EBSU Science Journal Vol. 1(1) 2020. pp. 61 - 70 ISSN: 2756-6641

Received: 26 May 2020. *Accepted:* 06 July 2020.

The Impact of Inquiry-Based Teaching Approach on Computer Science Learning

Edeh, M.O.[1], Nwafor, C.E.[2], Nnaji, A.D.[3], Fyneface, G.A.[4], Obiekwe, C.P.[5] and Omachi, D.[6]

[1]Department of Mathematics and Computer Science, Coal City University, Enugu, Nigeria.
[2]Department of Science Education, Ebonyi State University, Abakaliki, Nigeria.
[3]Deptartment of Science Education, University of Nigeria, Nsukka, Nigeria.
[4]Faculty of Education, Ebonyi State University, Abakaliki, Nigeria.
[5]Department of Physiotherapy, University of Nigeria Teaching Hospital, Nigeria.
[6]Educational Foundation, Peaceland College of Education, Enugu, Nigeria
Corresponding E-mail: michael.edeh@ccu.edu.ng

Abstract
The method of instruction used by the teacher can potentially motivate or dispirit learners' interests in a course and could also influence their learning outcomes. The traditional teaching approach is beginning to prove ineffective as seen during the recent COVID-19 pandemic, hence the need for adoption of more flexible and interactive approach like the inquiry-based approach. The study examines the impact of inquiry-based teaching on Computer Science learning. A total of 50 Second year students taking Computer Application Course (COS 234) in Coal City University participated in the study. They were selected using simple random sampling technique, and were divided into two major groups; Experimental Group (EG) and Control group (EG). The EG was taught using the inquiry-based teaching approach, while the CG was taught using conventional approach. We conducted an Achievement test to investigate the effects of Inquiry-based approach on the students' learning outcomes. The post-test results show that inquiry-based teaching had significant positive effects on the students' learning interests and academic achievements. The post-test mean score of the experimental group indicates higher academic achievements than that of the control group, showing an increase in both students' learning interests and academic achievement after the treatment. The study establishes that inquiry-based teaching approach presents a transformative alternative to the prescriptive didactic method by giving more opportunities to learners to engage in self-directed learning, exploration and discovery of many possible ways to solve problems on their own.

Keywords: *Inquiry-based teaching, Active learning, Scaffolding, Computer Science, Technology.*

Highlight
- The use of Inquiry-based approach had positive effects on the learning outcomes (academic achievements) of students in Computer Science.
- The use of Inquiry-based approach of students' learning interest in Computer Science course.
- Students who were taught using inquiry-based approach outperformed their counterparts who were taught using the conventional approach.
- Inquiry-based approach can sharpen student's skills to search for solutions and to solve immediate and future problems if properly implemented.
- The implementation of Inquiry-based teaching approach can be hindered by lack of inquiry-based experiences by teachers and students, and time constraints, and lack of supportive infrastructures.

Introduction

The emerging trends in education require the adoption of new patterns of teaching and learning that promote learners' involvement, technology use and problem-based learning. Education systems across the world are now changing their teaching techniques to meet the learning needs of 21st century learners, and to ensure continued education at all times particularly during emergencies or pandemics. For instance, many educational institutions had to migrate to remote education during the Coronavirus Disease 2019 (COVID-19) school closures, but some that have not embraced technology-based education were more affected during the COVID-19 lockdown. The traditional classroom approach leaves many students bored and unengaged, making it difficult for them to understand the material being taught (Grade power learning, 2018). The new changes in education require the use of new approach that would involve the learners and give them more responsibilities.

The nature of today's learners has increased the need for use of inquiry-based (student-centred) teaching approach, and educators have to evolve in line with the emerging educational and technological challenges and changes. Inquiry-based learning is one of many terms used to describe educational approaches that are driven

more by a learner's questions than by a teacher's lessons (Education Development Center, 2016). Inquiry-based teaching approach is a technique that ensures vibrant student involvement in a pedagogical process; whereby the problem is defined and the students are made to engage in critical thinking to create various possible solutions to the defined problems under the supervision of a teacher. Inquiry-based teaching emphasizes learner's participation and involvement in the learning process to sharpen their critical thinking and problem-solving skills, and to enhance productivity in education.

