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ASSESSMENT OF PROGRAMMING SKILLS POSSESSED BY UNDERGRADUATE COMPUTER SCIENCE EDUCATION STUDENTS

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ABSTRACT

Programming effectiveness is fundamental to computer science education students, as it directly enhances their ability to solve complex computational problems in the evolving technology trends. A survey research design was adopted in the study. The population consists of 998 students pursuing a degree in computer science education. A purposive sampling technique was used to obtain a sample of 250 students who participated in the study. The instrument for data collection was the Assessment of Programming Skills Questionnaire (APSQ). Experts in Computer Science Education ascertained the validity of APSQ. A reliability coefficient of 0.71 was obtained for APSQ using Cronbach's alpha. Data for the study were analyzed using descriptive statistics. The study's findings revealed, among other things, that the time allocated to practical classes and the teaching methods employed for programming courses are inadequate. Based on the findings of the study, programming class should be project-based. This will encourage undergraduate students to actively participate in writing program, and adequate time should be allocated to practical sessions in programming courses at various undergraduate study levels.

Keyword: Programming skills, Undergraduates, Computer Science Education

Introduction

A computer is defined as an electronic machine that accepts data through an input device, processes data internally through a central processing unit. Howie (2023) describes a computer as a programmable electronic machine used in storing, retrieving, and processing information. Computer science is the study of computers and computing, including their theoretical and algorithmic foundations, hardware and software, and their uses for processing information (Allen & Geneva, 2024). Computer science education as a course of study helps in developing essential skills for critical thinking and problem-solving ability, creative skill, analytical thinking, imaginative ability, and resilience in students. Computer programming is the backbone of computer science and is regarded as essential to undergraduate computer science education (Ullah *et al*., 2018).

Programming has been recognized as an important concept in computer science that

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requires the use of computational tools in problem solving (Einhorn, 2012; Grover & Pea, 2013; Yen *et al*., 2012). Learning programming is a prerequisite for becoming a computer scientist who is equipped with the necessary skills (Palumbo, 1990; Robins *et al*., 2003). Programmers use programming skills in planning and finding solutions to problems, syntactically correct instructions for execution, and consequent results (Deek, 1999; Brookshear, 2003; Ismal *et al*., 2010).

Despite the importance of programming skills to undergraduate computer science education students, studies have consistently linked poor conceptualization as one of the major causes of students' poor performance in programming (McCracken *et al*., 2001; Robins *et al.*, 2003; Lister *et al.*, 2004; De Raadt, 2007; Watson, *et al*, 2011; Hammond, 2017; Anthony, 2019; Paul *et al*, 2019; Eteng *et al*, 2022).

Objectives of the Study

Study assesses programming skills among undergraduate computer science education students and sought to determine the: -

i) Essential programming skills needed by undergraduate computer science education students.
ii) Problems encountered by undergraduate computer science education students in learning programming.

Research Questions

i) What are the essential programming skills needed by undergraduate computer science education students?

ii) What are the problems encountered by undergraduate computer science education students in learning programming?

Literature Review

Concept of Computer Programming

Programming is a complex, creative skill that requires a lot of specialized knowledge. To be able to write programs, a programmer needs to understand not only the grammar of a programming language and the notional machine used when executing it, but also common idioms and algorithms. Programming involves tasks such as: analysis, generating algorithms, profiling algorithms' accuracy and resource consumption, and the implementation of algorithms in a chosen programming language (commonly referred to as coding). Computer programming is defined as the process of writing instructions for a computer, application, or software (Zoe, 2023).

Computer Programming Skill

Computer programming skills are methods and processes that programmers utilize to provide computers with instructions on what actions to perform (Jamie, 2025). These instructions are written to solve problems or perform specific tasks. Therefore, anyone connected with programming needs to keep up with technological development, competency, and manipulative skills. Programming is used interchangeably with coding, generally resulting in a specific set of actions or the creation of a tangible result. Computer programmer skills often combine creativity with technical and analytical elements. In many ways, programming represents a perfect merging of art and science. As with many other

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fields, computer programmer skills can be grouped into hard and soft skills. Hard skills refer to measurable abilities that are developed over time through practice or study, the technical and analytical as shown in *Figure 1*. Soft skills, on the other hand, are abilities that enable people to fit into a working environment or work effectively with others.

