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Relationship Between Undergraduate Pre-Service Computer Science Teachers' Metacognitive Awareness And Achievement In Programming Skills In North Eastern Nigeria

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Abstract
This study determined the metacognitive awareness of undergraduate preservice computer science teachers and its relationship with academic achievement in programming skills in North Eastern Nigeria. The study employed a Correlational survey research design. The population of the study comprised of all 928 undergraduate Computer Science Education teachers in Universities in North Eastern Nigeria offering computer science Education at undergraduate level. Multi stage sampling technique was employed for the study. Firstly, purposive sampling was used to select only the universities that offer computer science Education at undergraduate level while 274 final year undergraduate preservice computer science teachers. The two instruments used for the study are Metacognitive Awareness Inventory and Programming skill assessment Inventory with reliability coefficients of 0.84 and 0.82 respectively. Simple percentage and Pearson product moment of correlation were used to analyze the data gotten from the study. Findings from the study indicated that the metacognitive awareness of undergraduate Computer Science Education teachers was moderate and there was a low positive relationship between preservice computer teachers' metacognitive awareness and their academic achievement in the learning of programming in universities in North Eastern Nigeria. The study recommends that a follow up study be conducted qualitatively in order to provide in-depth understanding on the problems undergraduate Computer Science Education teachers encounter on the use of metacognition in learning programming.

Keywords*: Metacognitive Awareness, Academic Achievement, Preservice Teachers, Programming skills*

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I. Introduction

The role played by science and technology in our ever-changing society cannot be over emphasized. This is evident in the demands of almost all sectors in achieving the collective aim and objectives of nations. One way to prepare adequately for the attainment of these stated objectives that will provide individuals with the skills and competences to fit in the society we live today is to encourage the acquisition of information and communication technology skills and to solve the numerous challenges students and teachers face in the conceptualization of topics in computer science Education such as programming.

Computer programming is one of the very first topics in Computer Science courses and, sometimes, one of the most complex from students' point of view (Ullah et al. 2018). Learning how to programme computers requires students to understand a new set of concepts and to develop new thinking strategies very different from what they are used to. Programming as a unifying topic in computer science education has been reported to be difficult for students to learn not only in Nigeria but the world at large (Hammond, 2017). This has resulted in increased number of students who are not motivated (Paul, et al 2019; Anthony, 2019). Several factors have been attributed for the cause of the problems stated above to include poor conceptualization of programming both at the senior secondary school and tertiary Education level. Others include the non-availability, inadequacy and underutilization of information and communication facilities needed for teaching programming (Anthony, 2019). Additionally, the lack of strategies, analytical skills and problem-solving skills that will lead to the development of higher order thinking skills such as metacognition needed for computer programming served as impediments (Soloway & Spohrer, 2013).

By examining the association between metacognitive awareness and programming achievement, this study can inform pedagogical approaches that cultivate both technical proficiency and self-regulated learning in pre-service teachers. This, in turn, can contribute to a more effective and empowered teaching force in North Eastern Nigeria. Teachers with strong metacognitive awareness are better equipped to not only master programming concepts themselves but also to effectively plan and deliver instruction that caters to the diverse learning needs of their students. Furthermore, by fostering a culture of self-regulated learning among pre-service teachers, this study can contribute to the development of lifelong learners who are adaptable and resourceful in the face of new challenges in computer science education. Ultimately, this can lead to a more robust and sustainable computer science education ecosystem in North Eastern Nigeria.

Research Objectives

i. Determine the level of undergraduate pre-service computer science teachers' metacognitive awareness in the learning of programming.

ii. Find out the relationship between undergraduate pre-service computer science teachers' metacognitive awareness and their academic achievement in programming.

Research Hypothesis

The following null hypothesis was formulated and tested at 0.05 level of significance.

i. There is no significant the relationship between undergraduate pre-service computer science teachers' metacognitive awareness and their academic achievement in programming.

II. Literature Review

Metacognition according to Ormrod, (2004) can be defined as what students know about their own cognitive processes and how they use these processes in order to learn and remember. Various frameworks of Metacognition have been developed by different researchers from their study of Metacognition which have led to the categorization of Metacognition into different components (Flavel, 1976; Meijer et al, 2013; Akyol & Garinnson, 2013; Taasoobshirazi & Farley, 2013). But generally, in the literature, metacognition has been categorized into three components to include knowledge of cognition, regulation of cognition and metacognitive experiences.

