

## Impact of Jigsaw IV Cooperative Learning Strategy (J4cls) on Computer Anxiety and Achievement of Federal Colleges of Education Students in STEM Practical Sessions

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### ABSTRACT

*This study is an investigation of the impact of Jigsaw IV Cooperative Learning Strategy (J4CLS) on computer anxiety and academic achievement in practical sessions of Federal Colleges of Education students: an implication for STEM education. The study answered two research questions and tested two hypotheses. The quasi-experimental design involving a pretest and posttest was utilized on a sample of 90 (40 experimental and 50 control) computer science students of Federal College of Education Zaria in line with the Central Limit Theorem (CLT) which proposed a minimum of 30 ( $N \geq 30$ ) participants. Two validated instruments tagged Computer Science Practical Achievement Test (CSPAT) and the Computer Anxiety Rating Scale (CARS) with respective reliability indices of 0.81 and 0.89 were used to collect data for the study. The *t*-test and Mann-Whitney *u*-test were used to test the hypotheses at  $P \leq 0.05$  level of significance. Result obtained showed a significant difference in achievement between the experimental and control group in favour of the former. In addition, students exposed to J4CLS had lower anxiety level compared to their counterpart in the control group. It was concluded that J4CLS is effective in the teaching of computer science practical sessions. Consequently, it was recommended that teachers should teach computer science at all level of our educational systems using the J4CLS. This will improve students' performance and reduce anxiety for computer science especially during the practical sessions. The future of STEM education is reliant on computer science pedagogy as it will create more jobs in the nation.*

**Keywords:** Jigsaw IV Cooperative Learning, Computer Anxiety, Academic Achievement

### INTRODUCTION

Every nation of the world has prioritized Science, Technology, Engineering and Mathematics (STEM) education because it is a common belief that its future lies in it. This indeed cannot be faulted since the realities that our basic senses of touch, smell, hear, feel and taste can detect are products of STEM. Hence, countries strive to inculcate its pedagogy in order to stay relevant. The

quality and sustainability of STEM in Nigeria is an endeavour that can put the nation on the map of countries to be reckoned with in the world. Bouchillon (2016) asserted that STEM education integrates concepts that are usually taught as separate subjects in different classes and emphasizes the application of knowledge to real-life situations. According to the website Engineering for Kids (2016) and Eberle (2010), STEM education creates critical

thinkers, increases science literacy, and enables the next generation of innovators. Innovation leads to new products and processes that sustain our economy. This innovation and science literacy depends on a solid knowledge base in the STEM areas. It is clear that most jobs of the future will require a basic understanding of mathematics and science. In addition, Engineering Kids (2016) submitted that:

“In the 21st century, scientific and technological innovations have become increasingly important as we face the benefits and challenges of both globalization and a knowledge-based economy. To succeed in this new information-based and highly technological society, students need to develop their capabilities in STEM to levels much beyond what was considered acceptable in the past.

STEM is a curriculum based on the idea of educating students in four specific disciplines namely: science, technology, engineering and mathematics; it is an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications

(Hom, 2014). Computer Science is a subset of mathematics which is central to realization of STEM.

The importance of computer science knowledge and applicability in every area of human life is on the increase. Consequently, an important aspect of STEM is the computer science. Its importance has gone beyond word processing to high technology programming used for problem solving in manufacturing, agriculture, business, scientific and social contexts (DePauw University, 2016). Computer Science is an exciting, growing, challenging field that has impact in most aspects of everyday life. These areas include medicine, communications, automotive technology, weather forecasting, entertainment, mining, pharmacology, forensics, manufacturing, disaster recovery, security, law, business. The application of computer technology is increasing and fast taking over every field of endeavour. Hom (2014) postulated that by the year 2018, jobs created under STEM in the United States will be as follows: Computing (71%), Engineering (16%), Physical Sciences (7%), Life Sciences (4%) and Mathematics (2%). A similar analysis was given by Partovi (2014) supporting the claim that computer science will create more jobs under the auspices of STEM. This presented in figure 1.