Onyema et al (2019a), stated that inquiry-based teaching enhances experimentation, and teachers play coaching role providing guidance and supervision to students rather than being sole holders of knowledge. According to Sharon and David (2013), inquiry-based learning enable students to undertake real problems, issues, and questions, consult with experts and authoritative sources, work collaboratively to improve ideas and products, and use elaborated forms of communication beyond a research paper (i.e., a podcast explanation, complex display board, or mini-documentary). The nature of Computer Science education is such that it is common to include some form of problem or inquiry based learning i.e. present the students with a problem, and a set of tools (applications, code, etc) with which to solve it (Neil and Mike, 2008). Considering the growing popularity of Computer Science across the globe and the need for problem-based education, the present study examines the impact of inquiry-based teaching approach on Computer Science learning, with a view to provide updated knowledge regarding the potentials of inquiry-based teaching in enhancement of productivity in education.

Objectives of the Study

The main objective of the study was to investigate the impact of inquiry-based teaching approach on Computer Science learning. Specifically, the study:

1. examines the effects of inquiry-based teaching on student's learning interest in Computer Application Course.
2. examines the effects of inquiry-based teaching on student's academic achievement in Computer Application Course.

Hypotheses

Ho_1: The use of inquiry-based teaching approach has no significant effects on student's learning interests in Computer Science.

Ho_2: There is no significant difference in the achievement of students taught using the inquiry-based teaching approach and those taught using the conventional approach.

Conceptual Framework

There are growing research interests on ways to enhance students' engagements, learning experiences and productivity in education. The conventional teaching methodologies can no longer guarantee effectiveness in education in the 21st century considering the nature of learners and technology evolutions. Wise (1996) states that the traditional approach often emphasize on transmitting the content of scientific theories to students: "teachers dispense knowledge to passive student audiences, with textbooks alone constituting the science curricula; and students are rarely involved in direct experiences with scientific phenomena. Hawkey (2001), described the conventional method of teaching as "a cathedral at which worship is expected rather than a quarry from which resources are extracted as required. The traditional classroom often looks like a one-person show with a largely uninvolved learner (Ali, 2014). In the present study, the traditional teaching approach is like a traditional shrine, where the traditional Chief Priest presides and prescribes solutions to the worshippers or clients/customers without any input from the clients. All the clients in such arrangements are often expected to follow the Chief Priest's prescriptions without questioning. This is unlike the inquiry-based pattern where everyone is involved in finding the best suitable solutions to problems. The Inquiry-based system has become a potential alternative to the traditional teaching approach.

The concept of inquiry-based pedagogy has its origin in ancient days during the time of early philosophers like Socrates and John Dewey whose ideologies encouraged inquiries and practicality in education. Inquiry-based technique is rooted on constructivist theory which underlines the importance of creativity and construction of ideas that solve problems. Constructivism emphasizes the need for learner's involvement in the teaching and learning process to enhance their abilities to think critically, construct ideas and create innovations. Every human being goes through different inquiries at one stage or the other both consciously and unconsciously. This is evident in the human quest for knowledge, technology, wealth and answers to problems that confront the world, including the search

for scientific clinical vaccines for the treatment of COVID-19.

Educational institutions are epicenters of inquiries. Most activities in education systems are based on inquiries, including the search for knowledge by students and educators, researches, experiments and innovations. Ken et al (1998), suggested that educators should take the responsibility in their own spheres of action to ensure that education becomes closer to intellectual work-the classes they teach, the future instructors they prepare, the teachers with whom they interact, the products they develop, the ideas they set forth as intellectual currency. In the inquiry-based approach, students are presented with the problem, and must discover for themselves the nature of the problem, and in particular to identify what knowledge and skills they will need to investigate and develop in order to solve the problem (Neil and Mike, 2008).

Alfieri et al (2011), performed a meta-analysis comparing inquiry to other forms of instruction, such as direct instruction or unassisted discovery, and found that inquiry teaching resulted in better learning. Similarly, Onyema et al (2019a) stated that inquiry-based learning is an effective learning strategy which can ease learning difficulties and increase students' interest in learning.

