EFFICACY OF LOGO INSTRUCTIONAL PACKAGE ON DIGITAL COMPETENCY SKILLS OF LOWER PRIMARY SCHOOL IN OYO STATE, NIGERIA

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Abstract
The lower primary classes (Primary I to III) are last part of early years education which is known as the foundation phase of basic education in Nigeria. This level of education is meant to prepare the pupils for the fundamental skills and knowledge required not only for further education but for successful living in the 21st century and beyond, hence the introduction of Basic Science and Technology. But the extent to which pupils in public lower primary schools, exposed to the digital skills and knowledge in Nigeria is in question. Based on this, this study exposed primary school pupils to programming using the Language of Graphics Orientation (LOGO) and measured their digital competence in it. The developed LOGO Instructional Package (LIP) through action research and implemented the package adopting a one-group pretest-posttest quasi-experimental design. Due to experimental mortality, 349 pupils fully completed the study, which cut across ages 5+, 6+, 7+ and 8+ years from four schools. Data were collected using a self-designed LOGO Programming Achievement Test (r = 0.70) and Computer Literacy Scale (á = 0.72). Descriptive statistics, graphs, t-tests, and Pearson product-moment correlation (PPMC) were used to analyse the data. Pupils at age 6 had competence in modules 6, 7 and 9 (Which deals with the command window, the input box and turtle to draw and saving works respectively) with a mean ranging from 2.77 to 4.36 (6.0 being the mark obtainable) among other results. Computer skills should be made compulsory in primary schools.

Key words: Primary school curriculum; LOGO programming; Digital competence; Lower primary classes

Introduction

Primary education is the foundation of formal or organized education that prepares children in fundamental skills and knowledge areas. It is regarded as the most important level of education because it serves as the foundation for all subsequent levels of education. The National Policy on

Education (NPE) (FRN, 2013) defines primary education as education provided in an educational institution for children aged 6 to 11 years plus. The policy emphasizes the essential goals of the educational system, which include but not limited to: the laying of a sound basis for scientific and reflective thinking; developing in the child the ability to adapt to the changing environment; and providing opportunities for the child to develop life manipulative skills that will enable the child to function effectively in the society within the limits of his capacity among others. To achieve these goals, the NPE document of 2013 proposes practical, exploratory and experimental methods of teaching and learning for Nigerian foundation schools.

Again, the African Union 2063 agenda has the first aspiration to be a prosperous Africa, based on inclusive growth and sustainable development. One of the objectives for achieving this goal is to create a well-educated citizenry and a skills revolution based on Science, Technology, and Innovation (African Union Commission, 2015). The dream of Africans in which the Nigerian government believed in, can only be achieved when the entire citizenry is initiated into the digital age through basic education, starting from the foundation level - primary education. To reach these goals, it is imperative to employ the use of Information and Communication Technologies (ICTs). The digital era has revolutionized pedagogical practices and expanded access to quality education by serving as a curriculum transformation (Agbatogun, 2010; Saravanakumar, 2018). The use of ICT enables learners to be more creative and imaginative as well as encourages learners to communicate more. It increases the learners' confidence to participate actively in the class; enhances thinking capacity so as to enable thinking outside the box and makes the best use of their learning process (Ghavifekr & Rosdy, 2015).

There is a widespread belief that computer technology can and will empower teachers and learners by shifting teaching and learning processes from highly teacher-dominated to learner-centred, resulting in increased learning outcomes for the learners by creating and allowing opportunities for learners to develop their creativity, problem-solving abilities, informational reasoning skills, communication skills, and other higher-order thinking skills (Akinyemi, 2013) which is the goal of instructions in Language of Graphics Orientation (LOGO).

LOGO was originated at the Massachusetts Institute of Technology in 1967. The originator is Seymourt Papert and his colleagues. The aim was to facilitate the use of computer for classroom instruction among learners of different ages (Papert, 1980). Papert, a computer expert, dwelled

extensively on the study of development of the child, using the interface of Piagetian theories and his expertise in computer to examine cognitive characteristics of children to invent a software programme to facilitates the use of programming language by children (Torgerson, 1984).