Though the application of metacognition in computing is newer and less understood, it has been found to be positively correlated with academic achievement (Bergwin et.al, 2005), enhances students' competency in programming (Richardson et. al, 2012) while the absence of thee skills is associated with difficulties in completing programming task resulting to low academic achievement (Leonardo, 2021).

III. Methodology

Design, Population and Sample

A quantitative design that involved Correlational Survey research design was employed in the study. A Correlational Survey design is a combination of Correlational research and Survey design.

The population of the study comprised of all 928 Computer Science Education students in the Federal Universities in North Eastern Nigeria offering computer science Education at undergraduate level in North Eastern Nigeria (*see Table 1*).

Multi stage sampling technique was employed for the study. Firstly, purposive sampling was used to select only the universities that offer computer science Education at the undergraduate level while 274 final year undergraduate Computer Science Education teachers' were selected due to the fact that they have adequately undergone all the programming courses contained in Computer science Education curriculum.

Table 1: Distribution of the number of Pre-service Computer Teachers in Universities

SN	University	Number of Students		
		Male	Female	Total
1	A	292	91	383
2	B	77	32	109
3	C	178	102	280
4	D	97	59	156
		Sum Total		**928**

Instrumentation

Two instruments were used for data collection. They include a) Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison (1994), b) Programming skill assessment Inventory. MAI was adopted to measure the level of pre-service teachers' metacognitive awareness. MAI is a 2 point scale questionnaire categorized as True and False. MAI is made up of two sections; the first section elicited pre-service computers teachers' demographic information while the second section contained 52 items spread across the components and sub-components of metacognitive awareness. The second instrument is a programming concept inventory assessment adapted from Kecskemety et al., (2021). The programming concept assessment inventory was made of three sections, first section elicited pre-service computer teachers' demographic information, section B consisted of 25-item multiple-choice questions. The assessment inventory is to assess student understanding in arrays, basics, for loops, function parameters and return values, if statements, logical operators, recursion, and while loops. These are topics that aligned with the final year Computer science education curriculum.

Validity and Reliability

A Pilot study was carried out in an area outside the area of the study due to similarities in demographics between the area and that of the main study. Kuder-Richardson reliability coefficient of 0.84 was obtained for Metacognitive Awareness Inventory (MAI) while a Split half reliability coefficient of 0.82 was obtained for Programming concept assessment Inventory making the instruments good and reliable for the conduct of the study.

Data Analysis

The students' responses of MAI and Programming skill assessment Inventory were quantitatively using simple percentages, Pearson Product Moment of Correlation (PPMC) and simple regression. In order to describe the metacognitive behavior/awareness of the students, the researchers categorized the metacognitive awareness as 0 – 0.39 is low, 0.40 – 0.69 is moderate and 0.70 – 1.00 as high.

IV. Results And Discussion

Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances and homogeneity of regression slopes.

Research Question 1

What is the level of undergraduate pre-service teachers' metacognitive awareness in the learning of programming?

Table 2: Mean and Standard Deviation of Pre-service Computer Teachers' Metacognitive Awareness

