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The use of truth table chart in the academic achievement of logic gate in computer science among junior secondary schools in port Harcourt City of Rivers State

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Abstract
The study is on the use of truth table chart (TTC) in the academic achievement (AA) of logic gate (LG) in computer science among junior secondary schools (JSS) in Port Harcourt. Quasi experimental design and descriptive research survey stood espoused for the study. The population of the study remained 4380 with 110 sample size. The study had four purpose of study, two research questions and two hypothesis. The instrument for statistical assemblage remained the questionnaire and the test items titled "Logic Gate Achievement Test (LG-AT)". The instruments were subjected to face in addition to content validity. The reliability of the instrument coefficient was 0.81 and 0.75 with the aid of Kuder-Richardson. And the split half of reliability was espoused. Mean as well as standard deviation (SD) was espoused to analyze the research questions whereas analysis of covariance (ANCOVA) for the hypotheses. The findings revealed that those groups taught using TTC achieved more than those taught without TTC. Also the results proved no significant difference in the interface influence of age in addition to sex on logic-gate learning achievement of students taught using TTC and those taught without using TTC.

Keywords: utilization, truth table chart, academic achievement, logic gate, computer science, junior secondary school, Port Harcourt Metropolis

1. Introduction
The computer is a technical novelty under the control of deposited database that can perform basic logical human duties even away from the proficiency of the latter. Adekomi (2001) defined computer as an assemblage of interrelated devices proficient of resolving glitches by accepting facts, acting designated operation on acquired information plus providing outcomes on such actions. Novelties currently on existence denotes that the world is reliant on computer knowledge. Ajibade (2006) [3], affirmed computer as only not a play-stuff but a significant learning and teaching gadget for grown-ups as well as children at all levels of school system. From the ongoing, there is need for computer education which is the capability of making everyone well-educated about computer. Computer literate involves the potentials of been competent reading, writing as well as speaking the language of computer. For enhancement of computer literacy, there is need for the subject computer science which is offered at secondary schools. The subject contains a lot of topics in the curriculum, in which logic gate is one. Logic gate (LG) is a scheme that opens (allows the passage of electrons) electron parts for digital signal, Oluka (2010). The Boolean logic is the rational calculus by means of algebra of truth figures of 0 and 1 signifying untrue and factual separately. Boolean logic is an apparatus that represents cognitive ideologies or rubrics. Usually the truth table (TT) and Venn diagram approaches are technical.
However, it has been observed that teachers and students find it difficult to teach, learn and manipulate the Boolean logic due to incomprehensive curriculum and scheme of work, lack of suitable approach to teach Boolean LG and lack of TTC as an instructional material to teach and understand LG. The study remains on the utilization of LG. It is believed that the TTC is the instructional material to facilitate the achievement of logic gate. It is on this premise that the researcher cast doubt on the teaching and learning of logic gate without the use of TTC. It is against his back drop that the study is focused on the utilization of truth table chart in the teaching and learning of logic gate and to what extent this can enhance the 'AA' of junior secondary school students (JSSS) in Port Harcourt Metropolis (PH-M).

1.1 Statement of the Problem
Government in recent past, have made frantic efforts in the enlisting of new subjects to be studied in the junior secondary school curriculum. This includes subjects like marketing, fine and applied arts, computer science among others. Government also ensured that professional teachers are employed to teach these subjects, delivery of computer-based systems to all colleges to boast the education of computer-based subjects was not ruled out. Provision of instructional materials at all levels to boost the education progression. The stakeholders have likewise created an enabling environment to teach as well as to learn computer. However, it has been observed that despite all these efforts by the government and other stakeholders' teachers find it extremely difficult to teach logic gates as one of the topics in computer science curriculum. Even, with the availability of TTC most teachers do not use the chart and cannot improvise, thereby making it difficult for the learners to understand. It is on this premise, that the academic

achievement of scholars in computer science in internal as well as external examinations were observed to be affected. It is against this backdrop that the researchers are skeptical that the topic logic gate cannot be taught and learnt without the use of TTC. Thus, the researchers are concerned in establishing the utilization TTC in the academic achievement of logic gate among JSSS in PH-M.

1.2 Significance of the Study

The outcome of this study will offer valued evidence for tutors on how to teach logic gate. The latter will be beneficial to the government, educational agencies on the available TTC that can be used in teaching logic gate in computer studies among junior secondary school students. It will also benefit the teachers and school administration on the magnitude of application of TTC in teaching logic gate in computer-based subjects. The result will confirm the use of TTC as a correlate to academic achievement of logic gate in computer studies and also show the defects where necessary which can be addressed. The study will also serve as a frontier for subsequent researches in this direction.

