programming and students' attitudes towards programming. In terms of the ability of children's minds to master programming, Attard and Busuttil (2020), stated that programming is a skill that is difficult for young students to understand. The main reason identified in previous studies is that students lack problem-solving skills (Apiola & Tedre, 2012), and

computational thinking training. These two skills are crucial to learn and understand the concept of programming language (Chetty & Barlow-Jones, 2014). Children's minds are not yet capable of understanding and using complex programming languages well. Gerjak (2017) also pointed out that many students struggle to learn programming languages. In terms of students' attitudes when learning programming, the study of Robins et al. (2003) identified the important role of students' attitudes in facing programming problem. There are students who persistently try to work through programming problems. But there are also students who quickly give up when face with complex programming languages. Napalit et al. (2023), highlighted that it is hard to maintain motivate and perseverance especially for those who find this subject is difficult.

Next challenge is metacognitive. Metacognitive challenge significantly affects primary school students while learning programming, which include the gaps in student knowledge and the relatively short attention span of young learners. The use of digital media is also linked to metacognitive challenges. Greifenstein et al (2021), stated that students are easily distracted when given new and interesting tools to play with. Children easily lose focus because they are too excited and eager to know about the newly introduced programming tool. As we know, it is common that young learners cannot stay focused to learn for a long time especially when they lack interest or are overexcited about new things introduced to them.

For primary school level, mostly they are introduced to programming which using block-based tools. Sırakaya (2018), points out that block-based programming is an application that children enjoy using it because it has an easy interface which using a more suitable method for children's level such as drag and drop instead of writing code that can led to errors due to syntax. Programming block-based tools used such as Scratch is similar to playing games like Roblock and Minecraft which they are familiar with. This situation will make the students overexcited and distracted as they consider that they have ‘new games’ to play with.

As a result, they will neglect teachers’ explanation and instruction about the programming task because they are too busy exploring ‘new games. Sometimes, young learners are eager to explore new knowledge without noticing that they are off track. They have short attention span. Greifenstein et al (2021), emphasize that maintaining focus among children is a struggle because they are frequently side-tracked when given an engaging new tool to experiment with. Therefore, to ensure that they remain focused and complete the assigned programming tasks is a challenge.

In addition, the challenge faced by primary school students is the student’s readiness to learn programming in early education. Basic programming helps develop and exercise young learners’ general and higher-order thinking skills such as problem decomposition, analysis, and evaluation, which are critical to problem-solving (Elena et al., 2021). However, Napalit et al (2023), highlighted that students’ diverse background and level of prior programming knowledge among students can lead to vary their level of readiness to learn. Singh (2022), support this by stated that the students’ learning challenges is related to students’ prior knowledge. Furthermore, Landman et al (2022), mentioned that there is a heterogeneity in prior education and programming knowledge among students. Some students have some programming experience. While, the others know nothing about it.

As programming education is newly introduced into curriculum started in 2016, students find it difficult to understand the programming language. Muhamad Yusof et al. (2021), in their study found that most young students find the programming language difficult to understand. Islam et al (2019), also found that students having issues in understanding filing, pointers, understanding syntax or debugging. It was also found that students who struggle with writing algorithms also have issues with filing. Furthermore, Gary et al. (2015) supports this statement by stated that learning different syntax of programming tools may be difficult for students, especially at their young age. The challenges encountered by primary students include difficulties relating to the program's syntax, errors and debugging processes; lesson-related; algorithm, analysis, resources, teaching, time-management, and personal factors (Olipas, 2022). This difficulty faced by the students will make them unmotivated to learn programming.

The next challenge is the availability of facilities and resources. It is important to have appropriate facilities to support the implementation of programming teaching and learning at primary school level. In order to learn programming effectively, students need a computer, an internet connection, reference materials and even a complete set of robotics programming. Ineffective programming teaching and learning sessions can also be impacted by limited access to facilities and equipment. Arslan (2022), mentioned that some of the schools did not have sufficient conditions to provide this education due to reasons such as teachers, internet and equipment inadequacy.

Renumol et al (2010), highlighted that the essential resources needed by novice students to learn programming are classroom instruction, computer lab training sessions, and learning resource textbooks. However, Abassi et al (2021), noted that there are inadequate programming facilities in school. This challenge echoed by Ray (2021), stated that inadequate equipment and material at school. He found that some pointed out the lack of a broader discussion regarding a more holistic perspective on the implementation of programming in primary school. Furthermore, Agnello (2019), in his study reported that many rural schools lack modern hardware and software. This situation extremely challenged them to keep up with the computer programming curriculum. This situation may lead to inequality in education.