Studies on LOGO programming indicates many positive effects on primary school pupils (Pardamean & Honni, 2011; Aremu & Akinyemi 2014). Reports indicate that pupils have more fun and are more enthusiastic, when they have increased engagement in learning and are more interested in self-directed learning. Furthermore, they also have greater self-confidence, self-esteem and increase their problem-solving and critical-thinking skills (Pardamean & Honni, 2011). In addition, pupils often enjoy spending more time working collaboratively and are more willing to share their work and help each other with the use of digital tools (Akinyemi, 2013).

As much as it has been established that pupils enjoy learning using ICT and this is capable of improving the learning outcomes, it may also be noteworthy to understand that one of the recurring themes in the under-utilization of ICT-related tasks is the lack of relevant competencies (Towolawi & Onuka, 2011). Computer literacy has been defined as the ability to make use of computer system for word processing, analyse data, develop small computer programmes, browse the Internet and install software (Idowu *et al*., 2004; Hall, 2005). Therefore, the primary goal of using computers in young children education might be considered computer literacy. Hence, computer literacy can be used to cover teaching children how to use the computer as a tool (a medium with which to calculate, draw or write); as a tutor (to provide instruction); as a tutee (to be programmed); or as a combination of these three (Tella & Mutula, 2008). It is thus pertinent to study how the development of pupils in computer usage can be, not only directed towards 21st century ICT lucrative skills such as programming and digital skills but also the extent to which they can be competent in the skills. The improved interest and performance of pupils in many ICT-related studies have been attributed to the type of schools (private or public) the pupils attend. This has been a subject of debate among educators (Corten & Dronkers, 2006). Generally, it has been found out empirically, that pupils in private schools outperformed their counterparts in public schools. Etsey, Amedahe & Edjah, (2005), in a study of 60 schools from peri-urban (29 schools) and rural (31 schools) areas in Ghana, found that academic performance was better in private schools than in public schools because of more effective supervision of work. This finding corroborates the finding of Onuka (2005) that private primary schools in Nigeria are better supervised than the public schools. Factors such as school

type have also been speculated to influence technology use. Empirical studies have shown that variations in ratings existed as a result of the types of school (Fuchs & Wossmann, 2004; Altonji, 2005).

Therefore, this study exposed lower primary pupils to LOGO and determine their level of competence in the 20 modules of programming carefully selected. The paper also examined the influence of types of school on pupils competence in programming. The outcome of the study could inform primary education curriculum reform.

Theoretical Model

Kerr's Model of Curriculum Design

Kerr's Model of Curriculum Development as modified by Urevbu (1985) was adopted for this study. Kerr's model contains the following four elements: objective, knowledge, school learning experience and evaluation. Urevbu (1985) avers that curriculum development should first focus on the objective to be reached, and distinguish between how knowledge and the subsequent learning experience should be organized, integrated, sequenced and reinforced. While evaluation in Kerr's model is considered as collection of information in terms of curriculum efficiency to improve the learning process. This is amplified in figure 1.