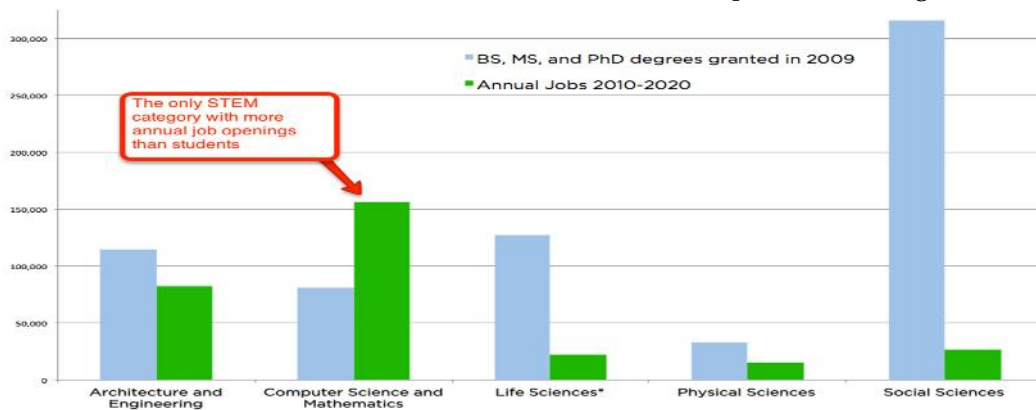


Figure 1: Job Gap and Growth Projections in STEM: Source: Partovi (2014)

This has a lot of implications for Nigeria since most jobs now employ the use of computers one way or the other. This establishes the importance of computer science in STEM. Unfortunately, students of computer science in the Federal College of Education have been observed to exhibit apprehension or anxiety for computer practical (Ebele, 2016).

Generally, anxiety refers to a complex combination of negative emotional responses that include worry, fear, apprehension and agitation. It could also be seen as an intense dread, apprehension or nagging worry. In addition, anxiety is a natural and unavoidable reaction to a perception of danger or risk. Everyone one who is human, experiences anxiety in a particular context and situation (Barbeite, & Weiss, 2004; Saadé, & Kira, 2009; Olatoye, 2009; Mathew, 2012; Achima & Al Kassim, 2015).

There are three types of anxieties: trait, state, and concept/ situation-specific (Al-Shboul, Ahmad, Nordin, & Rahman, 2013; Achima & Al Kassim, 2015). Trait anxiety defined as a general pervasive anxiety that is experienced by a person over the entire range of life experience. A person in this kind of anxiety will feel chronically anxious and constantly under pressure regardless of their situation. Following, state anxiety is described as anxiety that fluctuates over time and/or arises in a responsive situation where related to a person's learning background which a person may have experienced some anxiety in a situation and that anxiety is transferred to a similar situation when it occurred. Finally, concept/situation-specific anxiety is referring to a transitory-neurotic type of anxiety that the range between the trait and state anxieties. For that reason, a person with computer anxiety may

experience fear of the unknown, feeling of frustration, possible embarrassment, failure and disappointment hence, resulted avoidance towards computer usage.

Computer anxiety is a worldwide phenomenon (Sam, Othman, & Nordin, 2005; Shah, Hassan & Embi; 2012; Cazan, Cococrada & Maican, 2012). Conceptually, computer anxiety is seen as a multi-dimensional construct in three major dimensions of psychological, operational, and sociological. The psychological dimension includes attitudes toward computers, self-efficacy, personality types, avoidance, and self-perceptions. Operational dimension usually results from computer courses, teachers, nature of computers, the extent of experiences with the computer, and owning a personal computer while sociological dimension is related to factors of age, gender, nationality, socio-economic status, and the field of study (Simsek, 2011). The definition of what constitute computer anxiety varies with authors but converges at some point. Most researchers agree that computer anxiety is related to negative emotional feelings associated with direct experiences (Shah, Hassan & Embi, 2012). It is a feeling of frustration while using computers occur either when the applications are complicated or too advanced to cope with or sometimes when the system is down or malfunction. Computer anxiety may be defined as the experience of fear of the unknown, feeling of frustration, possible embarrassment, failure and disappointment hence, resulted avoidance towards computer usage (Olatoye, 2009; Achima & Al Kassim, 2015). According to Igi Global (2017), computer anxiety is a negative feeling of towards computer technology in which

the computer users experience discomfort, stress, or fear in front of computer or using it. The jigsaw technique was created with the goals of reducing conflict, enhancing positive educational outcomes and to help students realize they are essential components of a whole and encourage cooperation in a learning environment. Jigsaw is a cooperative learning strategy in which everyone becomes an expert and shares learning experience so that eventually all group members know the content. There are currently six types of Jigsaw cooperative learning strategies available for teachers to use in the classroom (Jansoon, Somsook & Coll, 2008). They are: Jigsaw I (Aronson, 2000), Jigsaw II (Slavin, 1987), Jigsaw III (Stahl, 1994), Jigsaw IV (Hilliday, 2002), Reversed Jigsaw (Hedeen, 2003), and the Subject Jigsaw (Doymus, 2007).