According to John (2005), the effective use of inquiry-based learning engages students in self-directed inquiry, in learning to think scientifically, and in understanding the relationships between evidence and theory, thereby allowing the individual student to tailor their own learning process. Padaste et al. (2015), identified five distinct phases of a contemporary inquiry-based learning, these include Orientation; Conceptualization, Investigation, Conclusion, and Discussion. Noriah and Suhaidi (2006) stated that the "essential elements of effective inquiry will enable skilled learners to; see patterns and meanings not apparent to unskilled ones, have in - depth knowledge of their subject matter, have their knowledge structured in order to be readily accessible, transferable and applicable, and acquire new information related to their content area with little effort. Similarly, Onyema et al (2020), states that inquiry-based teaching requires the use of cutting-edge technologies to yield the desired results. Computer-supported learning environments make it easier for students to propose their own research focus, produce their own data, and continue their inquiry as new questions arise, thus replicating scientific inquiry more realistically (John, 2005). This means that emerging technologies, if properly deployed can enhance robust inquiry-based system. The present study provides experimental evidence on the effectiveness of inquiry-based teaching approach on student's learning interest and academic achievement in Computer Science.

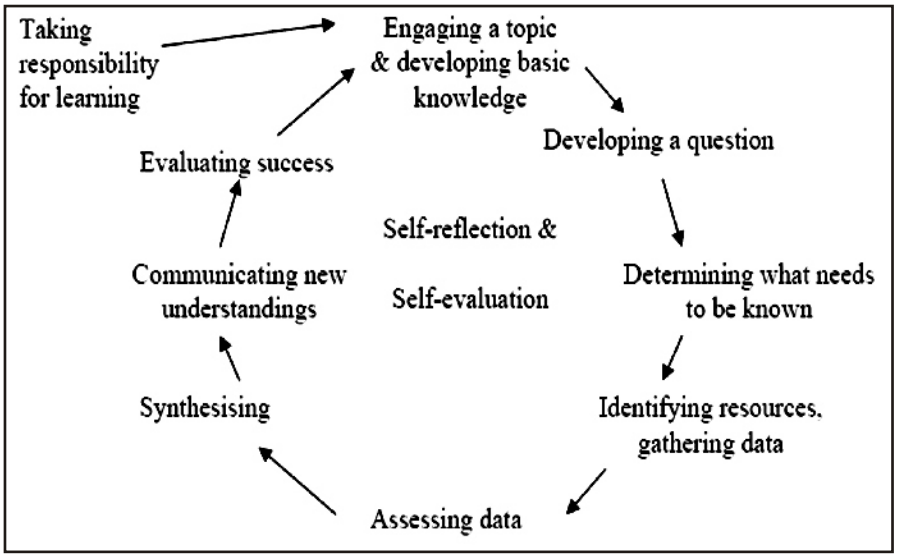

Fig. 1: Model of the inquiry process (Justice et al., 2002; Rachel, 2012)

Inquiry-Based Teaching

The rise of the Internet has altered the environment outside of the educational world, where children and adults alike carry out inquiry on a regular basis – as typified by the rise in search facilities and knowledge resources such as Google and Wikipedia (Neil and Mike, 2008). In Inquiry-based teaching arrangement,

both the teacher and students are involved in scaffolding which provides opportunities for them to ask critical questions relating to the problems at hand, get clarifications on their thoughts, and then formulate solutions.

Inquiry-based system is fast becoming popular among science educators, due to the global changes in education and the need for efficiency in education. According to Neil and Mike (2008), it is hard to think of any U.K. university or discipline which would not expect to use inquiry based learning as the driver for undergraduate learning. Inquiry-based teaching uses different approaches to learning, including small-group discussion and guided learning of which students are encouraged to explore the material, ask questions, and share ideas (Grade power learning, 2018). Learners can source information from the internet, discussions, brainstorming, questionings, experiments, journals, books, newspapers or reports during the inquiry process. For Ken et al (1998), the topic (task) for inquiry must be more interesting to students than homework problems from a textbook and must also be simple enough so that students being introduced to a topic for the first time can still gain required understanding to be able to ask appropriate questions during the inquiry process.

Students and teachers are the main actors in the academic inquiry-based process and they must play their expected individual and collective roles to achieve the objectives of the inquiry. The teachers must be versatile and patient to guide the students in the inquiry process. They must be able to set clear objectives, and provide robust facilitation to enhance the student's ability to engage in productive inquiries. Teachers have to devote more time and attentions to provide feedbacks to student's questions. In the other hand, the students have to be inquisitive and creative to optimize the benefits of inquiry-based teaching technique. They have to assume more responsibilities than they do in the traditional teaching approach, where the teacher solely disseminates knowledge. Students have to engage in team work and collaborative inquiries to develop solutions, taking responsibility for their own learning. Teachers have to give orientations and trainings to the students on how to identify and analyze problems, get resources for the inquiry, formulate strategies to generate the required knowledge or solutions to problems, and then generate reports. Having the supportive environment and resources would go a long way to improve the quality of the inquiry process. Thus, good inquiry-based activities should lead to answers to questions especially those that prompted the inquiry.

