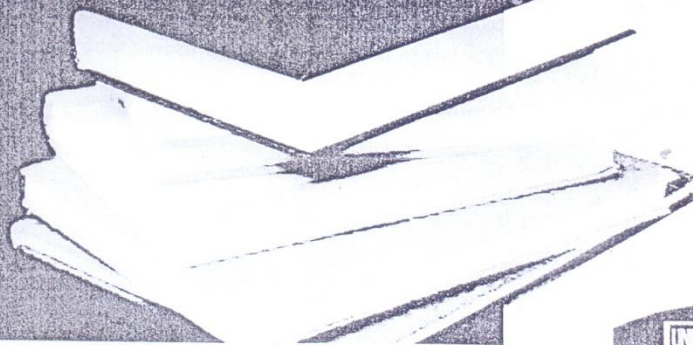


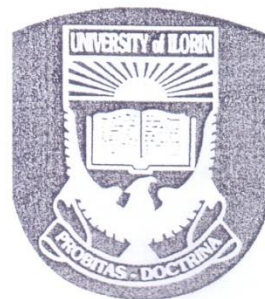
JOURNAL of CURRICULUM and INSTRUCTION

Vol. 11 Number 1, 2018



ISSN ONLINE - 2006-6937

PUBLISHED BY:
DEPARTMENT OF SCIENCE EDUCATION,
UNIVERSITY OF ILORIN, ILORIN, NIGERIA



FOREWORD

I consider it a befitting honour to have the medium of this special edition of the *Journal of Curriculum and Instruction*(JCI) to reflect on my sojourn at the University of Ilorin, Ilorin, Nigeria, for about 42 years. This is a Journal, which I participated in founding and naming, and thereafter serving as its Foundation Managing Editor.

I wish to thank God, the Almighty, sincerely, for the decision He inspired me to take to work with the University of Ilorin. I am happy I do not have any reason to regret this important life decision. I am grateful to the founding fathers of the University for the singular decision to appoint me at the rank of Assistant Lecturer in Education on 13 September 1976, and for providing me opportunity for the needed training, which enabled me to rise through the ranks and become a Professor of Science Education on 1 October 1998.

As I retire from the services of the University of Ilorin, I wish to admonish the academic and non-academic staff left behind to continue to uphold the high standard of operations for which our Department is noted. Academic members of staff should please continue to engage in original research works that could be published in high impact journals, like an online JCI, good teaching, using innovative teaching strategies, and community development, which would solve specific problems in the society. It is also important to have an early specialization in specific areas of research by which colleagues would be known nationally and internationally.

Incidentally, this special edition of the JCI contains papers on topics that are of interest to me, such as computer studies and entrepreneurship that are trending in science education at this time. In addition, the papers are widely spread over the major subjects that constitute science education, viz: biology, chemistry, and physics. All the papers contain pieces of information that are beneficial to science educators in Nigeria and beyond.

I wish to thank Dr. Mulkah A. Ahmed, the Head of Department and Professor Esther O. Omosewo, the Editor-In-Chief and Managing Editor, respectively, at this auspicious time, for facilitating the production of the special edition of the JCI to mark my exit from the Department and the University.

Professor Isaac Olakanmi Abimbola
Department of Science Education
University of Ilorin,
Ilorin, Nigeria
21 June 2018

NOTE FOR CONTRIBUTORS

The Department of Science Education, University of Ilorin, Nigeria, journal title Journal of Curriculum and Instruction publishes papers that report results of research, as well as descriptive, interpretative and persuasive articles related to curriculum and instruction which includes:

- a) Curriculum theory and practice;
- b) Instructional theory and practice;
- c) Educational technology and
- d) Subject methodology.

The journal is published biannually, which constitute two annual issue in one volume.

Guidelines for Authors

1. Articles should not exceed 15 pages (including references and appendices) in length. They must be typewritten, double-spaced on A4 size sheets. Ample margin should be provided.
2. Each article should be prepared by an abstract of not more than 200 words.
3. The title of the paper, the author's name and address, should accompany each article on a separate page for proper identification and recognition.
4. Footnotes are not acceptable except on the front page where they may be used to identify the author(s) or the article.
5. The editorial board of the Journal of Curriculum and Instruction adopts the APA format 6th edition, as a guide for preparing a journal article.
 - a. Table and figures should be as few as possible. All figures should be camera ready.
 - b. All references in the text must be accounted for at the end of each article. The list of references must be in alphabetical order.

