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LEARNING STEM IN AFRICAN SECONDARY SCHOOLS: BRIDGING GENDER INEQUALITY GAP AND LOCATION ON DIFFICULTIES CONCEPT

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Abstract
The new senior secondary computer studies curriculum for multilingual West African schools was introduced in 2015. Since its implementation, there have been limited studies on students' perceptions of its difficulty, gender equity, and geographical differences. This study aimed to investigate two primary objectives: (a) identifying topics within the curriculum perceived as challenging by secondary school students, and (b) examining how gender and school location influence these perceptions. The study included 1,501 computer studies students from nine public and 12 private senior secondary schools in Nigeria and Ghana, with approximately 51% female respondents. Three-quarters of the schools were located in urban areas, while the remainder were in rural settings. The top ten topics perceived as most difficult, in descending order, were: Flowcharting, Algorithms, Problem-solving skills, Program development cycle, Machine language, Computer Ethics and human issues, Logic circuits, Computer fundamentals and evolution, and Networking. The findings revealed slight gender differences and significant rural-urban disparities in perception. Recommendations were proposed to enhance the teaching and learning of computer studies in African schools, addressing these findings.

Keywords: Topic Difficulty, Computer Studies; Meaningful Learning, Gender

Introduction
Since the integration of information and communication technology (ICT) into the national secondary school curriculum in 1987, the subject remains limited to a subset of secondary schools in Nigeria. Although some private schools have introduced computer studies, the number of schools offering ICT is still disproportionate to the number of students. Many consider the subject irrelevant, resulting in negative attitudes toward it, while others find the topics difficult. No study has yet investigated the specific concepts students perceive as challenging in ICT. Statistics from the West Africa Examination Council (WAEC) show that from its inception until 2014, there was no enrolment for computer studies in Nigeria. In 2016, a state analysis of WAEC results indicated that about 3,000 candidates qualified for computer studies. Previous studies have debated the causes of low student performance in Nigerian secondary schools, attributing it to various factors such as poor study habits (Ayub et al., 2014), school environment (Chan & Fang, 2007), teacher competencies (Ayogu, 2008), parents' economic status and educational funding (Badiuzzaman, et al., 2021). However, these studies have not addressed the perceived difficulty of computer studies concepts taught in secondary schools. The significance of ICT literacy necessitates increased attention to computer/ICT education at all levels, especially in secondary schools in

Africa. Many schools lack standardized computer laboratories and instructional materials, and even those with facilities often do not fully utilize them.

The application of ICT knowledge is vital across all fields of science. It teaches students graphical design, problem-solving, and logical reasoning skills, which are valuable for their careers beyond the classroom. Furthermore, ICT can spark students' interest in technology, helping them become innovators, build skills, and design technical solutions to problems in science, mathematics, and other subjects. Researchers, governments, and educators worldwide increasingly recognize that ICT presents numerous opportunities for teaching and learning. The inadequacy of ICT facilities in classrooms disadvantages students, depriving them of the chance to acquire digital skills and attributes needed to bridge the digital divide and fully participate in an ICT-mediated globalized world (Badiuzzaman, et al., 2021).

In most secondary schools, students do not receive computer studies instruction with the same emphasis as other science subjects, which they consider more important. It is not compulsory for many students, and those who do take it often have only one lesson per week, exacerbated by a shortage of computer teachers. Students often find computer concepts difficult and boring due to a lack of practical experience and misunderstandings of some topics (Sanusi et al., 2022). Information and communications technology (ICT) is a transformational tool that integrates telecommunications, computers, middleware, software, storage, and audio-visual systems, enabling users to create, access, store, transmit, and manipulate information. ICT in education uses these technologies to support, enhance, and optimize the delivery of information. Research worldwide has shown that ICT can lead to improved student learning and better teaching methods. The influence of ICT on the global education sector has been profound, enhancing the effectiveness of teaching, learning, and research (Paudel, 2021). One reason for the shortage of computer studies/ICT teachers is that those qualified in the field often prefer to teach mathematics or other subjects. Additionally, many computer teachers receive predominantly theoretical training, with little emphasis on practical skills during their education (Aghadino, 2014).

This study aims to identify the difficult concepts in computer studies and the reasons for these difficulties. The consistently poor achievement of African senior secondary school students in computer studies concerns stakeholders, teachers, curriculum planners, and the government. Low registration for the subject, lack of student interest, and poor performance in computer examinations can be attributed to the difficulties students face with scientifically demanding tasks in certain topics during exams. The elective status of ICT, computer studies, or data processing in senior secondary schools is also a significant setback, especially in the digital age (Gbeleyi et al., 2022). Given these challenges, the future of ICT in Africa is at risk. There is an urgent need to address failures in computer science education/ICT to maximize benefits for the continent and the world. One primary goal of education is to promote meaningful learning, but numerous barriers impede this objective, including how the curriculum is delivered. Any effort to improve curriculum delivery is a welcome addition to enhancing the quality of education (Okebukola, 2019). This study is necessary to understand which computer study topics students find difficult and why. For this research, computer studies and ICT are considered synonymous, as the curriculum originally introduced the subject as computer studies before renaming it to ICT.