Technology and Inquiry-Based Teaching

Teaching and learning is characterized by stable and persistent changes in what a person or a group of people know and can do (Spector, 2012). The need to enhance teachers' competence and students' productivity and employability has since increased the use of technology in education. Technology evolution has stimulated tremendous changes in the world education systems. The changing learning environment now requires all educational institutions to adopt relevant technologies in their academic and related activities. The use of technology facilitates the modification of didactic methods and the adoption of more flexible inquiry-based approach to education (Onyema, 2019a).

Educational technologies increases accessibility to learning resources and multiple learning approaches to meet the need of diverse learners (Onyema et al, 2019b). Studies have shown that the integration of emerging technologies in teaching and learning process increase the interest of learners, and the quality of outcome in educational process (Onyema, 2019a; Onyema, 2019b). Mobile Technology provides support for inquiry-based learning processes, and also enhances ubiquitous opportunities for learners to carry out inquiry processes in a more self-directed way (Angel and Marcus, 2017). With the aid of mobile technology devices such as; Smartphones, laptops, notebooks, E-readers and wearable devices, students can easily conduct inquiries (ask questions) online, engage in collaborative and cooperative learning and interact with their teachers and environment during the inquiry process.

Several technology hardware and software aid idea development, data collection, analysis, synthesis and interpretation and understanding of concepts, all of which are part of the inquiry process. The evolution of computer and internet technology provides new supportive ways to facilitate the inquiry-based technique. The internet technology provides access to Massive Open Online Courses (MOOCs) and other vast resources that might be needed by the teacher or students during an inquiry. Teachers and students can both set up virtual meetings using the various mobile platforms like, ZOOM, GoTOmeeting, Google hangout, Whatsapp etc. during inquiries, particularly during school closures or pandemics. As the transition to remote learning increases, technology would play more important role in the inquiry-based process, and education at large.

Challenges of Inquiry-Based Teaching

Most educators and students often experience some challenges when transiting or engaging in inquiry-based teaching activities. According to Rachel (2012), there is a perceived higher workload associated with Inquiry-based teaching and learning, and teachers often struggle with adjusting to the approach. A study by Onyema et al (2019a) found that inquiry-based teaching and learning can be hindered by time constraints; poor digital literacy, lack of space, poor internet facilities, archaic educational policies and resistance to change. Also, the findings of a study by John (2005) shows that the inquiry-based approach can be hindered by multiple factors, such as amount of classroom time, lack of effective means for students to conduct independent investigations, the difficulty of incorporating abstract concepts with inquiry, and lack of teacher expertise and experience. Obviously, the implementation of inquiry-based teaching approach can be hindered by several factors, including time constraints, the nature of institution, state of teaching and learning infrastructures and facilities, teacher and student inquiry experiences, environment, language barriers, teacher and learner attitudes, digital skill issues, poor electricity and internet connections, unavailability and inaccessibility issues, and wrong application of the inquiry-based approach.

The large digital divide particularly in rural areas where most schools lack the infrastructures that support inquiry-based activities limits the implementation of inquiry-based teaching. Consequently, the effective implementation of inquiry-based approach demands a great deal of time, training and investment in supportive infrastructures. Since most aspects of education is being influenced by technology (Onyema, et al, 2019c), the use of relevant technologies in the inquiry-based process would go a long way to reduce the perceived challenges associated with the inquiry process. It is worthy to note that the inquiry-based teaching approach could be more effective, if it is properly planned or facilitated by the teacher. Teachers' experiences and facilitations are critical to the achievement of the set inquiry objectives. Thus, an effective inquiry-based approach in the 21st century would require constant training and retraining of educators and students on emerging teaching and learning technologies to enhance their competencies and abilities to implement inquiry-learning approach and other modern teaching techniques. The challenges of inquiry-based process are real, but its benefits are encouraging.