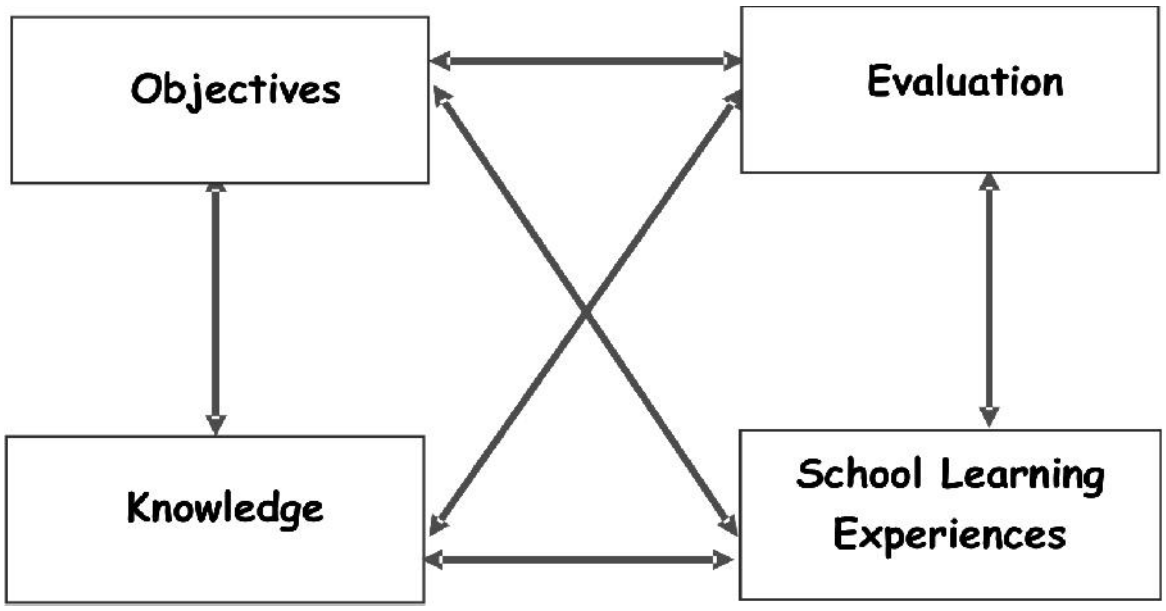

Fig. 1: A simplified Version of Kerr's Model of Curriculum Design (Urevbu (1985).

Figure 1 presents the four elements (objective, knowledge, evaluation, and school learning experiences) are interrelated directly and indirectly. Every two element of the model has double-headed arrow, which indicate the type of relationships that exist among the elements. This relationship ensure that the elements shared close content which will not allow derailing. The four elements contain in the model facilitate the achievement of the stated objectives. This study is anchored on Kerr's model to organise the elements and contents of LOGO instructional package. The stated objectives, the content, methods and the assessment and evaluation were all arranged to follow the model.

Fun-rigor Theory of Child Development

This study is also partly anchored to F-R Theory of Child Development which was developed by Salami, Ishola Akindele in 2018. The theory states that injection of some developmentally appropriate real-life rigours to the day-to-day fun activities of children will bring about the development of economic skills (determination-for-success, invention, endurance, persistence, self-dependent) and soft skills (responsibility, flexibility, team-spirit, integrity and courtesy) in the children hence, assure of success. The theory establish why children education should be by fun activities and some developmentally appropriate rigour activities so as to inculcate into the learners, the economic and supporting soft skills. One of such economic skills is the ICT skills, two of which are the programming and digital literacy skill. This theory is relevant to this study because it explains what would be the learning outcomes when the lower primary school pupils are exposed to ICT activities in a fun-filled atmosphere with challenging activities. The pupils will not only acquire the programming skills but also develop some appreciable digital literacy skills.

Research Questions

1. At what age do lower primary pupils acquire competences in each of the 20 LOGO Programming Language Package Modules?
2. What is the level of programming skills and digital competence of lower primary pupils before and after the intervention?

Hypotheses

$H_0$1: There is no significant relationship between pre and post-intervention digital competence measures of lower primary pupils.

$H_0$2: There is no significant difference in the digital competences of pupils based on school types.

Methodology

The study was in two phases: the first was action research which involved the development of the LOGO Instructional Package (LIP) using Kerr's Model of Curriculum Design (KMCD). KMCD has four major elements namely, The Objectives, Knowledge, School learning experience and Evaluation. The model observes dual interaction between any two elements of the curriculum which enable all the educational activities concentrate on the set objectives without derailing. The second phase of the study adopted Salami's F-R Theory of Child Development to implement LIP such that the pupils were exposed to developmentally appropriate rigour, while enjoying playing with computer. A one-group pretest-posttest quasi-experimental research design was adopted. Two public and two private primary schools in Ibadan North Local Government Area were purposively selected for this study. The criteria for selection include the availability of computer systems as well as enough pupils in Primary I, II and III. In each school, 25 pupils aged 5+, 6+, 7+ and 8+ were randomly selected from Primary I to III. This gives a total number of 100 pupils per school. But due to experimental mortality, only 349 pupils who participated fully and had complete data were considered in the data analysis. The stimulus and response research instruments used are the Guide on LOGO Instructional Package (GLIP) and the response instrument titled LOGO Programming Competency Test which was a self-designed instrument with psychometric property of (($r = 0.70$). Descriptive statistics, graphs, t-tests, and analysis of variance (ANOVA) were used to analyse the collected data at 0.05 level of significance.