The Jigsaw IV includes three new features: an introduction, quizzes, and re-teaching of material after individual assessment which makes it better than Jigsaw I, II and III (Jansoon et al, 2008). The J4CLS has been observed to boost students' interest and performance for school subjects whether science or art based (Bolaji, Kajuru & Timayi, 2015). Moreover, Duff (2012), Mbacho & Githua (2013), Tran (2014) and Timayi, Ibrahim & Sirajo (2016) asserted that due to the student-centered nature of the Jigsaw learning environment, interest for science-based subjects is promoted and anxiety reduced because the strategy stimulates cognitive activities.

### **Objectives of the Study**

The objectives of the study are to:

- i. investigate the effect of J4CLS on computer students' academic achievement in practical sessions.

- ii. determine the anxiety level of computer students' in practical sessions when exposed to J4CLS.

### **Research Questions**

The following research questions were formulated as guide to the study:

- i. What is the mean score difference between the performance of computer students taught practical sessions using J4CLS and those taught by the expository (lecture) method?
- ii. What is the difference between the anxiety level of computer students exposed to J4CLS and those taught by the expository (lecture) method in practical sessions?

### **Null Hypotheses**

The following null hypotheses were tested at  $P \leq 0.05$  level of significance.

**HO<sub>1</sub>:** There is no significant difference between the achievement of computer students taught practical sessions using J4CLS and those taught by the expository (lecture) method?

**HO<sub>2</sub>:** There is no significant difference between the anxiety level of computer students exposed to J4CLS and those taught by the expository (lecture) method in practical sessions?

### **METHODOLOGY**

The research design adopted for this study is the quasi-experimental non-randomized research design. This comprised two groups of students one tagged experimental and the other control which were pretested before treatment to ascertain their entry behaviour and anxiety level. The population of the study comprised of National Certificate in Education (NCE II) students of the Federal College of Education (FCE) Zaria. 90 NCE students participated in

the study (40 experimental and 50 control). The sample is in conformity with the requirement prescribed by Central Limit Theorem (CLT) [Tuckman, 1975] which proposed a minimum of 30 ( $N \geq 30$ ) participants as sample for an experimental study. Two instruments were utilized in the study namely the Computer Science Practical Achievement Test (CSPAT) and the Computer Anxiety Rating Scale (CARS). CSPAT is 20 item tests (10 written and 10 practical skill tests) developed by the researchers based on the NCCE computer science course content. CARS is a 20-item open ended questionnaire adopted from

Heinssen, Glass and Knight (1987) to elicit responses from students on their anxiety for computer practical. CSPAT and CARS were validated by experts and subjected to the appropriate reliability techniques which observed to be 0.81 and 0.89 respectively.

The experimental group were exposed to the J4CLS for six weeks while the control group were taught using the normal lecture approach also for six weeks. Both groups were taught simultaneously to avoid confounding variable. The experimental group were placed groups of four students (called Home Group [HG]) each coded by alphabetic letters A, B, C ... and so on as presented in Table 1.

**Table1:** Home Group Plan

Group 1	Group 2	Group 3	...	Group 10
A1 A2	B1 B2	C1 C2	...	J1 J2
A3 A4	B3 B4	C3 C4	...	J3 J4

**Source:** Adapted from Timayi, Bolaji & Kajuru (2015)

In each home group, a member was given a special code A1, A2, A3, or A4 etc. These numbers codes determined the Expert Group [EG] (Table 2) a student consequently

belonged to. Members in respective home groups with the same number code learnt a computer practical skill.

**Table 2:** Expert Group Distribution Plan

EG 1	EG 2	EG 3	EG 4
A1, B1, C1, D1, E1, F1, G1, H1, I1, J1	A2, B2, C2, D2, E2, F2, G2, H2, I2, J2	A3, B3, C3, D3, E3, F3, G3, H3, I3, J3	A4, B4, C4, D4 E4, F4, G4, H4, I4, J4

**Source:** Adapted from Timayi, Bolaji & Kajuru (2015)

Practical skill sessions were distributed according to codes (1, 2, 3 & 4). Students with the same number code were

placed in the same expert group and consequently learnt the same practical skill (Table 3).

**Table 3:** Expert Groups and Sub-topics

Sub-topics in Geometry for Expert Groups	
A1, B1, C1, D1 ... J1	Computer operation
A2, B2, C2, D2 ... J2	Programming
A3, B3, C3, D3 ... J3	Pascal
A4, B4, C4, D4 ... J4	Loop

**Source:** Adapted from Timayi, Bolaji & Kajuru (2015)

Upon completion of study, all students in the Expert group returned to their Home groups. After home group interactions, the posttest (CSPAT and CARS) were administered. The research hypotheses were analyzed using the independent t-test and Mann-Whitney U-test at  $P \leq 0.05$  with the aid of the Statistical Packages for Social Sciences (SPSS version 23).