Computer Science Learning

Computer Science remains one of the most desired disciplines globally. The application of Computer technology has become almost inevitable in all spheres of life as the world moves towards digitalization. Several innovations in computing world are helping humanity to solve several problems, including the areas of communication, data management, research, business, trainings, aviation, medicine, security, education, manufacturing, economy, marketing and law. Just recently, computer software and models were used to predict COVID-19 dynamics. Computer literacy has become one of the "must have" skills for all potential and existing employees who want to be competitive in a changing world. In fact, most employers now include computer skills as a major requirement for employment. Computer Science is run as a Certificate, Diploma or Degree course in most educational institutions, and it is designed to equip the learners with 21st century computing knowledge and skills (both on software and hardware) needed to enhance their competences, digital, creativity and employability skills. Many educational institutions also include "Introduction to Computer Science (CSC 101)" as one of the compulsory General Study Courses (GSTs) that all students irrespective of their various disciplines are required to complete as part of the requirements for their programme before their graduation.

Indeed, the continuous changes in technology have caused paradigm shift in Computer Science education, both in terms of content and methodology. These changes have led to constant review of Computer Science curriculums across different levels of education. Many educational institutions are now faced with the challenges of adjusting their mode of instructions and curriculums to accommodate emerging topics in computing.

Some of these emerging topics in Computing world include; Internet of Things (IoT), Machine learning, Cyber Security, Blockchain technology, Big data, Bioinformatics, Quantum and Distributed computing, Human Computer Interaction (HCI), Robotics, Augmented/Virtual Reality, Nanotechnology, Software Engineering, Technology law, Human/Net-Centric Computing, Cloud Computing, Artificial Intelligence, Python programming, 3/4-D printing, Data Science/Analytics, Survey and sequential programming, Voice technology, Neuromorphic computing, and Brain computing.

Computer Science and Inquiry-Based System

According to Ken et al (1998), Computer Science is well-suited for an inquiry-driven educational approach because the success of Computer Science learning depends on students' active engagement with the material, rather than passive recipients of it. The use of inquiry-based system to teach Computer Science is a great way to teach debugging skills, run program as an experiment, and consider alternative explanations. It encourages students to explore how things work and what their models of computation are and what they should be (Mark, 2010). The result of an empirical study conducted by Mat´ıas (2017) which examined the effectiveness of inquiry-based approach in teaching "Computer Organization Course" showed that students who were taught using the inquiry-based teaching approach performed better than others who were taught using the conventional approach. The researcher also found that most of the students who were taught using the didactic approach only tried to pass the course by merely studying enough without trying to think beyond that.

Ken et al (1998) conducted an experimental study on the delivery of some Computer Science courses using inquiry-based techniques to supplement the traditional lecture model. They found that inquiry-based learning increased students' comprehension, and it also has considerably more appeal to the students than other methods. From the foregoing, it obvious that today's computer Science learning requires flexibility in teacher methodology. Computer Science is a practical-based course, and inquiry-based system could potentially enhance the teaching and learning of the course as proven in the present study.

Materials and Method

Research Design

The study adopted a modified quasi-experimental design - "Equivalent control group with pre-post test" (Campbell and Stanley 1963; Berg and Latin 1994, Zahara and Anowar, 2010) as represented in table 1. From table 1, the X_1 represents the pre-test while the post test is represented as X_2 for the Experimental Group (EG) and Control Group (CG) respectively. The Inquiry-based teaching approach treatment is represented as Y. A teacher guided both the experimental and control group for one month**.**

Table 1: General

Groups	Pre-Test	x	Post-Test
Experimental Group (n-25)	X_1	Y	X_2
Control Group (n = 25)	X_1	Y	X_2

Sample

The sample consists of Fifty 2nd year students (25 students for EG and the other 25 students for CG) taking COS 234-Computer Application Course, from the Department of Computer Science, Coal City University, Nigeria. The sample was selected using simple random sampling technique, and was divided into two major groups; Experimental Group (EG) and Control group (CG) as contained in table 1.

Implementation of the Inquiry-based Teaching

The Computer Science lecturer who was assigned to implement the inquiry-based teaching had previous inquiry-based learning experiences from other Universities where he had taught before then. The lecturer was familiar with the inquiry-based technique and its application. Before the commencement of the inquiry-based process, a pre-test of the students' Computer Achievement was conducted. Thereafter, the teacher enlightened the participants (EG) about the inquiry-based technique, and their expected roles. He devoted some time to emphasize the benefits associated with the inquiry-based approach and how they can maximize it to improve their interest and achievement in the Course. Thereafter, students were assigned into groups and the inquiry process commenced. The exercise lasted for four weeks, after which the students were asked to make presentations on their inquiries and findings. These presentations were later followed by a post-test of the students learning interests and achievement. The Cronbach's alpha reliability was found to be 0.77.

