

Computer Programming Language as Tool for Developing Primary School Pupils' Academic and Thinking Skills

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Abstract

The role of computer programming in today's society cannot be over-emphasized due to its role in ensuring that learners acquire the needed skills to function and become educated citizens of society and in the development of individuals' cognitive ability. This paper seeks to define the term programming and its importance, the main body of the paper brings together existing research outcomes about the learning and importance of the acquisition of computer programming skills at the early age of learners. In doing so, it identifies the needs and the importance of the inclusion of computer programming language in the school curriculum, especially at the primary school level which is the foundation stage of a child's education. The Piagetian constructivism theory serves as the basis for this study as it explained how children learn and construct their knowledge in their foundational years which is important to the learning of programming in the early years of learners. The paper concludes by drawing a summary of the importance and needs to include computer programming language in the primary school ICT curriculum as learning computer programming tends to support cognitive development among learners.

Keywords: ICT, Programming, Computer Programming Language, Curriculum, Computational skill

Introduction

The rapid spate of knowledge explosion in global society has resonated with the call for technological innovation in the present society. As a result, primary school curricula around the world are being redesigned to provide learners with an insight into essential knowledge, skills, and competence needed to function and become educated citizens of society (Kalelioglu, 2015; Rich, Browning, Perkins, Shoop, Yoshikawa, & Belikov, 2019). These new curricula are designed to expose students to the best ideas and arguments ever put forth and to foster an appreciation of human ingenuity and accomplishment. Through this development, our society has become increasingly digital and interconnected. While technological transformation is growing at an accelerated pace, technology and innovation have become massive drivers of both social and economic change. With these changes, younger people who are not prepared technologically for the future are left behind in the swirl of already disadvantaged people and communities with less access and the ability to reap digital dividends. Learning computer programming is fast becoming a mandatory concept in the primary school curricula in some developed worlds (Falloon 2016; Sáez-López, Román-González, & Vázquez-Cano, 2016; Rich, Browning, Perkins, Shoop, Yoshikawa & Belikov, 2019). This implies that as part of 21st-century skills, computer programming should be introduced to learners at a tender age. According to Kalelioglu (2015), there is a rising desire for educational programs to change to include teaching computer programming language to young learners because children are raised in a technologically advanced society where new technological abilities must be quickly adopted. As a result, there are discussions and arguments in favor of teaching young children to program, and such materials are readily available online (Duncan, Bell & Tanimoto, 2014). Teachers and learners, could by this latest trend entreated to acquire programming skills to allow them to fit well into the current learning space. Although there are discussions regarding the role of programming for everyone (Olusola, Bahago, & Ogunmodede, 2021; Ebimomi, 2020; Sáez-López, Román-González, & Vázquez-Cano, 2016) irrespective of age, gender, and ethnic background. With evidence of the importance of programming in the development of individual pupils' cognitive abilities.

Computer programming is an actively highlighted area in education worldwide (Fessakis, Gouli & Mavroudi 2014; Ebimomi, 2020). This has spurred researchers, policymakers, and educators to see programming as an important

skill and form the basis of its inclusion in the curriculum of younger learners. This implies that pupils would acquire digital competence as a result of their engagement in programming activities (Regeringen, 2017; Sáez-López et al., 2016). While a computer programming language has traditionally been studied primarily in higher education and has been taught at that level for decades, nothing has been done to support the learning of younger students. According to scholars (Kalelioglu 2015; Rich, Browning, Perkins, Shoop, Yoshikawa & Belikov, 2019), programming is a crucial skill that all learner and worker categories across a wide range of businesses and professions must master in order to survive in modern society. Needless to say that the role of programming in shaping learners' minds and building their competence is beyond mere coding and arithmetic but also entails the rudiments of computational thinking and logical reasoning which represents one of the core skills of today often regarded as “21st-century skills”.