Computer programmers need to have a wide range of skills to perform the many responsibilities of the position at the highest level of professionalism. The most effective programmers combine knowledge, aptitude, and technical capability with soft skills such as the ability to work as part of a team and to communicate well with others. Aspiring computer programmers need to be able to demonstrate these skills (Jamie, 2025).

Some of the skills required by a computer programmer is summarily depicted in *Figure 1*. In the figure, programming skills are categorized into three different groups: technical skills, analytical and problem-solving skills, and soft skills. The technical skill involves specific knowledge and abilities used to perform programming-related tasks, while the analytical skill enables programmers to think logically and solve complex problems efficiently (Grover & Pea, 2013), and finally, the soft skill are interpersonal and behavioral skills that enhance collaboration and productivity in professional settings (Mainga, Daniel, & Alamil, 2022).

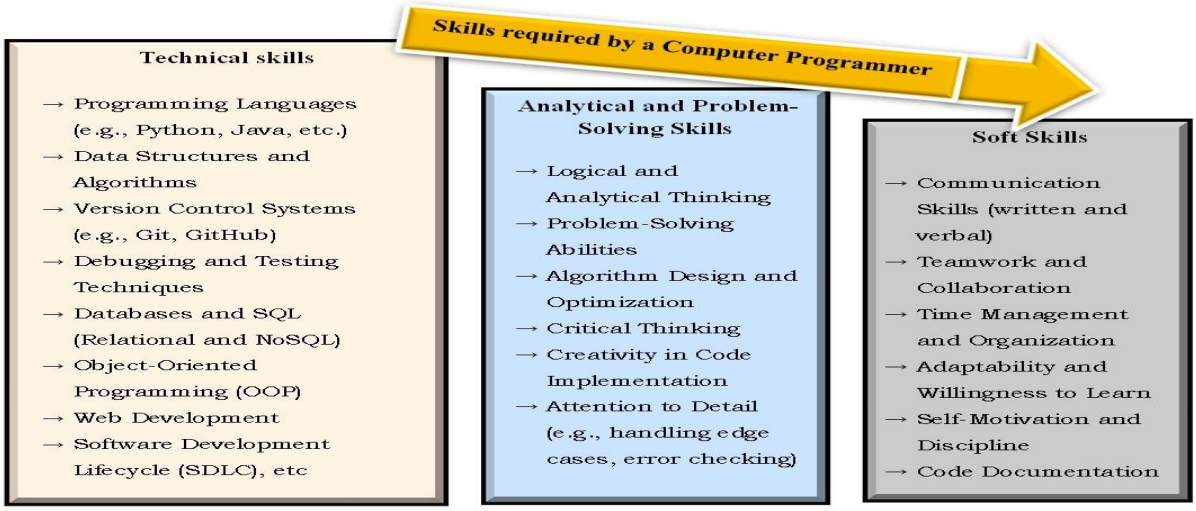


Fig. 1: Classification of Some Programming Skills Required by a Computer Programmer

Methods

The study adopted a descriptive survey design. The population consists of 998 undergraduate computer science education students at Abubakar Tafawa Balewa University, Bauchi. A purposive sampling technique was used to obtain a sample of 278 students who participated in the study. The instrument for data collection was a four Likert scale Assessment of Programming Skills Questionnaire (APSQ) consisting of twenty-eight (28) items on programming skills. Experts in computer science education

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ascertained the validity of APSQ. Reliability coefficient of the APSQ was obtained as 0.71 using Cronbach's alpha. Data for the study were analyzed using descriptive statistics of mean and standard deviation.

Decision Rule: acceptance mean value of 2.5 and above, signifying the respondent's agreement on an item, while a mean value below 2.5 portrays disagreement with the item.

Results

Research Question 1: What are the essential programming skills needed by undergraduate computer science education students?

Table 1: Mean and Standard Deviation on Essential Programming Skills Needed by Undergraduate Computer Science Education Students.