1.3 Purpose of the Study

The following objectives applies

- To establish the difference in the logic gate learning achievement of students taught using TTC and those taught without using TTC.
- Determine the interaction effect of sex and age on the logic gate learning achievement of scholars educated with truth table chart as well as scholars educated in the absence of TTC.
- Determine the substantial variance in the logic gate learning achievement amid scholars taught using TTC and those taught without using TTC.
- Find the significant difference in sex and age in the logic gate learning achievement between students taught using TTC and those taught without using TTC.

1.4 Research Questions

To guide the study, two research questions were framed

1. What is the mean difference in the logic gate learning achievement between students taught using TTC and those taught without using TTC?
2. What is the mean interaction effect of sex in addition to age on the logic gate learning achievement of scholars taught TTC and those taught without using TTC?

1.5 Hypotheses

Ho_1: Significant difference does not exist in the logic gate learning achievement between scholars educated with TTC and scholars educated in the absence of TTC.

Ho_2: Significant difference does not exist in sex and age in the logic gate learning achievement between students taught using TTC and those taught without using TTC.

1.6 Study Area

The study focused on the effects of TTC on the 'AA' of logic gate in computer studies among JSSS in Port Harcourt Metropolis. The Basic Education Board controls and supervises the public schools. They use the same curriculum; thus private schools are purely excluded from the study. The study will consider the difference, the interaction effect of sex and age on the logic gate learning achievement. The study area is in PH-M of Rivers State, Nigeria. It is a major commercial city in Rivers State with economic activities, encompassing 260 km^2 land mass plus more than 464,789 population as at 2006 population census. The high number of the population as inhabitants of this area creates attention in terms of assessment which will in turn help to advance the superiority of tutoring in college schools.

Review of Related Literature

A gate electronically, can be defined as an electric-powered apparatus designated for calculation of functions on a dual esteemed indicator. A logic gate is often utilized as the basic digital circuits. Thus, all LGs retains a lone output plus dual inputs. They are physical equipment espoused to establish the Boolean function. LGs are espoused to execute a rational task with single/more inputs in addition to produces reasonable outcomes. Logic circuits are fashioned by linking a single or dual LGs connected. They remain the heart of digital electronics.

Types of logic gates and truth tables (TT)

There are seven (7) basic LGs known today. These are shown below with a conforming TT.

1. The AND gate is a modernized LG comprising of 'n' i/p one 0/p, for logical conjunction tasks based on the combinations of its inputs. The output of this gate is true only when all the inputs are true when one or more inputs of the AND gate's i/ps are false then only the output of the AND gate in false. AND gate and its TT (the Boolean expression for a dual input AND gate is output = A.B)
2. OR gate, it's a modernized logic consisting of 'n' i/ps plus single o/p, which takes the task of logical conjunction based on the combinations of its inputs. The output of the OR gate is true only when one or more inputs are true. If all the i/ps of the gate are false, then only the output of the OR gate is false. The Boolean expression for dual input OR gate is output = A + B.
3. NOT gate: Is a modernized LG involving single input plus single output that controls an inverted operation of the input. The output is the reverse of the input. When the input of the NOT gate is true then the output will be false and vice versa. The Boolean expression for a dual input NOT Gate is output = $\overline{A}$.
4. NAND Gate, a modernized LG consisting of 'n' i/ps plus a single o/p, which takes up the task of AND gate accompanied by NOT gate workings. NAND gate is fashioned through the assemblage of AND plus NOT gates. If the input of former is greater, then the output of the latter will be small. Boolean expression for dual input NAND gate is output = $\overline{A.B}$.
5. NOR gate is a modernized LG comprising of n inputs plus a single output, which takes up the tasks of OR gate accompanied by NOT gate. Thus NOR gate is a combination of OR plus NOT gate. Once one i/ps of the NOR gate is un-false, the output of NOR gate remains un-true. Boolean formulation for a dual input NOR gate is output = $\overline{A + B}$.
6. Exclusive-Or gate, a modernized LG involving dual inputs plus single output. Ex-OR is the undersized sort of the gate. Its tasks is on the basis of OR gate. Once a single input of the gate is amplified, the output of EX-

OR gate becomes great. Boolean formula for dual input EX-OR gate becomes output = A⊗B.