The rudiment of programming is best learned at the primary level of education, being the first step in compulsory universal education that is aimed at providing learners with basic skills that are necessary for problem-solving and societal social norms. Among the anticipated skills to be provided to learners at the primary school level are communication, problem-solving, decision-making, self-management, cooperation and teamwork, leadership, and entertainment (Ministry of National Education, 2006). Interestingly, all these skills could be enhanced when learners are exposed to programming in their early years. Today, programming is at the heart of most digital solutions, software, and systems used in practically all areas of specialization. To fully fathom the digital world, there is a need for one to possess a basic idea about the concept of computer programming. Programming is defined as a method for developing new ideas, resolving issues, and implementing them. Programming is described by Skolverket (2017) as a problem-solving method. In his opinion, programming should be viewed from a wide angle that includes imagination and simulations. Similarly, it was noted in the works of Fessakis, Gouli, and Mavroudi (2013) as cited in Ebimomi (2020) that programming demands higher-order thinking, algorithmic, and problem-solving skills, which might provide kids with an exceptional way to build their social and mathematics skills. However, it has long been believed that learning programming helps students become more adept at solving problems and developing algorithms. Fessakis, Gouli, and Mavroudi (2014), on the other hand, stressed that learning programming skills is vital for the improvement of high-order thinking because these skills are increasingly seen as essential life skills due to the increasing availability of fresh information and ideas via the internet.

According to Duncan, Bell, and Tanimoto (2014), teaching computer studies to young pupils is widely recommended in order to help them comprehend the fundamentals of computer programming and the general benefits of computational thinking (CT), which are useful skills for all careers. In a similar vein, they suggested that a long-term solution to the "skills gap" between the amount of technology-based employment in the modern world and the number of people who are qualified to fill such jobs would be the teaching and learning of programming, especially for children. Given this, the developing programming skills and competence of pupils at the primary school level have become important skills to teach learners. This would play directly into the recent complaints of industries that Nigerian graduates are not qualified to fill vacancies in recent times an indicator that the current school curriculum does not adequately tackle the rising cases of graduate unemployment. This has led to the Federal Government of Nigeria adopting a National Information Communication Technology (ICT) policy that aims to provide frameworks for the ICT sector that would streamline it and improve its capacity to catalyze and sustain socioeconomic developments that are essential to Nigeria's vision of becoming a top economy country (Federal Ministry of Education, 2019). This strategy would make it easier for Nigeria to transition to a knowledge-based economy. As such, developing a working curriculum to achieve this lofty goal has become sacrosanct for the attainment and enhancement of sustainable development, global competitiveness, and individual's ability to survive in a contemporary environment.

The integration of programming to curricula today means that new content would be taught by most teachers since it is a fundamental literacy ability in the digital age that has not previously been included in early-age education. It's interesting that research on the idea of teaching and learning programming in schools has historically been done at the university level (Heintz, Mannila, & Färnqvist, 2016), whereas there hasn't been much written on using programming to teach thinking skills in primary schools (Lye & Koh, 2014). It is noteworthy to highlight the challenges facing the teaching and learning of programming, a subset of computer studies and Information Technology (IT) curriculum in Nigeria. These challenges include a lack of ICT personnel, poor attitude of teachers, lack of adequate teaching materials, and obsolete curriculum. Therefore, the proposed new curriculum is expected to expose younger learners to core digital literacy skills. This would teach students how to write code, how to build small programs from

scratch, rather than only how to use a computer and, by extension, how a computer operates.

It has been argued that exposing pupils to programming in their early years indirectly encourages them to become developers, it encourages them to become creative, become articulate, and think logically. With this, learners think about breaking down what is happening, and start predicting what is going to happen. Through programming exercises, learners at this level are anticipated to acquire computational thinking, especially in mathematics, which is believed to be based on both established experience and scientific principles that have the potential to change the world (Wing-Kostner, 2012). Shute, Ventura, and Ke (2015) observed that children like participating in educational activities and have possibilities to develop mathematical ideas, problem-solving skills, and social skills through learning in a game-based environment. This is because playing is considered as fun. This further implies that happy student's study more and harder, and they are more willing to develop their ideas (Fessakis, Gouli and Mavroudi, 2013). However, the majority of kids appear to gravitate toward gaming in their daily lives. According to research, playing video games and programming have positive impacts on students' visual-spatial abilities, concentration, openness to new things, perseverance, creativity, and civic involvement. Maloney, Peppler, Kafai, Resnick, and Rush (2008) observed the children as they used Scratch to recognize the need to increase learners' participation in computing (a visual, game-like programming language that is designed to facilitate learning). Therefore, it is appropriate to state that digital media, which includes digital games, is where children's interest in technology begins. Digital media may also offer a more promising route for children to acquire and develop the necessary skills and competence in programming.