Books

Abdullahi, A. (1982). Science teaching in Nigeria. Ilorin: Publisher.

Fafunwa, B. A (1972). The purpose of teacher education. In A. Aderalegbe (Ed). A Philosophy for Nigerian education (pp. 22-33). Lagos: Heinemann Education Books.

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EDITORIAL

Members of the Editorial Board of the *Journal of Curriculum and Instruction*, JCI, are happy to publish another special edition of the Journal, so soon after Volume 10, Number 2, of 2017, which was dedicated to Professor Michael OlubusuyiFajemidagba on his retirement from the services of the University of Ilorin.

This special edition of JCI, Volume 11, Number 1 of 2018 is published in honour of Professor Isaac Olakanmi Abimbola, a foundation member of the Department, and a member of the Editorial Board of the Journal who is retiring from the services of the University of Ilorin, Ilorin, Nigeria, on 2 August 2018.

Professor Abimbola is leaving behind a legacy of distinct areas of research in student learning, related to misconceptions and alternative conceptions (or misunderstood) in biology, history and philosophy of science, use of innovative instructional strategies involving analogies, metaphors, and lately, study technology instructional and learning strategies. We shall continue to remember him for his legacy books—Principles and Practice of Instruction, Philosophy of Science for Degree Students, History of Science for Degree Students (with Esther O. Omosewo), Preparation of Lesson Plans, Learning How to Learn for Perfect Understanding, Methods of Teaching Science, Basic Technology, and Computer Studies (with others), A Practical Guide to Research Project Reporting, and Biology Teaching Methods,

He shall be remembered for the high standards he set for himself in the conduct of his life activities, as exemplified in his integrity, forthrightness, organization, thoroughness, warm interpersonal relations, and so forth.

Some of the papers published in this edition include some research areas that are of interest to the honouree. These include areas such as computer studies curriculum, philosophy and curricula, problems of chemistry teaching, biology process skills, curriculum implementation, and secondary school students' performance, and entrepreneurship education. Useful recommendations were made for specific stakeholders that could serve to improve science education in Nigeria. We commend this edition of JCI for the reading pleasure of science educators and teachers.

Esther O. Omosewo, PhD
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Computer Studies' Curriculum Review: A Proposal for an Innovative Curriculum

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Abstract

This paper proposes an innovative curriculum prototype for Nigerian Computer Studies' Curriculum (NCSC) having examined the current situation of secondary school computer studies curriculum and the need for its review. This proposal is premised on the need for the NCSC to be redirected towards being activity-based, learner-centered and contextualised. Computer studies is not a subject to be taught in an abstract sense thus, the need to be fully packed with problem-based activities for students' immersion in computer science concepts. Learning is being clamoured for to be less of teacher-centered but learner-centered in order for students to be able to create meaning with their learning. Finally, the concept of GLOCALIZATION is hinted in this proposal to enable students link global concepts of computer studies to their immediate environment (local). This innovative computer studies curriculum proposal provides examples of how concepts in computer science are explored in human comprehensible formats and localised contents.

Keywords: Computer Science, Innovative Curriculum, Learner-Centered, Globalization, Contextualised.

Introduction

A comprehensive comparative review of the computer studies textbooks adopted in Junior Secondary Schools (JSS) and the NCSC was conducted by Adedokun-Shittu, Daramola and Muhammad (2016). They examined the Junior secondary school III textbook written by Otuka, Akande and Iginla (2010), JSS II textbook authored by HIIT, (2010) and JSS I Textbook written by Olatokun, Agbonlahor, Adeniran and Ajayi (2007), in line with the corresponding curriculum content as found in the Junior Secondary School Curriculum, Basic Science and Technology JSS 1 –3, Nigerian Educational Research and Development Council (NERDC, 2009). After a thorough and careful analysis, a major curriculum review was recommended. This thoughtful recommendation was given having observed that: the curriculum and the textbook are not consistent with one another; the arrangement of the topics in the curriculum is incoherent; the contents under each topic also differ in the curriculum compared to the textbooks; teachers' activities are not well addressed and some topics in the textbooks are not relevant to the subject and corresponding classes. On the final analysis, they suggested that computer studies curriculum should incorporate class activities that are learner-centered; learning process should be problem-based; the convention of teaching should involve using real-life situations; learning should be inquiry-based; curricular materials should be selected based on core concepts such that students understand through induction rather than memorization and student-context learning should be emphasised in the curriculum.