Perception of difficulties

Perception involves how an individual processes received information and expresses their thoughts and actions in response. It encompasses awareness of environmental elements through physical sensations, such as color perception. Thus, perception is not merely visual; it is a complex process where individuals selectively absorb stimuli from their surroundings, cognitively organize this input into a specific framework, and then use this organized information to assess their context. Since perception is a subjective process, different individuals may interpret the same situation differently.

Perception implies quick and often sympathetic discernment of subtle feelings (Gbeleyi, 2021).

The New Computer Studies Curriculum

We selected the computer studies curriculum for several reasons. Globally, computers are used every day and everywhere, solving problems in our daily activities and becoming a standard across many professions. Computers are relevant in fields ranging from education and medicine to banking and finance. Recent research shows that 90% of job opportunities require basic computer skills, such as data processing and proficiency with the Microsoft Office suite (Ranjan & Foropon, 2021). As technology continues to evolve, making our work easier and fitting into the workforce increasingly necessitates computer education in all schools. The major areas covered in the curriculum include Computer fundamentals and evolution; Computer hardware; Computer software; Basic computer operations; Computer applications; Machine language; Logic gates; Binary numbers; Managing computer files; Developing problem-solving skills; Information and communication technology; and Computer ethics and human issues (Gbeleyi & Potokri, 2022). The objectives of the syllabus are to test candidates' understanding, knowledge, and acquisition of basic computer concepts and operations. Additionally, it aims to assess manipulative, computational, and problem-solving skills; the application of software packages; the operation of computer-related simple devices; online skills and their applications; safe attitudes and good practices in the effective use of computers; and potential for higher studies in computer-related areas (Polat & Yilmaz, 2022).

In light of the above, this study has two main purposes – to find out (a) the topics in the new computer studies curriculum that secondary school students perceive to be difficult; and (b) to determine if gender, school location, and ownership impact students' perception of difficulty of the computer studies topics. The questions that the study sought answers to are:

1. What topics in the new computer studies curriculum do students find difficult to learn?
2. Are there statistically significant differences in students' (a) gender in (b) urban and rural schools; in their perception of difficulty of computer studies concepts?

Methods

A survey research design was adopted for the study. To achieve this, a self-developed instrument was used: the Difficult Concepts in Computer Studies Questionnaire which elicited students' responses on the subject. Two West African countries, Ghana and Nigeria, were selected for the study because both countries use the same WAEC computer studies syllabus, providing a common framework to identify concepts learners perceive as difficult. Participants in this study included 1,501 computer studies students from nine public and 12 private senior secondary schools in Nigeria and Ghana. Approximately 52% of the respondents were males. Three-quarters of the schools are in urban areas, with the remaining located in rural areas. Students from senior secondary school 1 (SS1) to senior secondary 3 (SS3) participated in the study to establish the difficult concepts perceived in ICT.

Data Collection

The questionnaire had five sections. Section A collected demographic data. Section B included 18 topics (see Table 1) drawn from the new computer studies syllabus used in all schools in Nigeria and Ghana. This section featured a three-point rating scale: very difficult, moderately difficult, and not difficult. Section C aimed to identify the factors influencing respondents' perceptions of the difficulty of the topics. This section listed reasons for the difficulties, derived from a pilot study, and used a four-point rating scale: strongly agree (SA), agree (A), disagree (D), and strongly disagree (SD). Section E gathered respondents' suggestions for improvement. The validation of the questionnaire was conducted by a team of 12 experts in science and technology education. Upon endorsement of validity, the test-retest reliability coefficient of the instrument, measured two weeks after administration, was found to be 0.87. IBM-SPSS Version 23 was used to analyze the data generated from the questionnaires.

After the initial raw analysis of the three-point scale (not difficult, moderately difficult, and very difficult) and the four-point scale (strongly agree, agree, disagree, and strongly disagree), data transformation was performed for simplicity, clustering responses into "difficult" or "not difficult" and "yes" or "no" categories (see Table 2).