Exclusive-NOR gate, a modernized LG consisting of dual inputs plus a single output with EX-NOR as an undersized sort. It functions on the basis of NOR gate tasks. Once the inputs of the latter appears high, then the output of the EX-NOR gate according to documented reports are low. It has been observed that the usage of LGs remain predominantly evaluated via their corresponding TT, with approaches of operations. The LGs are espoused in countless circuits; i.e. push-button lack, light triggered-burglar alarm, security thermostat, spontaneous watering scheme as building blocks for digital electronic. All digital products such as computers, mobile phones, calculators, digital watches etc.

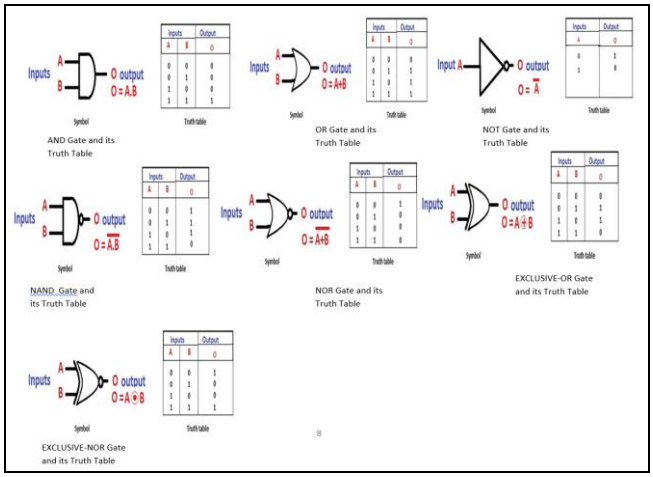

Fig 1: A Diagrammatic Section of the Seven Types of Logic Gate

Truth Table Chart Operations, Availability and Utilization

The TT is a scientific table espoused in logic specifically with Boolean algebra, Boolean functions plus propositional calculus which maps out the purposeful tasks of logical expressions on each of their basic arguments (Enderton, 2001). The chart could be espoused to illustrate if a propositional statement is factual for entirely legitimate input values that is rationally valid. The TT has a single column for each input variable (e.g. A plus B in addition to a single concluding column showing completely the probable outcomes of the rational task that the table represents. It is believed that the TTC ought to be used in describing logic system. The table is a layout which depicts the relationship between the output from the logic circuit and all possible inputs to the circuit. Both input and output are expressed in terms of 0's and 1's. Remillord and Heck (2014) commented on instructional materials as resources that organize and supports instructional context. Jimoh (2009) also opined that instructional material is a sine qua non for efficient behavior modification in scholars. Adekunle (2008) as well as Okobia (2011) stressed that once scholars are offered opportunity to study via more sanities, they study faster as well as easier. Therionwu (2000) denoted teaching resources as models which aid the tutor in making learning interesting to the scholars. Morduck and Desberg (1994) observed that students could use TTC to break the wall of conventional teaching of logic gate in the classroom. Crooks (1994) realized that it is meaningful to gain knowledge through the use of TTC. Thus landau also agreed that access to TTC can ignite students thought and eventually gain better learning experiences. Daniels (2008) commenting on the availability of TTC and its utilization in teaching logic gate in computer implicated the government to do the needful by ensuring all schools have enough TTC.

The study is linked to materials. First – rational model developed by Belland in 1981. It can as well be called opportunity models of lesson plan. Ibe-Bassey (2012) on citing the above theory opined that teachers must unify resources to simplify learning amid the scholars. It encouraged the use of objects for instructions. A related study has been undertaken on the use of instructional materials by Mbah (2011). He carried out a study on the use of instructional materials plus educational performance of the student's in integrated science in utility school in Jalingo, Taraba State. The design was experimental. The study had a simple size of 100 students randomly selected from test-posttest. With the use of z-test, the result exposed that there is a substantial dissimilarity in the educational performance of scholars when they are educated via instructional materials than when they are not educated with instructional materials.

Research Methodology

The experimental design espoused for the study remains quasi experimental plan. The population of the study was made up of 47 JSS in Port Harcourt Metropolis with a population of 4380 students. About 94 computer teachers in junior secondary school were also involved. Out of the 47 schools, 10 schools were selected through simple ballot technique to represent the entire school. The 10 schools had students population of 522, out of this number 110 was selected via simple random sampling technique. Out of this number, 57 made up of male and 53 female. The instrument for assemblage of facts was the test tagged: "Logic Gate Achievement Test (LGAT)". The section A of the test consist of basic facts on individual respondents, while segment B contains a 20 item multiple choice objective questions with five options having a single truthful answer. The treatment procedure for the experimental group was such that there was pretest and post-test with one hundred and ten students (110) being separated into groups A and B comprising 55 scholars singly through the assistance of simple poll system. Group A was taught using TTC for 40 minutes and for three days within 7-days. Whereas group B was educated similar without the use of TTC.