Based on the above submission and the crude reality of the current situation in Nigerian secondary schools ranging from unavailability/inadequate basic infrastructures and amenities; insufficient instructional resources and dearth of competent facilitators; non-provision of enabling environment and inadequate stakeholders' support; and non-commensurate standard with the global demands of teaching computer science in schools, it is imperative to propose a prototype curriculum to salvage the situation. Against this background, this paper sets to predicate this proposal upon the following subheadings: Benchmark with Global Curriculum, Learner-centered/Activity-based Curriculum and Innovative Curriculum Prototype.

Benchmark with Global Curriculum

This section x-rays the NCSC in the light of the K-12 Computer Science Framework and Model Curriculum (CSTA, 2011; Tucker, Deek, Jones, McCowan, Stephenson & Verno, 2006). The model curriculum proposes the integration of computer science fluency and competency throughout primary and secondary schools world over. The K-12 Computer Science Framework represents a vision in which all students engage in the concepts and practices of computer science from the earliest grades through to the 12th grade where students develop a foundation of computer science knowledge and learn new approaches to problem solving that harness the power of computational

thinking to become not just computer users but also computationally literate creators who are proficient in the concepts and practices of computer science. The K–12 Computer Science Framework informs standards and curriculum, professional development, and the implementation of computer science pathways.

The Framework illuminates the big ideas of computer science through a lens of concepts (i.e., what students should know) and practices (i.e., what students should do). The core concepts of the framework represent major content areas in the field of computer science being the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications, and their impact on society. The core practices represent the behaviors that computationally literate students use to fully engage with the core concepts of computer science. The framework's learning progressions describe how students' conceptual understanding and practice of computer science grow to provide authentic, meaningful experiences for students engaging in computer science. It shows the core concept, subconcept, concept statement, elaboration and example which gives teacher an insight into what is to be taught, how to engage students and make appropriate selection in terms of teaching methodology and rightful selection of instructional material. It emphasizes majorly on computational approach in solving problems.

In simple terms, computational thinking is fundamentally a human ability, "[h]umans process information; humans compute" (Wing, 2008). Computational thinking refers to the thought processes involved in expressing solutions as computational steps or algorithms that can be carried out by a computer. The assessment of computational thinking can be improved by having students explain their decisions and development process (Brennan & Resnick, 2012). Computational thinking is a fundamental skill for everyone, not just for computer scientists. "To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability" (Wing, 2006).

Computational thinking is a form of inquiry-based approach which guides teaching and learning. How teaching through inquiry allows students to conceptualize a question and then seek possible explanations. This approach will give teachers insights into how to sustain students' curiosity and help them develop the sets of abilities associated with scientific inquiry. This would develop in them the ability to provide powerful strategy for solving many problems encountered in the work place and in everyday life. This would provide young people with the opportunity they need to develop their scientific understanding and ability to inquire (National Research Council, 2000).

Computational Thinking isn't (necessarily) used to solve problems with a computer, but to use ideas from Computer Science to solve real-world problems. Computational thinking focuses on using the combined strength of human and computer brains to solve problems and accomplish tasks. It develops in students an analytical ability that helps them confront the riddle of machine intelligence - what can humans do better than computers and what can computers do better than humans. It's

not that everyone must reason like a computer scientist or develop algorithms, but rather apply it to solve problems and discover new questions that can generate application in real life situations (Barr & Stephenson, 2011).

This computational thinking approach is handsomely reflected in all the Goals of K-12 curriculum which includes: to live and work successfully in an increasingly information rich society, that students must learn to use computers effectively and incorporate the idea of algorithm into their daily problem solving vocabulary, to access and exchange information, to draw conclusions and make generalizations from information gathered, to become self-directed learners, to collaborate and cooperate in team efforts and to interact with others using computers in ethical and appropriate ways. All these goals are fully entrenched in the topics catered for all through the grades of the K-12, the teaching methods suggested for teachers and the activities provided in the curriculum to actualise the learning outcomes and generally the goals of the curriculum.