S/N	Items	Mean	Std.	Remark
1.	I am confident in my ability to write a complete program from scratch	2.35	1.07	Disagreed
2.	I am aware of various programming skills like database, web programming, mobile app, game programming, etc.	3.23	1.00	Agreed
3.	I am proficient with programming languages like C, C++, Java, Python, HTML, etc.	2.74	1.51	Agreed
4.	I am familiar with related programming syntax and semantics	2.58	1.04	Agreed
5.	I am proficient in debugging and troubleshooting my code	2.53	1.12	Agreed
6.	I can efficiently use algorithms to solve programming problems	2.53	1.12	Agreed

Key: Std – Standard Deviation

Table 1 shows the mean scores of students' responses on the essential programming skills required of them. It was observed that students agreed with five (5) items, as shown in the mean range of 2.53 to 3.23, which falls within the threshold of 2.50 and above on a given item. Indicating most students are aware of the essential programming skills required of them, such as debugging programs, familiarity with programming syntax, and semantics. However, the response on item 1 has a mean of 2.35, which falls below the acceptable mean range, indicating students in ability to complete a program. More so standard deviation for both agreed and disagreed items falls within the range of 1.00 to 1.51, depicting homogeneity in data dispersion.

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Research Question 2: What are the problems encountered by undergraduate computer science education students in learning programming?

Table 2: Mean and Standard Deviation on Problems Encountered by Undergraduate Computer Science Education Students in Learning Programming

S/N	Items	Mean	Std.	Remark
	Personal Challenges			
(1)	I find programming a difficult subject to understand	3.45	0.89	Agreed
(2)	I lack the motivation to improve my programming skills	2.94	1.16	Agreed
(3)	I experience anxiety/frustration when attempting programming problems	3.45	0.89	Agreed
(4)	I find it difficult to concentrate during programming lectures and assignments	3.09	1.02	Agreed
(5)	I am not confident in my programming abilities	3.52	0.84	Agreed
	Educational/instructional Challenges			
(6)	The programming assignments and tasks are too difficult	3.45	0.89	Agreed
(7)	The teaching approach adopted in programming makes the concept difficult to comprehend	3.09	1.02	Agreed
(8)	Time allocated for teaching programming courses is limited	3.52	0.84	Agreed
(9)	Practical sessions allotted to the programming course are not enough	3.52	0.84	Agreed
(10)	I do not have access to quality materials (e.g., textbooks, tutorials, etc.) for learning programming.	2.94	1.16	Agreed
	Technological/ Resource-Based Challenges			
(11)	I do not have access to a personal computer to practice programming outside the classroom	3.09	0.95	Agreed
(12)	I do not have access to online coding platforms to practice programming	2.85	1.09	Agreed
(13)	Internet connection within my university is unreliable, making it difficult to access online programming resources	3.52	0.84	Agreed
(14)	I lack access to the programming software/tools required for solving assignments and projects.	2.85	1.09	Agreed

Key: Std – Standard Deviation

Table 2 depicts some of the factors militating against the acquisition of programming skills among undergraduate computer science education students. The mean scores on all fourteen (14) items ranges from 2.85 to 3.52, which revealed the respondents' agreement with the items. The respondents concurred that personal, educational/instructional, and technological/resource-based challenges are some of the major clogs in the wheels of their progress in programming.

Discussions

Findings revealed that undergraduate computer science education students are knowledgeable of programming skills such as database, web programming, mobile application development, debugging, and troubleshooting programs. This result agrees with that of Islam *et al* (2024), who found an improvement in students' programming skills. Also, in line with Zhang *et al*. (2019) and Chen (2020), who reported poor instructional techniques as a major impediment to learning programming, the study revealed that personal, educational/instructional, and technological/resource-based challenges are factors impeding students' ability to learn programming skills.

Conclusion

The study reveals a wide range of undergraduate computer science education students' awareness of essential programming skills, with attributes such as instructional and technological being major challenges to programming. Students who have a basic understanding of programming are more critical in practical skills.

Recommendations

The study recommends the following: -

i) Programming class should be project-based to encourage undergraduate students in writing programs.

ii) Adequate time should be allocated to practical sessions in programming courses at various undergraduate study levels.

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