Results

Research Question 1: At what age do lower primary pupils acquire competences in each of the 20 LOGO Programming Language Package Modules?

To answer this question, Table 1 and multiple line graph is presented in Figures 1

Table 1: Age in Relation to Modules Mastered

Modules	Contents	Age levels at which Competence is acquired in public schools	Age levels at which Competence i acquired in private school
1– 4	Module 1: Let's get started. After completing the module, pupils were able to open Microsoft Windows LOGO and identify Microsoft Windows LOGO Software. Module 2: How to Exit LOGO. At the completion of the module pupils were able to open and exit Microsoft Windows LOGO software. Module 3: LOGO Turtle Graphics. At the completion of the module, pupils were able to Identify the turtle, Locate the turtle home position, hide the turtle and show the turtle again. Module 4: LOGO Opening Screen. At the completion of the module, pupils were able to Identify The Main Screen and The commander Window on the LOGO Opening Screen.	5, 6, 7 and 8	5, 6, 7 and 8
5 and 6	Module 5: LOGO Main Screen. At the completion of the module, pupils were able to identify the title bar, menu bar, drawing area and vertical scroll bar on the LOGO Main Screen Module 6: The Commanded Window. After completing this module, pupils were able to identify the commander window and use the component of the commander window.	6, 7 and 8	5, 6, 7 and 8
7	Module 7: The Input Box and Teaching the turtle to draw a CIRCLE: After completing this module, pupils were able to describe the Input box, enter and execute commands, draw different sizes of circles	5, 6, 7 and 8	5, 6, 7 and 8
8, 10 and 12	Module 8: Saving your work. After completing this module, pupils were able to save their pictures. Module 10: Turning Primitives in LOGO (Right/RT command). At the completion of this module, pupils were able to identify the position of the turtle, turn the turtle to the right side at different steps using RT command Module 12: Printing your Pictures. After completing this module, pupils were able to print their pictures.	6, 7 and 8	5, 6, 7 and 8
9 and 11	Module 9: Primitives/Commands in LOGO FORWARD and CLEAN Commands. At the completion of this module, pupils were able to apply the rules of giving commands in LOGO Programming Language, demonstrative the use of FD and Clean commands Module 11: Teaching the turtle to draw a SQUARE. At the completion of this module, pupils were able to draw different sizes of squares.	6, 7 and 8	5, 6, 7 and 8
13 and 14	Module 13: Opening your saved pictures. After completing this module, pupils were able to open their pictures. Module 14: Penerase/PE. After completing this module, pupils were able to demonstrate the command Pererase/PE and the command PENPAINT.	8	6, 7 and 8
15 – 20	Module 15: PenPaint. Pupils were unable to use the command **PENPAINT** Module 16: Teaching the turtle to use repeat and cleartext commands. Pupils were unable to use REPEAT command to draw different shapes, use the CT to erase. Module 17: Turning Primitives in LOGO Left/Lt. Pupils were unable to, turn the turtle to the right side at different steps using RT command Module 18: Teaching the turtle to draw POYGONS. Pupils were unable to draw different types of Polygons Module 19: Changing PEN Colour. Pupils were able to change the PEN colour Module 20: Letter Graphics in LOGO. Pupils were unable to use all the LOGO Primitives to make different designs and other graphics like alphabets	7 and 8 7 and 8 8 8 None None	7 and 8 None 7 and 8 8 8 None

Table 1 presents the content of each module and the age of pupils as well as the type of school of those who were able to master the content of the modules. For instance, age 5, 6, 7 and 8 pupils from both public and private school mastered module 1 to 4. whereas, only age 7 and 8 of public schools mastered module 16 and age 7 and 8 of private school mastered module 17.