S/N	Item (N = 274)	True (%)	False (%)
1	I ask myself periodically if I am meeting my goals in programming	58.4	41.6
2	I consider several alternatives to a problem before I answer questions on programming	53.5	46.5
3	I try to use strategies that have worked in the past during programming task	48.4	51.6
4	I pace myself while learning in order to have enough time on programming	44.7	53.3
5	I understand my intellectual strengths and weaknesses on programming task	49.3	50.7
6	I think about what I really need to learn before I begin a programming task	53.1	46.9
7	I know how well I did once I finish a programming task	48.8	51.2
8	I set specific goals before I begin a programming task.	45.4	54.6
9	I slow down when I encounter important information in programming	42.2	57.8
10	I know what kind of information is most important to learn in programming	58.2	41.8
11	I ask myself if I have considered all options when solving a problem in programming	48.6	51.4
12	I am good at organizing information on programming task	52.9	47.1
13	I consciously focus my attention on important information in programming	52.7	47.3
14	I have a specific purpose for each strategy I use in programming	46	54
15	I learn best when I know something about programming	57.5	42.5
16	I know what the teacher expects me to learn on programming	45.8	54.2
17	I am good at remembering information on programming	49.2	50.8
18	I use different learning strategies depending on the situation during programming task	47.2	52.8
19	I ask myself if there was an easier way to do things after I finish a programming task	49.8	50.2
20	I have control over how well I learn in programming	48	52
21	I periodically review to help me understand important relationships in programming	50.6	49.4
22	I ask myself questions about the material before I begin programming task	55.5	44.5
23	I think of several ways to solve a problem and choose the best one during programming	57.6	42.4
24	I summarize what I've learned after I finish a programming task	48	52
25	I ask others for help when I don't understand something on programming	48.1	51.9
26	I can motivate myself to learn when I need to in programming	48.3	51.7
27	I am aware of what strategies I use when I study programming	45.9	54.1
28	I find myself analyzing the usefulness of strategies while I study programming	45.4	54.6
29	I use my intellectual strengths to compensate for my weaknesses in programming	40.6	59.4
30	I focus on the meaning and significance of new information in programming	46.6	53.4
31	I create my own examples to make information more meaningful in programming	51.2	48.8

S/N	Item (N = 274)	True (%)	False (%)
32	I am a good judge of how well I understand something in programming	54.4	45.6
33	I find myself using helpful learning strategies automatically when solving programming task	53.7	46.3
34	I find myself pausing regularly to check my comprehension in programming	39.3	60.7
35	I know when each strategy I use will be most effective in programming	38.3	61.7
36	I ask myself how well I accomplish my goals once I'm finished programming	53.3	46.7
37	I draw pictures or diagrams to help me understand while learning programming	51.8	48.2
38	I ask myself if I have considered all options after I solve a problem in programming	51.9	48.1
39	I try to translate new information into my own words in programming	51.4	48.6
40	I change strategies when I fail to understand programming	36.3	63.7
41	I use the organizational structure of the text to help me learn programming	50.7	49.3
42	I read instructions carefully before I begin a programming task	59.4	40.6
43	I ask myself if what I'm reading is related to what I already know in programming	47.1	52.9
44	I reevaluate my assumptions when I get confused in programming	40.4	59.6
45	I organize my time to best accomplish my goals in programming	53.6	46.4
46	I learn more when I am interested in programming	46.6	53.4
47	I try to break studying down into smaller steps during programming	33.7	66.3
48	I focus on overall meaning rather than specifics in programming	30.9	69.1
49	I ask myself questions about how well I am doing while I am learning something new in programming	43.7	56.3
50	I ask myself if I learned as much as I could have once I finish a programming task	42.3	57.7
51	I stop and go back over new information in programming that is not clear	37	63
52	I stop and reread when I get confused in programming	32.9	67.1
	Grand mean	**47.8**	**52.2**

Table 2 shows that, items in MAI had a range of values in percentage from 36.3 to 59.4 with an overall mean percentage of items in MAI of the responses from preservice computer teachers was 47.8. The overall value of 47.8 indicates that preservice computer science teachers have a moderate level of metacognitive awareness in the learning of programming. On taking the average of the list of items of the various components of metacognition and their subcomponent i.e. knowledge of cognition and regulation of cognition. The data also shows that preservice computer teachers have moderate level of awareness in the components of knowledge of cognition (mean percentage = 48.4) with declarative knowledge (items, 5, 10, 12, 16, 17, 20, 32, 46), procedural knowledge (items, 3, 4, 27, 33) and conditional knowledge (items, 15, 18, 26, 29, 35). Under the regulation of cognition component of metacognition, planning (items, 4, 6, 8, 22, 23, 42, 45), monitoring (items, 1, 2, 9, 11, 13, 21, 25 28, 30, 31, 34, 37, 40, 41, 43, 44, 47, 48, 49, 51, 52 and evaluation (7, 18, 24, 36, 38, 49), the data shows that preservice computer teachers possess moderate level (mean percentage = 48.8) of metacognition in all the skills of planning, monitoring and evaluation. Findings from this study further shows that, preservice computer teachers possess moderate level of metacognitive awareness in all the formative constructs/sub components of metacognition.

Research Question 2

What is the relationship between undergraduate pre-service teachers' metacognitive awareness and their academic achievement in programming?