In the data coding process, "not difficult" was scored as 1, "moderately difficult" as 2, and "very difficult" as 3. Each respondent's difficulty score ranged between 1 and 3. The mean rank method was used to answer the main research question of the study, which involved a two-step process. First, the difficulty scores of the respondents for each topic were summed and divided by the number of respondents to get the mean difficulty score for that topic. Second, the mean topic difficulty scores were rank-ordered for the 18 topics in the questionnaire. This ranking identified the topics from 1st (most difficult) to 18th (least difficult) as perceived by computer studies students in the sample. To address the second research question, the chi-square statistic was applied to the cross-tabulated data. The mean rank method was used to answer the main research question of the study. This involves a two-step process. The first step was the summing up of the difficulty score of each topic for the respondent divided by the number of respondents to get the mean difficulty score and the second step involved ranking the mean topic difficulty score in order from the 1st (most difficult of the 19th concepts) to the 19th (least difficult concepts) as perceived by computer studies student in the sample.

Findings

As shown in Table 1, students indicated varying levels of difficulty across the nineteen concepts taught in computer studies. The responses reveal that flowcharting, with a mean score of 2.12, is perceived as the most difficult concept. Algorithm, with a mean score of 2.07, is the second most difficult, while developing problem-solving skills ranks as the third most difficult, with a mean score of 2.00. Booting and telecommunication, both with a mean score of 1.53, are perceived as the 14th most difficult concepts. The least difficult concept was reported to be components of the computer system, with a mean score of 1.35. The logic gate was chosen for this study because the first to sixth topics had already been used in other studies for publication.

Table 1: Mean rank analysis on difficult concepts in ICT *(N- 1501)*

S/N	Topics	Mean score	Rank
1	Flowcharting	2.12	1st
2	Algorithm	2.07	2nd
3	Problem-solving skills	2.00	3rd
4	Program development cycle	1.96	4th
5	Machine language	1.91	5th
6	Computer Ethics and Human Issues	1.84	6th
7	Logic circuit	1.82	7th
8	Computer fundamentals and evolution	1.81	8th
9	Networking	1.77	9th
10	Arithmetic logic unit	1.74	10th
11	Managing computer files	1.73	11th
12	BASIC programming	1.65	12th
13	Computer applications	1.55	13th
14	Booting	1.53	14th
15	Telecommunication	1.53	14th
16	Basic computer operations	1.49	16th
17	Binary numbers	1.45	17th
18	Operating system	1.44	18th
19	Components of a computer system	1.35	19th

Discussion

This study investigated concepts in the computer studies/ICT curriculum that are perceived as difficult by African students. The top ten topics in order of perceived difficulty were found to be flowcharts; algorithms; problem-solving skills; problem development cycle; machine language; computer ethics and human issues; logic gates; computer evolutions; networking and arithmetic logic units. From the study components of a computer system were the least difficult; this is because the concepts have been taught right from primary school to junior school with little modification in the content. Gauging by a student who had graduated from university and claimed to have studied computer science with the inability to code due to poor performance and adequate knowledge in flowcharts and algorithms, this is a result of the inability to understand the concepts which leads to a skills deficit, emphasis should not only be laid on learners having credits in five subjects including mathematics and English language but also in ICT to build their programming skills, innovations as well as inventions (Ayogu, 2008).

Table 2: Cross Tabulation of Perception of Difficulty of Computer Studies by Students in Rural and Urban Areas

		Rural		**Urban**		
S/N	Topics	Difficult	Not difficult	Difficult	Not difficult	Chi-square
1	Flowcharting	73.2	26.8	77.2	22.8	7.97
2	Algorithm	72.8	27.2	74.9	25.1	5.28
3	Problem-solving skills	73.0	27.0	68.6	31.4	4.67
4	Program development cycle	68.2	31.8	71.6	28.4	6.55
5	Machine language	56.2	43.8	68.3	31.7	17.84*
6	Computer Ethics and Human Issues	51.0	37.1	61.8	38.2	5.94
7	Logic circuit	61.6	49.0	63.5	36.5	45.28*
8	Computer fundamentals and evolution	54.6	38.4	60.5	39.5	8.89
9	Networking	53.3	45.4	56.4	43.6	30.67*
10	Arithmetic logic unit	56.9	46.7	54.7	45.3	9.59
11	Managing computer files	56.9	43.1	55.6	44.4	7.36
12	BASIC programming	47.6	52.4	51.3	48.9	8.03
13	Computer applications	41.8	58.2	41.6	58.4	3.86
14	Booting	34.4	65.6	39.4	60.6	5.16
15	Telecommunication	38.2	61.8	40.8	59.2	5.65
16	Basic computer operations	37.4	62.6	40.4	59.6	3.91
17	Binary numbers	31.6	68.4	32.7	67.3	13.57
18	Operating system	31.2	68.8	35.5	64.5	5.66
19	Components of a computer system	28.6	71.4	27.2	72.8	7.93

* Significant at less than 0.05

The results confirmed that of the 19 topics, only three showed a significant difference in the location of respondents, which are machine language logic gates and networking while flowcharts remain the most difficult concepts for students in rural areas (73.2%) and urban areas (77.2%).