Results

Testing of Hypotheses

<u>*Hypothesis One:*</u> The use of inquiry-based teaching approach has no significant effect on student's learning interests in Computer Science.

Table 2: Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Computer Learning Interest	Control Group	25	31.1200	5.57016	1.11403
	Experimental Group	25	34.5600	4.89115	.97823

Table 3: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
									Lower	Upper
Computer learning Interest	Equal variances assumed	1.469	.231	-2.320	48	.025	-3.44000	1.48257	-6.42090	-.45910
	Equal variances not assumed			-2.320	47.211	.025	-3.44000	1.48257	-6.42218	-.45782

From table 2 & 3, the experimental group that received the treatment of inquiry-based teaching showed a significant difference in their learning interests in Computer Science. Since the p-value of the t-test 0.025 at 48 df is lower than the hypothesized $\alpha = 0.05$. Also, the mean of the Experimental group 34.56 exceeds that of the control group 31.12. This means that there is a higher gain of students' learning interest due to inquiry-based teaching compared to those who were taught using the conventional approach. This implies that students developed more interest in Computer Science after their exposure in the inquiry-based teaching process. The results are consistent with the position of Vera (2016) that the use of inquiry-based learning model increases students interest in learning by providing them with the opportunity to construct their own knowledge, and to solve the problems encountered. It also support the finding of a study by Onyema et al (2019a) which found that inquiry-based learning inspired students and enhanced their development of interest in course activities.

Hypothesis Two: There is no significant difference in the achievement of students taught using the inquiry-based teaching approach and those taught using the conventional approach.

Table 4: Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Academic Achievement Post test	Control Group	25	58.2800	13.20833	2.64167
	Experimental Group	25	66.3600	13.60723	2.72145

Table 4 & 5 shows that the experimental group that received the treatment of inquiry-based teaching showed a significant difference in their academic achievement in Computer Science. Since the p-value of the t-test 0.038 at 48 df is lower than the hypothesized $\alpha = 0.05$. Also, the mean of the Experimental group 66.36 exceeds that of the control group 58.28. This means that there is a higher gain of students' achievement in computer studies due to inquiry-based teaching. Hence, students who were taught using the inquiry-based teaching approach outperformed those who were taught using the conventional approach. The result is consistent with an earlier study by Thompson (2006) which shows that inquiry-based teaching and learning can effectively improve the achievement of students. It also support the finding of a study by Onyema et al

Table 2: Group Statistics

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
									Lower	Upper
Academic Achievement Post test	Equal variances assumed	.075	.786	-2.130	48	.038	-8.08000	3.79271	-15.70576	-.45424
	Equal variances not assumed			-2.130	47.958	.038	-8.08000	3.79271	-15.70593	-.45407

(2019a) which shows that the use of inquiry-based learning approach improves students' attendance and productivity in learning. Minner, Levy, and Century (2010) also found a positive trend supporting inquiry-based science instruction over traditional teaching methods. The findings validate an earlier assertion by Hattie (2009), that inquiry-based teaching improves student's performance. Similarly, the results also agree with the position of Sharon and David (2013), that inquiry-based approaches to learning positively impact students' ability to understand core concepts and procedures.

Discussion

In order to establish the differences between the experimental and the control groups, we performed independent samples t-test analyses. According to the results as seen in Table 2-5, there are statistically significant mean differences between the experimental group and the control group in the post-test. There is a statistical improvement in the learning interests and academic achievement of the Experimental group compare to the Control group. This implies that the inquiry-based teaching approach had significant positive effects on the learning interests and academic achievement of the EG compare to the CG that was taught using the conventional method. The result is in agreement with the finding of an earlier study by Ali (2014) which showed that students who were instructed through inquiry-based learning achieved higher scores than the ones that were instructed through the traditional method. The findings of the present study support the earlier finding by Hattie (2009) which showed that students on inquiry-based activities comprehend better than those who are not. Similarly, the results of the present study agree with the popular quote by Benjamin Franklin *"Tell me and I forget, teach me and I may remember, involve me and I learn"* and John Dewey's assertion that a "*student learns more by doing than by listening*"