On the other hand, the goals of the NCSC though very inclusive and elaborate, provides no realistic means of achieving them. Among the goals of the NCSC are: to facilitate the teaching and learning process, to promote problem-solving critical thinking and innovative skills of students, to promote life-long learning, to enhance the various teaching/learning strategies required to meet the needs of the population, to foster research and development, to support effective and efficient education administration, to enhance universal access to information, to widen access to education and the range of instructional options and opportunities for any-where, any-time, any-place and any-path learning. As much as fascinating and globally acceptable these goals are, the topics provided in the Nigerian computer studies curriculum are far from realising them. The teaching methods are teacher-centered and activities provided for in the curriculum (if any exist) are inadequate to match these goals. The subject name itself (computer studies as opposed to globally and widely used – computer science) suggests just the study of computers and not the science behind computers. Going by the definition of computer science given by CSTA (2011), as the study of computers and algorithmic processes¹, including their principles, their hardware and software designs, their applications, and their impact on society, teaching and learning of computer science should be all inclusive and impactful.

Computer Science being a mainstream discipline can no longer be ignored or undermined in the 21st century. With the strong basis provided by the K-12 model curriculum for education policy makers world over, schools can begin to implement a coherent computer science curriculum that is available to all students. Thus, it is recommended that education policy makers in Nigeria should take a leap from the K-12 curriculum to improve the NCSC with innovative teaching approaches, globally accepted computer science concepts and problem-solving activities that will actualise the goals of the curriculum.

Learner-centered and Activity-based Curriculum

"You can't make a fish climb a tree but you can make a monkey swim for its survival. Making a fish climb a tree is an impossible mission because a fish has neither hands nor legs but has fins and tail which can only make it dive or swim in water. Fish cannot survive on land, so to make it climb a tree is a cruel act. Making a monkey swim for its survival is however realistic because it possesses both hands and legs which are meant for jumping and climbing but they can be trained to dive if that is the only means of survival. This can be referred to as justification done or solution to the problem at hand. This analogy is a simple description of the present situation of teaching and learning in Nigeria and perhaps the way out. The similitude of a fish climbing a tree is expecting a theoretically-trained student to compete favourably with his/her practical-trained counterparts. Thus, introducing the monkey trained to swim style which is the practical application of theoretical concepts through learner centred and activity-based learning is imperative. In contemporary times, the nature of learning is such that learners are at the centre stage, teachers therefore need to get used to the challenges that come with this reality.

Learner-centered learning emphasises that teachers must be comfortable with being a facilitator rather than a "sage on the stage" such that learners become active participants in their own learning. As such, the curriculum cannot remain "safe" from change and learning can no longer be confined within the four walls of the classroom (Adedokun-Shittu, Shittu & Obielodan, 2016). In learner-centered and activity-based curriculum, inquiry-based learning, learner engagement and learner-context are key elements to focus on where teacher-learner collaboration becomes paramount.

Inquiry-based Learning

A form of inquiry-based approach is Computational thinking which guides teaching and learning through inquiry by allowing students to conceptualize a question and then seek possible explanations (Barr & Stephenson, 2011). Can you figure out how binary representations, permutation and combination relate to Oracle divination? Create a scenario for binary representation or creatively give inquiry based activities for students to search, you will be surprised how much you are learning from these geniuses (Adedokun-Shittu, Obielodan & Shittu, 2016). How does a human brain work? Compute like computers? If you are hooked up in any difficult situation, what is the first thing you do? Think? Of what! How to get out of the mess? You strategize a way out. That is exactly how a computer works, it thinks of solutions to human problems posed to it. How computer thinks is what is referred to as "computational thinking". Students need to learn the principles and concepts of science and acquire the reasoning and procedural skills of scientists and understand the nature of science as a particular form of human endeavour. An example of students' inquiry is given below: [excerpt from a computer science education pre-service training methodology course]

Q: How will you use the concept of computational thinking to achieve putting theoretical concept of error detection into practice

A: Reflecting on a movie they have watched before e.g 'why do the Fbi or CIA.agents use hand gloves in a crime scene in movies?' ...to prevent them from adding their own prints

or DNA to the existing ones at the scene, taking note of what have been moved, even the dust particles can be used to take note of the activities that took place in one's absence. For instance, the location of the sound system might be in a position for weeks, if it is moved from that position, there will be a mark or shape of the sound system on the floor, the person's hand print will be on the system and if it is cleaned, it will look neater than the other ones. This can be used to detect theft.