In addition, the lack of resources such as technical equipment at primary schools was also raised as a challenge. Muhamad Yusof et al (2021), in his study also stated that limited access to programming equipment is another barrier in implementing effective robotics programming learning sessions. Mason and Rich (2019), also mention that physical barriers such as a lack of computers or reliable Internet access will hinder programming learning session. Teaching aids and supportive materials are very important in delivering programming content effectively. Teachers struggle to deliver the programming content appropriately without adequate resources. Adequate resources used during programming lessons can attract young learners to engage to the lesson and help them to understand the content easily.

However, the high cost of robotic kits makes it difficult to supply for all students (Muhamad Yusof et al., 2021). This challenge echoed by Greifenstein et al (2021), which stated that the school faces the issue of financial constraints to provide robotic sets to students

because the expensive price is exceed the money allocation given. Consequently, in certain schools, students must share the robot kits which led to limit students' hands-on experience. Whereas, in this learning area, hands-on learning experience is very necessary to ensure effective learning is carried out. Luisa et al (2021), also mentioned about the challenges with school funding, particularly concerning resources' accessibility need to be overcome if we aim for a successful programming education in primary school.

To teach robotics programming, physical robots are preferable because they offer more engaging and enjoyable real-world experiences. Physical robots have a greater positive effect on students in this study area. According to Greifenstein et al (2021), due to the lack of teaching aids such as robotic sets and appropriate modules, it causing students can only learn programming trough simulation or virtual robots. As a result of limited learning resources, students only can learn programming theory and robotics by watching online videos. This kind of learning session will make it difficult for students to understand the concepts and how to program properly. It can hinder grasp of programming concept and practical skill. Tengler et al. (2020) stated that coding and robotics with the help of tangible robots contributes to the development of skills such as creativity, communication and problem-solving ability.

The finding from Muhamad Yusof et al (2021), study highlighted that some students find learning robotics programming difficult in the absence of a robotics kit. Practical programming learning using robotics kit can improve student understanding and motivation. Chalmers (2018), in his study found that many of the studies included educational robotics kits such as the KIWI robotics kit, WeDo 2.0 kit, M-bot, and Ozobot kits can kept students engaged and excited about learning Ali et al (2018), further supported this, discovered that according to the majority of teachers, students showed high interest in learning programming activities conducted by teachers if there's sufficient equipment available. However, if there are no supplementary teaching tools, such as robotics kits, some students believe that programming for robots is still challenging.

**Limitation and Recommendation for Future Study**

The implementation of programming education in primary schools is still in its early stages, and there is a lack of research in this area (Elsawah & Hill,2023). Despite the challenging nature of programming course, there is lack of studies that analyse about the actual challenges that students face during learning programming. There are not much recent studies reported regarding the topic area; programming in primary school level which discuss about the challenges faced by the young learners. However, there are numerous studies regarding the challenges faced by teacher in teaching programming. The proposed study to be carried out in the future is that the researcher can conduct an empirical studies investigating programming challenges faced by elementary school students.

**Conclusion**

In conclusion, based on this SLR study found that challenges experience by primary school during learning programming are multifaceted and can be categorise into several key point which are cognitive, metacognitive, digital skill, comprehension of programming language and students' readiness. Inadequate of basic computer skills and digital literacy are the main cause of cognitive challenge to young programming learners. This situation will make students difficult to grasp the abstract of programming concept and engage in problem-solving. The

difficulties occur by different level of students' programming knowledge and skill can cause lack of confidence and interesting among the young learners. Metacognitive challenge also plays a significant role. Primary school students often struggling to keep focus when new tools newly introduced. They are easy to be distracted. In addition, the readiness of students to learn programming differs greatly depend on their varied programming knowledge and skill. Other than that, limitation of infrastructure and resources also can make the programming challenge issue among primary school students become worse. Many schools lack sufficient infrastructure and resources. This shortage hinders hand-on learning which is important to programming students to experience while learning this skill. Hands-on experience can help students understand programming concept and catch students' attention and interest. Overall, addressing all these challenges need attention from all the related stakeholders. To achieve the objectives of learning programming skill, young learners need to improving digital literacy, infrastructure need to be upgraded, and learning resources must be provided adequately. It is hoped that this study will assist computer science educators to improve their teaching approaches for basic programming courses, enhance students' interest and increase students' performance in programming subjects.