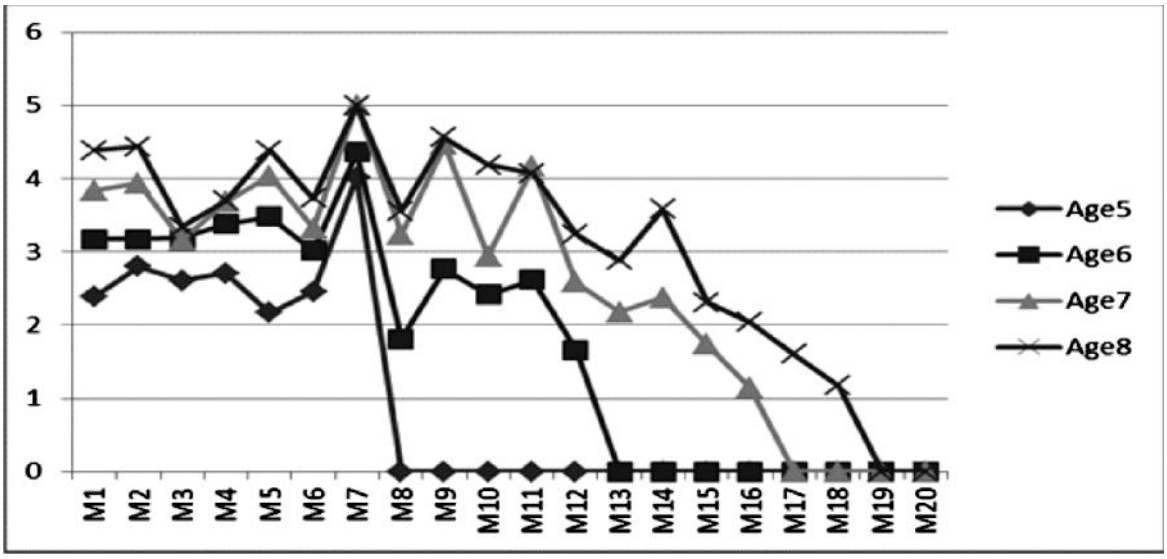

Fig. 1: Mean Scores of Pupils in LOGO Competence

As shown in Figure 1, this study revealed that all the age levels of pupils in lower primary classes (5 to 8) obtained high mean scores, ranging from 2.39 to 4.44 on modules 1 to 4. But pupils of age five had low mean score in module 5 with mean score of 2.17. This same age (5 years) had the least mean score of 2.46 in module 6 and 4.02 in module 7 which implies improvement in their competence. Age 5 year old pupils acquired no competence at all in modules 8 to 20.

Pupils of age 6 had competence in modules 6, 7 and 9, with mean ranging from 2.77 to 4.36. This age level acquired low competence in modules 8 and 10. The competence level of age 6 was increased in module 11 (mean = 2.62) after which it dropped to 1.66 in module 12 and subsequently to zero in all other modules.

Pupils of ages 7years and 8years had high mean scores, ranging from 3.24 to 5.00 in modules 6 to 10. Again, age 7 also had relatively high competency in modules 11 and 12 (mean = 4.16 and 2.58) but the level of competence dropped thereafter till the last module. Age 8years old pupils achieved competence up to module 14 (mean = 3.58) while the level of competence acquired declined at modules 15 to 18 and no competence at all on modules 19 and 20.

With these results, it can be inferred that age 5years old were able to acquire programming skills and competence up to Module 7 with the skill of using Input Box to draw; age 6 years old were able to acquire skills up to Module 11 with ability to use FD and Clean commands; age 7years old were able to acquire the skills up to Module 12 with ability to printing their works and age 8years old were able to acquire the skills up to Module 18 with the ability to draw polygons with the programme.

Research question 2: What is the level of programming skills and digital competence of lower primary pupils before and after the intervention?

Table 2: Programming and Digital Competence Skills Before and After Intervention

Age (Year)	N	Pre Scores		Post Scores		Mean Gain
		Mean	Std.D	Mean	Std. D	Value
5	82	2.94	2.27	20.54	7.01	17.60
6	87	4.85	2.73	27.86	4.92	23.01
7	90	3.98	2.18	32.02	4.82	28.04
8	79	4.73	2.38	34.63	4.87	29.90

Mark Obtainable = 50

Table 2 shows that the lower primary school pupils have relatively low programming and competence skills before the intervention as their mean scores range from 2.94(for age 5years old) to 4.85 (for age 6years old). But at post intervention, the pupils have better skills as their mean scores range from 20.54 (for age 5years old) to 34.63 (for age 8years old). Again, the table shows that age 5years old pupils were able to acquired 17.6 points from the intervention; age 6years old acquired 23.0 points; age 7years old acquired 28.0 points while age 8years old acquired 29.9 points from the intervention.