How amazing students were able to come up with reasoning even beyond what the teacher can think of or relate to the concept of error detection. This active participation from the students in their own learning through inquiry-based learning leads to peer collaboration and engagement among students which is a required skill for success in the work place environment.

Learner Engagement

When students are engaged in their own learning, they use collaborative tools to effectively work together and to create meaningful outcomes. Teachers can facilitate students' learning, raise their achievement level and improve their career aspirations by integrating this into their teaching activities. Learner engagement involves asking for the contributions and feedback of students through effective collaboration which can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. The ability to recognize appropriate and worthwhile opportunities to apply computation is a skill that develops over time and is central to computing. Solving a problem with a computational approach requires defining the problem, breaking it down into parts, and evaluating each part to determine whether a computational solution is appropriate. This could be achieved with collaborative computing which is the process of performing a computational task by working in pairs and in teams. Computational situation such as deadlock and routing could be presented to students in activity sessions in a class. It will give them experience with such situations which requires a cooperative procedure for everyone to accomplish the desired result without becoming deadlock.

'Suppose you are stuck up in a traffic jam, no way out seems to be imminent – a deadlock! This is a concept in computing 'deadlock and routing'. Deadlocked situation can be re-routed in real life situations as it is carried out by a computer system, think of two other deadlock situations in real life and figure a way out. This experience will develop cooperative skills in the students, giving them the courage to solve problems collectively and help them relate computational problems to their immediate environment.

Learner Context

Culture and language form the context in which students learn actively and engagingly. How fun will it be if students are taught mathematics, physics, chemistry, biology and particularly computer science using localized, culturally-situated and traditional context materials, language and art? This student-context approach is described as GLOCALIZATION in (Adedokun-Shittu, Shittu, AbdurRaheem, Salawu&

Ahmed, n.d) where global contents are created in local scenario with some universal and unique values such as child's play, proverbs, idioms, antiques, tradition, culture explored as a blend of resources for teaching and learning various subjects. Peradventure, students will start to develop more interest in learning and both teachers and students will collaborate to become creators of contextualised, universal knowledge and not just consumers of foreign knowledge.

Imagine teaching 'addition' in fact the whole of BODMAS with *lanka-lanka*(hop-scotch), *ayoolopon*, for addition/subtraction, *tente*, *tinko*, *okototita*, to teach multiplication/division. Think of proverbs that go along with concepts in physics, chemistry, biology. '*Laalaa to roke, ile lo nbo*' - a Yoruba proverb explaining perfectly the 'Law of Gravity'. '*Iroñito n jo loriomi, onilu re wanisaleodo*' - relating the upthrust that exist when a body is immersed in a fluid that's Archimedes principle in Physics. All these are in our tradition, we need not wait for an *Oyinboman* to call it ETHNOCOMPUTING for us before we adopt it. Dr Ron Eglash came up with the concept of Ethnocomputing or culturally situated learning to get students to learn to solve problems in creative ways through the use of culturally Situated Design tools (CSDT).

The CSDTs are web-based software applications that allow students to create stimulations of cultural arts. It provides a potent space for students to reconfigure their relationship with culture, mathematics and technology. It could be created so that students would be intellectually challenged and also be able to find the commonality between them and computer science. Students would be able to learn, think, plan and experience creative processing which are fundamental skills that are learned through the use of culturally situated materials. They would be able to analyze the effects of computing on society within economical, ethnical, sociological and cultural contexts (Eglash, Bennett, O'Donnell, Jennings & Cintorino, 2006).

Students can create a sand box environment where they program characters to dance, to create unique audio clips with musical instruments such as *apala*, *faji*, *dundun*, program a virtual human to perform dance moves (*bata*, *gelede*) by the use of trigonometric functions. By teaching permutation and combination through *ayoolopon*, relating binary representation *tooduifa*, by counting rhythm beats "*Eni bi eni, eji bi eji, eta ntagba, erinworoko,....*" so that this can help the students to learn numbers and operations and to solve problems in creative ways through computer-based design tools. Through this approach, students will be involved in several indepth projects to demonstrate application of computing concepts in real-life situations. These would ultimately allow them to utilize appropriate tools and methods to carry out indepth researches and gain insights into developing algorithms to solve real life problems.