## RESULTS

**Research Question One:** What is the mean score difference between the achievement of computer students taught practical sessions using J4CLS and those taught by the expository (lecture) method?

**Null Hypotheses Two:** There is no significant difference between the achievement of computer students taught practical sessions using J4CLS and those taught by the expository (lecture) method?

**Table 4.5:** Independent t-test for Achievement between Experimental and Control Groups

Group	N	Mean	SD	df	t-value	P-value	Decision
Experimental	40	50.03	12.62	88	15.73	0.001*	Reject $H_{01}$
Control	50	24.78	5.48				

\*Significant at  $P \leq 0.05$

Table 4 revealed that the mean achievement score of the experimental group (50.03) is higher than that of the control group (24.78). In addition, analysis show a t-value of 15.73 and P-value of 0.001 which is lower than the stated value of 0.05. Therefore, the null hypothesis one ( $H_{01}$ ) is hereby rejected. This implied that there is significant difference between the achievement of students in favour of exposed to J4CLS.

**Research Question Two:** What is the difference between the anxiety level of computer students exposed to J4CLS and those taught by the expository (lecture) method in practical sessions?

**Null Hypotheses Two:** There is no significant difference between the anxiety level of computer students exposed to J4CLS and those taught by the expository (lecture) method in practical sessions?

**Table 5:** Summary of Mann-Whitney U-test for Anxiety between Experimental and Control Groups

Group	N	Mean Rank	Sum of Ranks	U-value	P-Value	Remarks
Experimental	40	61.76	2470.50	349.50	0.001*	Reject $H_{02}$
Control	50	32.49	1624.50			

\*Significant at  $P \leq 0.05$

From Table 5, the experimental group had a higher mean rank interest score (61.76) compared to that of the control group (32.49). The Table also revealed that the U-value of 349.50 corresponds to a P-value of 0.001 which is lower than the stated value of 0.05. Hence, the null hypotheses two ( $H_{02}$ ) is hereby rejected. This means that the interest level of students exposed to J4CLS better.

## DISCUSSION

The study revealed that a significant difference in achievement between students in the experimental and control groups in favour of the former who were exposed to the J4CLS. This finding is consistent with that of Mbacho & Githua (2013), Tran (2014), Bolaji, Kajuru & Timayi (2015), Mari & Gumel (2015) who observed that the Jigsaw Cooperative Learning Strategy provides an enabling learning environment which enhances students' performance in science-based subjects like mathematics, computer science, chemistry, physics and biology because its activity base and student-centered nature.

Another finding from the study revealed that there is significant in computer anxiety level of students for computer science when exposed to J4CLS and the lecture method. These finding tallies with that of Duff (2012) and Timayi, Ibrahim & Sirajo (2016) who asserted that the cooperative learning strategy stimulates cognitive activities and collaborative development which promotes students interest and reduces their anxiety level.

The findings of this study have a lot of implication for STME this is because computer sciences are taking over every sphere of human endeavour latently. Consequently, its study must be encouraged

at all levels of education especially among teachers-in-training who will in turn teach others.

Computer science has been observed to produces more jobs than other areas of STEM which suggest that its pedagogy should be taken seriously. This means the future of our young people may depend on computer knowledge since every job will require skilled people at it.

Also, for Nigeria to be achieved the laudable benefits of STEM, computer science an aspect of mathematics must be enhanced and popularized in all our educational system. This will boost the attainment of STEM and lead to a scientific and technological breakthrough the country seeks.

## CONCLUSION

The Jigsaw IV cooperative learning strategy (J4CLS) was more effective at improving students' performance in computer science compared to the conventional method. Moreover, the J4CLS creates an enabling environment for reducing students' anxiety for computer science practical sessions. Computer science is central to the overall realization of STEM objectives and so it is imperative that it study is given the needed attention. Quality computer science knowledge at all Nigeria's educational level will in turn enhance the nation's quest for the needed scientific and technological breakthrough as well as create more jobs for a better economy.

## RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. The J4CLS should be used by teachers to teach computer science at all level of our

educational systems. This will improve their achievement and reduce anxiety for computer science especially during the practical sessions.

2. The Ministry of Education in association with the Ministry of Science and Information should make computer studies a core subject in all our educational systems so that our school graduates can fit into future jobs needed to advance the country into a developed nation.
3. Further research on computer science anxiety among teachers and students by researchers, National Mathematical Centre (NMC), National Education Research and Department Council (NERDC) with applicable results should be carried out.

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