We deduce from our findings that the use of inquiry-based teaching approach inspired students to develop more interests in learning Computer Science, and also improved their learning outcomes. Students were excited to attend classes with vested interests in the inquiries, questions, presentations and discussions that will take place. The study shows that inquiry-based approach can potentially sharpen student's skills to search for solutions and to solve immediate and future problems if properly implemented. However, wrong application of inquiry-based approach could lead to compromise of course content. Therefore, there is need for proper students' orientation before the inquiry, and guide by the teacher to enhance student's ability to collect and interpret valid information and to discard fake or baseless ones that may be found on the internet or other sources. Also, there is need for educational institutions to train their staff and students on the application of inquiry-based system, and also prepare them for the transition to other modern teaching and learning techniques in line with the emerging trends in education.

Conclusion

The study establishes that inquiry-based teaching approach remains one of the ways that can be used to enhance students' learning interests and academic

achievements. Students demonstrated enthusiasms for the chance to own their own learning and tried to discover ways to solve problems or accomplish a given task during the inquiry process. Also, student's involvements in the inquiries and discussions increased their learning interests and experiences, making it easier for them to understand concepts, and identify different possible solutions to a given problem. This was evident in their increased academic achievements after the treatment. If the inquiry-based teaching technique is properly implemented, it can enhance students' critical thinking and problem-solving skills, and productivity in education. Consequently, educational institutions have to provide the supportive infrastructures/technologies that could facilitate inquiry-based or problem-based education.

Future Work

We are working on a project to investigate the effectiveness of inquiry-based teaching and blended learning approach on education of special people.

Acknowledgement

We acknowledge the efforts of Barrister Mrs. Chinecherem Deborah Edeh, and the Department of Mathematics and Computer Science, Coal City University, for their contributions towards the success of the study.

Data Availability Statement

All relevant data are within the paper

Declaration of Conflict Of Interest

We declare that there is no conflict of interest, and there is no financial support received from any organization for the submitted work.

References

Alfieri, L., Brooks, P. J., Aldrich, N. J., Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology*, 103: 1–18. doi:10.1037/a0021017.

Ali, A. (2014). The Effect of Inquiry-based Learning Method on Students' Academic Achievement in Science Course *Universal Journal of Educational Research*, 2(1): 37- 41. DOI: 10.13189/ujer.2014.020104.

Angel, S. and Marcus S. (2017). A review of the types of mobile activities in mobile inquiry-based learning. *Computer and Education*, 118: 38-55.

Berg, K., and Latin, R. (1994). Essential of modern research methods. Englewood Cliffs, NJ: Prentice - Hall, Inc.

Campbell, D.T., and Stanley, J.C. (1963). Experimental and quasi-experimental design for research. Chicago: Rand Mcnally College Publishing Company.

Education Development Center (2016). Inquiry-Based Learning: An approach to Educating and Inspiring Kids. pp 1-10. Retrieved from http://youthlearn.org/resources/inquiry-based-learning/. Accessed 15 May 2020.

Grade power learning (2018). What is Inquiry-based learning (and How is it effective)? Retrieved from: http://www.gradepowerlearning.com. Accessed 2 April, 2020.

Hawkey, R. (2001). Science beyond school – representation or re-presentation? In A. Loveless and V. Ellis, (Eds), *ICT, Pedagogy and the Curriculum.* London: Routledge Falmer.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analysis relating to achievement.* New York, NY: Routledge.

Justice, C., Warry, W., Cuneo, C., Inglis, S., Miller, S., Rice, J., and Sammon, S. (2002). A grammar for inquiry: Linking goals and methods in a collaboratively taught social sciences inquiry course. *The Alan Blizzard Award Paper: The Award Winning Papers*, Windsor: Special Publication of the Society for Teaching and Learning in Higher Education and McGraw-Hill Ryerson.

John, P. K. (2005). Inquiry-based learning, the nature of science, and computer technology: New possibilities in science education. *Canadian Journal of Learning and Technology*, 31(1):1-5.

Ken, A; Paula, G; and Kevin, T. (1998). Inquiry-Based Computer Science Instruction: Some Initial Experiences. ACM- ITiCSE '98 DublWin, 14-17.

Minner, D. D., Levy, A. J., and Century, J. (2010). Inquiry-based science instruction – what is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching*, 47: 474–496. doi:10.1002/tea.20347.