Table 3: Crosstabulation of Perception of Difficulty of Computer Studies Concepts by Male and Female Students

				Male		Female		
S/N	**Difficult Topics**	**Mean**	**Rank**	**Not Difficult**	**Difficult**	**Not Difficult**	**Difficult**	**Chi square**
1.	Flowcharting	2.12	1st	28.4	71.6	19.4	80.6	24.13*
2.	Algorithm	2.07	2nd	28.0	72.0	23.2	76.8	7.20
3.	Developing problem-solving skills	2.00	3rd	38.2	61.8	22.6	77.4	58.91*
4.	Program development cycle	1.96	4th	31.5	68.5	27.3	72.7	3.73
5.	Machine language	1.91	5th	35.5	64.5	34.3	65.4	7.81
6.	Computer ethics and human issues	1.84	6th	43.1	56.9	32.9	67.1	15.57*
7.	Logic circuit	1.82	7th	37.7	62.3	40.3	59.3	13.89
8.	Computer fundamentals and evolution	1.81	8th	47.9	52.1	30.6	69.4	40.18*
9.	Networking	1.77	9th	41.9	58.1	45.7	54.0	15.08
10.	Arithmetic logic unit	1.74	10th	47.1	52.9	44.3	55.7	11.08
11.	Managing computer files	1.73	11th	50.2	49.8	38.1	61.9	28.93*
12.	BASIC programming	1.65	12th	46.2	53.8	53.0	46.8	10.80
13.	Computer applications	1.55	13th	60.7	39.3	56.2	43.8	18.20*
14.	Booting	1.52	14th	59.3	40.2	58.7	40.3	9.84
15.	Telecommunications	1.53	15th	58.8	41.2	60.7	39.3	7.84
16.	Basic computer operations	1.49	16th	62.6	37.4	58.4	41.6	14.80*
17.	Binary numbers	1.45	17th	64.2	35.8	70.2	29.8	14.04
18.	Operating system	1.44	18th	66.3	33.7	64.9	35.1	3.41
19.	Components of a computer system	1.35	19th	73.7	26.3	71.1	28.9	1.80

The results confirmed that of the 19 topics, only eight showed gender differences. These are flowcharting, developing problem-solving skills; computer ethics and human issues; Computer fundamentals and evolution; managing computer files, Computer Applications, and Basic computer operations. Flowcharting remains the most difficult concept for female students (80.6%), the algorithm is perceived as most difficult by the male students (72.0%).

The computer studies curriculum in secondary schools expects learners to state the functions of algorithms, develop an algorithm that can be easily executed, write an algorithm for problem-solving, identify the meaning of each flowchart symbol, and draw a flowchart for a given problem. In decision-making today, it is crucial to consider both the gender and context of students. Yuan (2022) highlights this in their study on the role of mobility in constructing gender. The study provides empirical evidence by examining both embodied and situational agencies of women in cycling tourism. It found that the practice of cycling allows women to exercise agency, improve their skills, and reconsider gender identities, challenging traditional gender dualism. However, the exercise of this agency is context-dependent. Yuan's study contributes to understanding the intersection of mobility and gender through the lens of embodied and situational agency.

Conclusion

Despite the identified reasons for difficulties in computer studies, the study reveals that some students find certain aspects of the topic easy while others struggle due to a lack of practical experience and difficulty relating concepts to their familiar contexts. Rahimi et al. (2017)

suggest that algorithms and flowcharts are perceived as particularly challenging by senior secondary students. To improve student performance, it is essential to make these concepts less difficult. Trained secondary school teachers should be facilitated and encouraged to use technologically integrated teaching strategies, relating the material to students' cultural backgrounds and their environmental contexts (Davies & West, 2014). This paper highlights the difficult concepts faced by secondary school students across Africa in ICT and provides suggestions for improvement. To enhance the value of teaching and learning in this subject, there is a need for activities such as intensive ICT skills training for both students and teachers, increased ICT equipment and applications in schools, and the establishment of innovation centers (Ayogu, 2008). Considering the importance of education in sustainable development, the management of instructional delivery by teachers remains a major national concern (Igu et al., 2022). Despite improvements, significant work remains to be done in Africa's education system. As we approach the third decade of the 21st century and aim to achieve the goals of the African Union's Agenda 2063, there is an urgent need for more professionals in ICT-related disciplines.

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