**Contribution**

This SLR study offers both theoretical and contextual contribution which can help us to improve understanding of programming education specifically for primary school level. The study provides a systematic framework for educators and researchers to address specific challenges faced by primary school students while learning programming. The challenges categorize into cognitive, metacognitive, digital skills, programming language difficulties and students' readiness. In line with theories of cognitive development, the framework deepen insight into cognitive and metacognitive issues emphasising the need for tailored instructional strategies that can suit the level of young learners in programming. Furthermore, this SLR study also emphasis on the problem-solving skills and computational thinking skills as both of thinking skills is the fundamental competency needed to be master by students in the 21$^{st}$ century. Contextually, the study also highlights the important of digital literacy to be mastered before learning programming; which has significant implication for curriculum development. This insight can guide the policymakers and programming teachers developing age-appropriate curriculum which take into consideration about students' different level of readiness. Additionally, the study revealed the necessity for improving school funding and resources allocation. The aim is to reduce education inequality; particularly schools in rural area. Overall, this study contributes significantly to improve the primary programming education.

**Acknowledgement**

This study did not receive support from any public, commercial, or not-for-profit sectors. Appreciation goes to all quarters who contributed directly and indirectly to make the publication of this article possible.

**References**

Abbasi, W. T., Ibrahim, A. H., & Ali, F. B. (2021). Perceptions About English as Second Language Teachers' Technology Based English Language Teaching in Pakistan: Attitudes, Uses of Technology and Challenges. *Proceeding of International Conference on Emerging Technologies and Intelligent System*, 314-325. http://doi.org/10.1007/978-3-030-82616-1_28

Adıgüzel, S., Eryılmaz, S., Gencer, T. & Göksu H. (2023). Coding activities in IT courses through the lenses of IT teachers. *Journal of Educational Technology & Online Learning*, 6(2), 384-402. http://dergipark.org.tr/jetol

Amanullah, K. (2019). Teaching Programming to School Children using Elementary Patterns. *2019 IEEE Frontiers in Education Conference*, 1-2. https://www.doi.org/10.1109/FIE43999.2019.9028653

Apeanti, O. W., & Essel, D. (2021). Learning Computer Programming Using Project-Based Collaborative Learning: Students' Experiences, Challenges, and Outcomes. *International Journal for Innovation Education and Research,* 9(8). http://dx.doi.org/10.31686/ijier.vol9.iss8.3278

Arslan, S. and Çelik, Y. (2022). Primary School Teachers' and Students' View about Robotic Coding Course. *African Educational Research Journal,* 10(2), 178-189. https://files.eric.ed.gov/fulltext/EJ1349353.pdf

Attard, L., & Busuttil, L. (2020). Teacher Perspectives on Introducing Programming Constructs through Coding Mobile-Based Games to Secondary School Students. Journal of *Informatics in Education*. 19(4), 543-568. https://doi.org/10.15388/infedu.2020.24

Badrulhisham, A., Mat Johar, M. H. & A. Rashid, T. (2019). Mendepani Cabaran Revolusi Industri 4.0 (IR4.0) Dalam Konteks Mahasiswa: Analisis Menurut Perspektif Islam. *Journal of Ilmi,* 9, 90-101. https://www.unimel.edu.my/journal/index.php/JILMI/article/view/620/504

Bakari, A. D. & Ali, M. (2023). Introduction of ICT subject in Zanzibar primary education: Challenges and opportunities. *Social Science & Humanities Open*, 8(1). http://doi.org/10.1016/j.ssaho.2023.100522

Brannon, M. & Novak, E. (2019). Coding Success through Math Intervention in an Elementary School in Rural Amish Country. *Journal of Computer Science Integration*, 2(2). https://doi.org/10.26716/JCSI.2019.02.2.1

Chalmers, C. (2018). Robotics And Computational Thinking in Primary School. *International Journal of Child-Computer Interaction,* 17, 93-100. https://doi.org/10.1016/j.ijcci.2018.06.005

Elsawah, W. & Hill, C. (2023). Barriers to Programming Education in UAE Primary Schools: A Qualitative Review from ICT Teachers' Perspectives. *Discover Education Journal,* 2 (20). http://doi.org/10.1007/s44217-023-00043-0

European Schoolnet (2015). Computing our Future: Computer Programming and Coding. http://www.eun.org/documents/411753/817341/Computing+our+future_final_2015.pdf/d3780a64-1081-4488-8549-6033200e3c03

Gary, W., Ho, C. & John, H. (2015). School Perceptions of Coding Education in K-12: A Large-Scale Quantitative Study to Inform Innovative Practices. *IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE),* 5-10. https://www.researchgate.net/publication/304295837

Greifenstein, L., Graßl, I., & Fraser, G. (2021). Challenging but Full of Opportunities: Teachers' Perspectives on Programming in Primary Schools. *21st Koli Calling International*

*Conference on Computing Education Research*, 10, 1-10. https://doi.org/10.1145/3488042.3488048

Heintz, F., Mannila, L., and Färnqvist, T. (2016). A Review of Models for Introducing Computational Thinking, Computer Science and Computing in K–12 Education. *IEEE Frontiers in Education Conference (FIE) 2016: The Crossroads of Engineering and Business*, 1-9. https://www.ida.liu.se/divisions/aiics/publications/FIE-2016-Review-Models-Introducing.pdf