Table 3: Mean and Standard Deviation and Relationship Between Pre-service Computer Teachers' Metacognitive Awareness and their Academic Achievement in Programming.

Variable	N	Mean	Std. Deviation	r_{value}
META-AWARENESS	274	47.81	13.71	
				0.372
ACHIEVEMENT	274	52.71	11.63	

Table 3 above shows that preservice computer teachers had a metacognitive awareness mean score of 47.81 and standard deviation of 13.712 while the mean and standard deviation of preservice computer teachers' academic achievement in programming is 52.71 and 11.627 respectively. An $\mathbf{r_{value}}$ of 0.372 was established as the coefficient of relationship between preservice computer teachers' metacognitive awareness and their academic achievement in the learning of programming. This indicates that, there exist a low positive relationship between preservice computer teachers' metacognitive awareness and their academic achievement in programming.

Research Hypothesis

There is no significant relationship between senior secondary school students' metacognitive awareness and their academic achievement in geometrical optics.

Table 4: Mean, Standard deviation and Testing of Hypothesis at 0.05 level of significance.

Variable	N	Mean	Std. Deviation	r_{value}	p_{value}	Decision
META-AWARENESS	274	47.81	13.71			
				0.372	0.543	Accept
ACHIEVEMENT	274	52.71	11.63			

Table 4 shows that preservice computer teachers had a the metacognitive awareness mean score of 47.81 and standard deviation of 13.71 while the mean and standard deviation of preservice computer teachers academic achievement in programming is 52.71 and 11.63 respectively. An $\mathbf{r_{value}}$ = 0.372 and a $\mathbf{p_{value}}$ = 0.543 was established between them. Since the r-value (0.372) is greater than the p-value (0.543), the null hypothesis which states that there is no significant relationship between pre-service computer teachers' metacognitive awareness and academic achievement in programming is accepted. This implies that though preservice computer teachers have a moderate level of metacognitive awareness and that there was a positive low relationship between pre-service computer teachers' metacognitive awareness and academic achievement in programming, the metacognitive awareness preservice computer teachers did not significantly influence their academic achievement scores in programming.

V. Discussion

The main aim of the study was to investigate pre-service teachers' metacognitive awareness and its relationship with academic achievement in programming in universities in North Eastern Nigeria. The research question one sought to determine the extent of preservice teachers' metacognitive awareness in the learning of programming. Findings from the study indicate that preservice computer teachers have a moderate level of metacognitive awareness. They possessed moderate level of skills in almost all the components and subcomponents of metacognition which includes declarative knowledge, procedural knowledge and conditional knowledge under knowledge of cognition while they also had skills of planning, monitoring and evaluation under regulation of cognition component of metacognition. This is agreement with the findings of Özçakmak, et al., (2021) who found out that preservice teachers metacognition to high and way above average in their study on the relationship between preservice teachers' metacognitive awareness and academic achievement.

The second research question determined the relationship between preservice computer teachers' metacognitive awareness and their academic achievement in programming. To answer this question, one hypothesis was formulated and tested at 0.05 level of significance. Findings from the result show that there was a low positive relationship between preservice computer teachers' metacognitive awareness and their academic achievement in the learning of programming. The results also indicates that, though preservice teachers have a high metacognitive awareness and that there was a positive low relationship between pre-service computer teachers' metacognitive awareness and academic achievement in programming, the metacognitive awareness they have did not influence their academic achievement scores in programming. These findings are in-line with the findings of Özçakmak, et al., (2021), Young and Fry (2008), Alotaibi et al., (2017), Aloqleh and Teh (2019) in their separate studies on the relationship between students' metacognitive awareness and academic achievement who found that there exist a positive relationship or effect between metacognition and academic achievement.

VI. Conclusions

Based on the findings and discussions, it was therefore concluded that there was a low positive relationship between undergraduate preservice computer teachers' metacognitive awareness and their academic achievement in the learning of programming in federal universities in North Eastern Nigeria. The moderate level of metacognitive awareness of preservice computer teachers did not influence their achievement in programming.

VII. Recommendations

Based on the findings of this study, it was recommended that other studies should be carried out that relates to the pedagogical content knowledge of teachers for teaching of programming in institutions of learning. Additional studies should also be carried out on other students' psychological related factors that affect learning.

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