To answer the research question, it can be inferred that lower primary school pupils had very low skills in programming and digital competence before the intervention, but the skills were improved significantly after the intervention. These results point to the fact that though the lower primary school pupils have no programming and competence skills but if given the training, they are capable of acquiring the skills.

Testing the Null Hypotheses

Hypothesis 1: There is no significant relationship between pre and post-intervention digital competence measures of lower primary pupils.

Table 2: Relationship between Pre and Post Intervention Skills

	N	Mean	Std. Deviation	r	Sig.	Remark
Prescore	338	4.1272	2.50669	.477	.000	Remark
Postscore	338	28.7751	7.56278			

**Significant at $p < .05$*

Table 2 shows that there is a significant relationship between the programming and digital competence level of the lower primary school pupils before and after the intervention ($r = 0.48$; $p<0.05$). Therefore, the null hypothesis 1 is rejected. This implies that the amount of computer literate skills acquired by the pupils before the intervention can significantly influence the skills acquired after the intervention.

Hypothesis 2: There is no significant mean difference between public and private schools in achievement in LOGO Programming Language.

Table 3: T-test Analysis Shows Mean Difference between Private and Public Schools Pupils' Competence in LOGO Programming Language

SCHOOL	N	Mean	Std. D.	t	df	Sig.
Private	165	31.56	8.80	8.13	347	.000*
Public	173	24.38	7.68			

**Significant at $p < .05$*

Table 3 shows that private school pupils had higher mean competence score (31.56) than their public school counterparts (24.38). This difference is also shown to be significant ($t = 8.13$; $df = 336$; $p<0.05$). Hence, hypothesis 2 is rejected. This implies that there is significant mean difference in pupils' competence in LOGO Programming based on school type.

Discussion of Findings

There are different types of computer programming for children, such as Alice - developed to encourage girls to write programming, kudo, RoboMind, Sratch and Language of Graphics Orientation

(LOGO). One of the globally accepted programming languages to introduce programming in Nigerian curriculum is the Language of Graphic Orientation (LOGO). This study examined the age at which lower primary pupils can acquire competence in LOGO Programming Language. This study found that age 5years old were able to acquire programming skills and competence up to Module 7 with the skill of using Input Box to draw; age 6 years old were able to acquire skills up to Module 11 with ability to use FD and Clean commands; age 7years old were able to acquire the skills up to Module 12 with ability to printing their works and age 8years old were able to acquire the skills up to Module 18 with the ability to draw polygons with the program. This could be as a result of the fact that LOGO is a simple programming language that children can easily operate. It offers easy entry into the world of programming because it involves a very simple command. Besides, pupils are always interested and create joy to use the computer and to interact with the turtle to make their chosen designs. Leslie and Chen (2010) reported high child interest and drawing activities as typical to above expectation when using computer, usually for practical, process-focused reasons without being forced. However, Vail (2001) once warned against some risks associated with the interaction of children with computers such as social isolation, lack of imagination, repetitive, stress injuries, poor concentration and even poor language and literacy skills, this study guided against these risk by ensure that the LOGO programming Instructional Package designed for lower primary pupils are properly scheduled with their other academic activities so as to enable them blend the acquisition of the digital literacy with other learning outcomes.

Findings of this study showed that all age levels in the lower primary classes were able to acquire competence in modules 1 - 4. At this level, age 5 pupils were able to open Microsoft Windows LOGO, exit LOGO software and identify LOGO Opening Screen. They were able to identify the input box and command the turtle to draw different sizes of circle. Here, all the pupils at lower primary classes, ages 5 to 8 years old demonstrated 100% competence. Pupils of age six acquired more competence by being able to differentiate between LOGO Main Screen and The Commander Window; they were able to apply the rules of giving commands in LOGO Programming Language by using Forward (FD) command in LOGO and Clean command to draw different sizes of squares. Some set of pupils, most especially those in public primary schools cannot go further because of their limited experience with computer system. Rache (2004) observed that children in different locations or from different family backgrounds will have different experiences of childhood,

and that when it comes to ICT, not all children will be starting from the same point. This finding generally corroborates the findings of Harrison *et al*. (2002) that the use of ICT improves attainment levels of school children in English, in Science and in Design and Technology between ages 7 and 16, particularly in primary schools.