Husain, N. M. (2017). Model Kompetensi Guru Pengaturcaraan Berasaskan Sistem Pendidikan di Malaysia (IR). Tesis Kedoktoran. Universiti Pendidikan Sultan Idris. https://ir.upsi.edu.my/detailsg.php?det=3883

Islam, N., & Sheikh, G. S., & Fatima, R., & Alvi, F. J. (2019). A Study of Difficulties of Students in Learning Programming, *Journal of Education & Social Sciences*, 7(2), 38-46. https://doi.org/10.20547/jess0721907203

Kadar, R., Wahab, N. A., Othman, J., Shamsuddin, M., & Mahlan, S. B. (2021). A Study of Difficulties in Teaching and Learning Programming: A Systematic Literature Review. *International Journal of Academic Research in Progressive Education and Development,* 10(3), 591–605. http://dx.doi.org/10.6007/IJARPED/v10-i3/11100

Kibirige, I. (2023). Primary Teachers' Challenges in Implementing ICT in Science, Technology, Engineering, and Mathematics (STEM) in the Post-Pandemic Era in Uganda. *International Open Access Week,* 13(4). https://www.doi.org/10.3390/educsci13040382

Kong, R., & Wong, G. K. W. (2017). Teachers' Perception of Professional Development In Coding Education. *2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE).* https://www.doi.org/10.1109/TALE.2017.8252365

Lai, W. S., & Aziz, N. (2019). Persepsi Pelajar Terhadap Kebolehpasaran Graduan dalam Era Revolusi Perindustrian 4.0. *Jurnal Personalia Pelajar*, 22(2), 121-127. https://www.ukm.my/personalia/wp-content/uploads/2019/12/Artikel_2_Dr-Lai-Wei-Sieng_FEP.pdf

Landman, M., Futschek, G., Unkovic, S. & Voboril, F. (2022). Initial Learning of Textual Programming at School: Evolution of Outreach Activities. *Olympiads in Informatics*, 16. 43-53. http://dx.doi.org/10.15388/ioi.2022.05

Macrides, E., Miliou, O., & Angeli, C. (2021). Programming In Early Childhood Education: A Systematic Review. *International Journal of Child-Computer Interaction,* 32, 1-58. https://doi.org/10.1016/j.ijcci.2021.100396

Mannova, B. (2022). Teaching Coding in School. *14th International Conference on Education and New Learning Technologies.* https://doi.org/10.21125/edulearn.2022.1399

Yusof, M., Ab Jalil, H., & Perumal, T. (2021). Exploring Teachers' Practices in Teaching Robotics Programming in Primary School. *Asian Social Science,* 17(11). https://doi.org/10.5539/ass.v17n11p122

Napalit, F., Tanyag, B., So, C. L., Sy, C., & San Pedro, J. R. (2023). Examining Student Experiences: Challenges And Perception In Computer Programming. *International Journal of Research Studies in Education,* 12(8), 101-112. http://dx.doi.org/10.5861/ijrse.2023.71

Olipas, C. N. (2022). A Phenomenological Study on the Feelings, Challenges and Difficulties Experienced by Information Technology Students in Learning Computer Programming.

*Path of Science: International Electronic Scientific Journal*, 8(7). http://dx.doi.org/10.22178/pos.83-3

Predrag, O. (2021). Prospective Teachers' Opinion on Computer Programming in Primary Education. *13th International Conference on Education and New Learning Technologies.* https://www.researchgate.net/publication/353212865

Rafi, M., Jianming, Z., And Ahmad, K. (2019). Technology Integration For Students' Information And Digital Literacy Education In Academic Libraries. *Inf. Discov. Deli,* 47, 203–217. https://doi.org/10.1108/IDD-07-2019-0049

Sáez-López, J. M., Román-González, M., & Vázquez-Cano, E. (2016). Visual Programming Languages Integrated Across The Curriculum In Elementary School: A Two Years Case Study Using "Scratch" In Five Schools. *Computers and Education*, *97*, 129-141. https://doi.org/10.1016/j.compedu.2016.03.003

Saha, B. & Thakur, M. G. S. (2022). Learning To Program: Hurdles and Remedies. *SSRN.* https://ssrn.com/abstract=4213000 or http://dx.doi.org/10.2139/ssrn.4213000

Tengler, K., Kastner-Hauler, O., & Sabitzer, B. (2020). Programming in Primary Schools-Challenges & Opportunities. Proceedings of ICERI2020 Conference, 7556-7563. https://www.researchgate.net/publication/346096621