Why is Computer Programming Important?

Computer programming consists of step-by-step instructions for the computer. It is regarded as a must-have skill in the 21st century. In the digital age, programming is a necessary sort of literacy (Kong & Wang, 2021). It is a branch of computer science that entails the development and coding of procedures that enable a computer to solve a problem (Israel, Pearson, Tapia, Wherfel, & Reese, 2015). In recent years, programming has grown in significance as a component of education. According to research (Brackmann, Rom'an-Gonz'alez, Robles, Moreno-Leon, Casali, & Barone, 2017; Zhang & Nouri, 2019), it promotes pupils' cognitive growth. The necessity of including programming in the curricula of primary schools is now the focus of discussion. Computer programming, according to Manches and Plowman (2017), tends to support the development of a variety of skills, making it equally as significant as traditional reading and writing (Turan & Aydodu 2020). According to recent research, students develop other abilities including critical thinking, social skills, problem-solving, and self-management while learning to code (Popat & Starkey 2019; Chao 2016; Scherer, Siddiq & Sanchez 2018), preparing them to use these skills in an information society. In today's digital age, it is imperative to develop tech-savvy students and give them an excellent education that will enable them to function and operate in a technologically advanced society (Wakl, Khdr, Sabr, & Nawzad, 2019; Ebimomi, 2020; Shorena & David, 2020). This knowledge could best be acquired when learners are introduced to the rudiments of computer programming in their elementary years. In today's society, programming is introduced as a critical skill for 21st-century learners and has become a key component of many curricula around the world, even in primary schools. Though in the past, it was assumed that computer programming language should be learned by special and talented learners with critical and logical minds, programming is now introduced as a critical skill for 21st-century learners (Akinyemi, 2013; Sterling, 2016). But then, the fundamental question has been what the benefit of teaching programming language to children. Why is computer programming important? Starting with the advantages of programming, scholars Wakıl, Khdir, Sabır, & Nawzad (2019) in their research opined that learning programming among others would help improve learners' problem-solving skills, improve learners' communication skills, and logical thinking skills.

According to (Ebimomi, 2020; Akinyemi, Ogundipe & Adelana, 2021), a programming language is described as set of rules given to the computer to perform a specific task. Thus, a computer programming language can also be described as the process of writing a program that a computer can execute to produce the expected or desired result. Computer programming known for its complexity and difficulty has in recent years been adopted in elementary schools in many countries but has yet to be fully immersed in the Nigerian primary school curriculum. According to recent studies, computer studies are compulsory and have become an important part of the educational process in Nigeria (Duncan, Bell, & Tanimoto 2014; Ebimomi, 2020; Shorena & David 2020; Olusola, Bahago & Ogunmodede, 2021). This would support students in developing their capacity to traverse or engage with digital technology as well as their

ability to construct, recreate, and innovate some of the contemporary applications.

From the foregoing, it can be seen that programming fosters creativity in kids and increases their self-esteem. As a result, programming is one of the most crucial talents that must be mastered, according to Maloney, Resnik, Rusk, and Silverman (2012). Programming provides numerous advantages, such as helping to learn some mathematical abilities for offering a solution to issues, which can be utilized in many industries. Al-Rashidi, Al-Rashidi, and Al-Maamari (2015) agreed that some programming languages help to teach earlier grades pupils the principles of programming in a fast and enjoyable way while giving learners great ease in the creation of interactive stories, entertaining games, in addition to helping them to visualize abstract concepts to their understanding (Wakil, et al. 2019, Tyker, 2017). Despite this, there are few research reports on computing and coding practices in earlier years in schools, this is because it is believed that these practices are less important for students.