Mat´ıas L. (2017). Tell me and I forget, teach me and I may remember, involve me and I l e a r n " : Changing the Approach of Teaching Computer Organization. *2017IEEE/ACM 1 s t International Workshop on Software Engineering Curricula for Millenials (SECM),* pp 68-71.

Mark, G. (2010). Teaching Computer Science through Inquiry. Published in Computing E d u c a t i o n R e s e a r c h B l o g . R e t r i e v e d f r o m h t t p : / / w w w . c o m p u t i n g e d - wordpress.com/2010/12/27/teaching-computer –science-through-inquiry/

Noriah, I. and Suhaidi, E. (2006). Inquiry Based Learning: A New Approach to Classroom Learning. *English Language Journal*, 2 (1): 13-24.

Neil, G. and Mike, B. (2008) Inquiry based Learning in Computer Science teaching in Higher Education, Innovation in Teaching and Learning in Information and Computer Sciences, 7 (1): 22-33, DOI: 10.11120/ital.2008.07010022.

Onyema, E.M. (2019a). Integration of Emerging Technologies in Teaching and Learning Process in Nigeria : the challenges. *Central Asian Journal of Mathematical Theory and Computer Sciences*, *1*(August), 1. 35-39.

Onyema, E.M. (2019b).Opportunities and Challenges of use of Mobile Phone Technology in teaching and learning in Nigeria-A Review. *International Journal of Research in Engineering and I n n o v a t i o n* , 3 (6) : 3 5 2 - 3 5 8 . http://doi.org/10.36037/IJREI.2019.3601.

Onyema, E.M. and Deborah, E.C. (2019a). Potentials of Mobile Technologies in Enhancing the Effectiveness of Inquiry-based learning. *International Journal of Education (IJE)*, *2*(1), 1–25. https://doi.org/10.5121/IJE.2019.1421

Onyema, E.M., Deborah, E. C., Alsayed, A. O., Noorulhasan, Q. and Sanober, S. (2019b). Online Discussion Forum as a Tool for Interactive Learning and Communication. *International Journal of Recent Technology and Engineering*, *8*(4), 4852–4859. https://doi.org/10.35940/ijrte.d8062.118419

Onyema, E.M., Ani,U.E; Nnaji, A.D; Abdullahi, I; Alhuseen, O.A; and Quadri N.N. (2019c). T h e Role of Technology in Mitigation of Examination Malpractices in West Africa. *International Journal of Innovative Research in Computer and Communication Engineering*, 7(10): 3990-4002. https://doi.org/10.15680/IJIRCCE.2019.0710007

Onyema, E.M., Quadri, N.N; Alhuseen, O.A; Nwafor,C.E; Abdullahi, I. and Faluyi S.G. (2020). Development of a Mobile-Learning Platform for Entrepreneurship Education in Nigeria. *British Journal of Science* (BSJ), 18 (2):123-141.

Padaste, M.; Mario, M; leo, A.S; Ton, D.J; Siswa A.N; Van, R; Ellen, T.K; Constantinos, C.M; Zacharias, C.Z. and Eleftheria, T. (2015). Phases of inquiry-based learning: definitions and the Inquiry circle. *Educational Research Review,* 14: 47-61.

Rachel, S (2012). Experiencing the Process of Knowledge Creation: The Nature and Use of Inquiry-Based Learning in Higher Education. Paper presented at International Colloquium on Practices for Academic Inquiry. University of Otago. PP 1-17.

Spector, J.M. (2012). Foundations of Educational Technology: Integrative Approaches and Interdisciplinary Perspectives. Routledge, New York (2012).

Sharon, F. and David,S. (2013). Inquiry-Based Learning: A Review of the Research Literature. Paper prepared for the Alberta Ministry of Education, June, 2013.

Thompson, C. J. (2006). Preparation, practice, and performance: An empirical examination of the impact of standards based instruction on secondary students' math and science achievement. *Research in Education, 81* (1): 53-62.

Vera, S.A. (2016). The Effectiveness of Inquiry Learning Method to Enhance Students' Learning Outcome: A Theoretical and Empirical Review. *J. of Education and Practice*, 7 (3): 38-42.

Wise, K. C. (1996). Strategies for teaching science: What works? *The Clearing House,* 69, 337-338.

Zahara, A and Anowar, H. (2010). A comparison of cooperative learning and conventional teaching on students' achievement in secondary mathematics. *Procedia Social and* Behavioral Sciences, 9:53–62.