Innovative Curriculum Prototype

The situation in Nigerian schools has relegated the teaching of computer studies to theoretical subject alone where it is taught in classrooms rather than in computer laboratories, this is not commensurate with global demands of teaching computer science. Despite this unfavourable situation, Nigeria students desperately require the skills and requisite knowledge to compete favourably with their peers globally.

Considering this situation, there is need for stakeholders in education especially computer studies to look into best practices world-wide that are cost effective and that can be adapted locally to help our students match with their counterparts.

Imagine a situation where computer science is taught without computers, (*hmmm!!!, boring, abstract, theoretical*). Yes, abstract teaching is boring, but that is the situation in most of Nigerian public schools, so, how can we turn the situation around to be interesting, realistic non-abstract and practical without proper and adequate instructional resources? **CSunplugged** – Computer Science unplugged, hmmm! Simply, it's saying you can teach computer science in an interesting, student-engaging way without having to connect or plug any port/cable/wire. The unplugged" approach to computer science (i.e., teaching computer science without computers) and explain how computational thinking can apply beyond the borders of computer science to a variety of disciplines, such as science, technology, engineering, and mathematics (STEM), arts and humanities (Bundy, 2007), where "humans process information; humans compute" (Wing, 2008,). CSunplugged program has generated interest around the world and currently has advocates in at least 16 countries in addition to International organizations. It takes an unusual approach of exposing students to the great ideas of computer science without using computers. Among the principles of CS Unplugged are to engage students in fun and captivating activities, use domestic and inexpensive materials to improvise learning. It provides mechanism for educators to exchange ideas, including teaching methods and ways to integrate problem solving activities into the curriculum. It also motivates students through a sense of creative story to capture their interest and engage students in inquiry-based computational thinking. The unplugged goal is to develop a community that is able to share good teaching practices and novel ideas that builds on the key idea of enabling students to explore computer science without learning programming first(Bell, Alexander,Feeman& Grimley, 2009).

Take an instance, a big concept in computer science – network sorting, how can you teach this without having to border students too much with computer jargons and using complex illustrations? Will you open up the case of a computer Central processing unit (CPU) before students can get the gist? *That's like opening up a human brain to show biology students how the brain processes information.* Below is an example of an activity for suggestion on how to develop our computer science curriculum for each topic/concept.

Sample Activities for Level I: Foundations of Computer Science

Activity: Color by Numbers

Time: 3 hours

Description: The computer stores drawings, photographs, text, and other pictures using only numbers.

This activity demonstrates how that is done.

Level: I (K-2)

Topics: 11—using 0s and 1s to represent information

Prior Knowledge: Grade 2 geometry (exploring shapes), counting, graphing

Planning Notes:

Motivational discussion questions include, "What does a fax machine do?"

"In what situations would a computer want to store pictures?"

"How computers store pictures when they can only use numbers?"

Teaching/Learning Strategies:

A 5x6 rectangular grid is used as a basis for representing different images (such as letters) by coloring

in some of the squares (pixels).

Coding of the image is done by scanning the sequences of 1s (shaded squares) and 0s in each row of

the grid and recording the length of each sequence.

Assessment and Evaluation:

Worksheet activities.

Accommodations:

No computers are required; students use two worksheet activities, called "Kid fax" and

"Make your own picture"

Resources:

See www.unplugged.canterbury.ac.nz to learn more about this activity.

Pedagogical Implications of these Approaches

We have started to experience a shift in the nature of learning predicated by demographic shifts, technology advancements, changes in the expectations and behaviour of employers and changes in the nature of work. This calls for stakeholders in education to flexibly provide learning in a more creative and dynamic way to respond to different market niches. To be able to realistically adapt this model as emphasised in the framework; teacher preparation, content standards, and curriculum materials development are crucial areas of focus. The implication of these includes; conducting intensive teacher training on the curriculum innovation, building a network of teachers ready to drive the cause of learner-centered/activity-based learning and challenging students to brainstorm on localised content for the application of computer science. Understanding the constraints that might plague this development in Nigeria, it is recommended that support in finance and expertise be sought from international organizations such as ACM, the IEEE Computer Society, ISTE, institutions of higher education, and national and local teacher organizations. These identified stakeholders will help in rebuilding the NCSC, not by blindly adopting but by adapting the model curriculum to our context.

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Journal of Curriculum and Instruction, Volume 11, Number 1, 2018

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