Level of programming skills and digital competence of lower primary pupils before and after the intervention:

This study found that lower primary school pupils had very low skills in programming and digital competence before the intervention, but the skills were improved significantly after the intervention. This finding might be as a result of the fact that computer has the ability to provide concrete experiences for the pupils to learn from. Pupils have free access and control the learning experience, children and teachers learn together, teachers encourage peer tutoring, and teachers use computers to teach powerful ideas. This finding corroborates the view earlier findings of Huppert (2002), that simulation software used in science learning provides higher achievements of students than those not using the simulation. Hyde and Mertz (2009) also found out that, in the United States of America, the girls now perform as well as boys in all grades when exposed to computer-based learning. Judge *et al*. (2004) have reported that it is increasingly important for early childhood educators to introduce and use computers in their settings, particularly for those children who do not have access to it in the home like most pupils in public schools. Providing learning opportunities at preschool means that these children are better prepared for their school experiences. Offering access to computers in the early childhood setting helps to reduce the digital divide that occurs at school when those who have had access in the home are better prepared for school activities.

This study found that private school pupils had significant higher mean competence score than their public-school counterparts. This implies that there is significant mean difference in pupils' competence in LOGO Programming based on school type. The detailed results showed that the private primary schools pupils of ages 5 to 8 acquired competence in modules 1 to 12, that is opening Microsoft Windows LOGO, exiting LOGO software, LOGO Turtle Graphics, Identify LOGO Opening Screen, ability to differentiate between LOGO Main Screen and the Commander Window, executing commands to draw different sizes of circles, save their works, use forward, right and clean commands and many more. This might be as a result of the fact the private school pupils are children of average Nigerians most of who have access to computer system at home and

in school. Several researches have indicated that people with more computer experience show significant higher levels of computer confidence and more computer training is effective at raising user computer efficacy levels, which results in improved performance on computer-related tasks (Torkzadeh & Koufteros, 1994; Marakas *et al*., 1998; Rozell & Gardner III, 1999). The programme enable the child to take in information and then changes it in his mind to fit his ideas, using neutral words, body outlines and equipment a child can touch which gives him an active role in learning (Pardamean & Honni, 2011). LOGO Programming fits well into this stage because pupils use the software in such self-directed ways, can experience mastery and competence at many different levels and can become more adept to programming.

Conclusion

This study investigated at what age can lower primary school pupils be exposed to acquisition of the 21st century lucrative ICT skills - programming and digital competency skills. This is important because of the ages of pupils at this level of education which span from 5 to 8 years. This study has revealed that lower primary school pupils can acquire programming skills and develop competence in digital literacy. The study was able to expose level of skills the pupils could operate successfully with based on their chronological ages.

Recommendations

Based on the findings of this study, the following are proffered for better primary education that can compete with global education:

1. Agencies such as Ministry of Education, Universal Basic Education Board (UBEC), Nigerian Educational Research and Development Council (NERDC) and other relevant stakeholders should see to it that the primary school curriculum is reviewed to incorporate 21st century ICT skills such as programming and digital literacy skills. This could be achieved through collaborative efforts among the government agencies, private ICT companies, educational technology as well as childhood education experts.
2. It should now be compulsory for all primary schools, be it publicly owned or private ones, to have ICT, most especially, computer laboratory in the schools. For the children to be exposed to the skills, the facilities must be available. This can also be achieved with collaboration with the communities, NGOs and philanthropists in the country.

3. All lower primary school teachers should be empowered with ICT skills. Since generalised system of teaching, whereby a class teacher will teach all subjects, is the practices now, these teachers need to acquire the basic knowledge of ICT so as to enable them inculcate such to the pupils.

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