Experts and educators also acknowledge the advantages of programming for students of all ages. They held the opinion that programming has a significant role in driving innovations and success in other spheres of life (Sande & Sande 2014). It is considered that computer programming is a potent learning tool, particularly for young learners. As a result, they thought that students who program would apply their programming skills to other fields. Consequently, Dan Shapiro, Robot Turtles inventor in (Gardner, 2014) opined that:

“Being able to program will make children better at whatever they do... irrespective of what they do, programming unlocks their potentials, helps them express themselves, and helps them become more successful in anything they decide to do in the future”.

Considering programming as an important and valued 21st-century skill for improving mathematical and thinking skills in learners, it is a general opinion that programming is best learned early (Santos, Gomes, & Mendes, 2010; Tynker, 2017). This implies that age is not a barrier to learning programming, as no age is too early therefore, 'the earlier, the better to learn' provided that it is included in the national school curriculum at the primary school level. Therefore, researchers asserted that learning to code in a child's early years involves more than just developing a set of technical skills; it also involves developing a new kind of literacy and self-expression that learners need to succeed in the twenty-first century as well as a new way for them to organize and communicate their ideas (Abiodun & Lekan, 2020; Vico, Kim & Ko, 2017; Kanbul & Uzunboylu, 2017; Manches & Plowman, 2017; Resnick, 2017).

This paper is hinged on Jean Piaget's (1969) constructivism theory, the theory explained how children learn and construct their knowledge in their early years. The constructivist theory of Piaget examined how children learn, the process of learning, and the progression of learning from young children to adults. According to the hypothesis, kids actively create their own view of the world and actively look for answers to issues in their immediate surroundings. The approach acknowledges the value of kid-initiated activities as being necessary for meaningful learning, which forms a crucial part of their development. As part of the interaction between nature (genes) and nurture, Piaget held that children's thinking began to develop during infancy and that each new experience or challenge aided in the process (environmental influences, such as experience, materials, and opportunities). However, Piaget thought that before children could progress to the following set of ideas or concepts, they needed to have achieved a specific level in their development. Each phase develops from the previous one and entails the reconstruction or transformation of prior information. The sensorimotor stage (0–2), pre-operational stage (2–7), concrete operational stage (7–11), and formal operational stage (11–18), according to him, are all developmental stages that children go through. These levels therefore indicate children's cognitive abilities and learning order at various developmental stages. Each child's advancement through each stage is therefore based on their aptitude and the way that people and their environment interact with one another. According to this idea, constructivist learning as it relates to learning computer programming is a potent paradigm for enhancing students' enthusiasm in learning, creativity, and competency.

Researchers have found that some programming languages, such as text-based programming languages, are not thought to be developmentally appropriate for children between the ages of 5-7, which includes pre-readers (0–5) and emergent readers (6–7). This is in relation to constructivism-based learning (Sullivan & Bers, 2019; Pelánek & Effenberger, 2020). When given the right tools, however, children can learn computer programming at an early age, which could encourage play and lighten their cognitive load in a way that is attractive to them (Murcia, Pepper, Joubert, Cross, & Wilson., 2020). It's interesting to think that in the near future, children may use programming languages as playgrounds. Because kids are naturally interested learners who are eager to learn new things despite their short

attention spans and tendency to become tired soon. Robot programming could possibly begin at extremely early stages, according to Macrides, Miliou, and Angeli's (2022) proposal (at three years old). Piaget thought that children are motivated to investigate and master their surroundings from birth, to find joy in mastery, and to grow in confidence by doing. Given these developmental traits, it is therefore crucial, though perhaps difficult, to include programming languages in the curricula for young children (Bers, 2020).

Conclusion

The swift development of technology requires us to prepare adequate manpower that would be able to utilize technologies. Mastery of computational thinking and problem-solving skills are the capabilities that must be mastered to learn programming skills. Although, programming has become a new literacy in the 21st century that should be introduced and implemented in the primary school curriculum along with the current development of digital technology that has been inseparable from our society. The constructive development of young learners through learning computer programming tends to support cognitive development among novices and provide a robust environment for learning programming. These hopefully will help to increase learners' interest and motivate them to learn to program, contrary to the general perception that programming is difficult to learn and often designed for few brilliant ones.

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