Straightaway, afterward the action session for both groups, a post test was administered to the groups separately. The interval for the research process stood at 14-days. The scholars were exposed to set of 20 multiple objective questions. The face plus content validity of LGAT were certified via experts of measurement as well as evaluation. The reliability of the LGAT stood estimated via split half reliability procedure. The Kuder-Richardson, KR-21 method stood espoused for correlating scores to obtain a coefficient of 0.81 and 0.75. This scheme sufficiently agrees that the LGAT was extremely reliable.

The data gathered stood analyzed via statistical tools such as mean, SD and ANCOVA.

Data Presentation and Analysis

Research Question 1: What is the mean difference in the logic gate learning achievement between students taught

using TTC as well as scholars taught without TTC?

Table 1: Mean plus standard deviation analysis of the difference in the logic gate learning achievement between students taught using TTC and those taught without using TTC

Treatment	Pretest			Post test		Gain	
	N	Mean	SD	Mean	SD	Mean	SD
With TTC	56	36.96	14.39	47.59	14.65	10.63	6.61
Without TTC	54	28.70	10.29	36.67	9.47	7.96	4.61

Table 4.1, above shows that the mean pretest score of students in the investigational group taught using TTC was 36.96, SD = 14.39, whereas that of those taught without using TTC was 28.70, SD = 10.29. The mean posttest score of students taught using TTC was 47.59, SD = 14.65 whereas those taught without TTC was 36.67, SD = 9.47. The mean learning gain of those taught using TTC was 10.61, SD = 6.61, whereas that of those taught without using TTC was 7.96, SD = 4.61.

A graphical presentation of mean pretest, post-test and learning gain of students taught using TTC and those taught without using TTC is shown below.

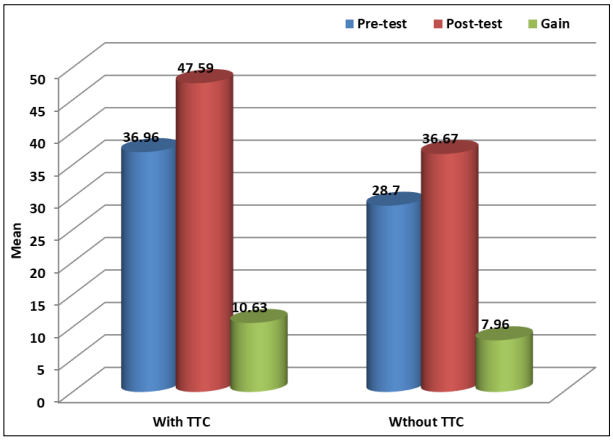

Fig 2: Mean Pretest, Posttest and Learning gain of scholars educated with TTC and scholrs educated in the absence of TTC

Research Question 2: What is the mean interaction consequence of sex in addition to age on the logic gate learning achievement of students taught using TTC and those taught without TTC?

Table 2: Mean and SD of the interaction effect of sex plus age on the logic gate learning achievement of scholars educated with TTC plus scholars educated without TTC

Sex		Pretest			Post test		Gain	
	Years	N	Mean	SD	Mean	SD	Mean	SD
Male	10-12yrs	41	34.63	14.12	45.37	14.89	10.73	5.87
	13-15yrs	16	36.56	16.20	45.31	15.11	8.75	5.63
Female	10-12yrs	42	30.83	11.09	39.52	11.20	8.69	5.95
	13-15yrs	11	29.09	11.14	36.36	10.74	7.27	5.18

Table 2 above shows the mean as well as the SD of the interaction influence of sex plus age on the logic gate learning achievement of junior secondary students in PH-M. The results shows that the mean learning gain of male students within 10-12 years age was 10.73, SD = 5.87 whereas that of scholars within 13-15 years age was 8.75, SD = 5.63. Similarly, acquired data illustrates that the mean learning gain of female scholars within 10-12 years age was 8.69, SD = 5.95 whereas that of scholars within 13-15 years age was 7.27, SD = 5.18.

A graphical presentation of interaction of sex and age over logic gate achievement between students taught using TTC and those taught without TTC is also shown below.

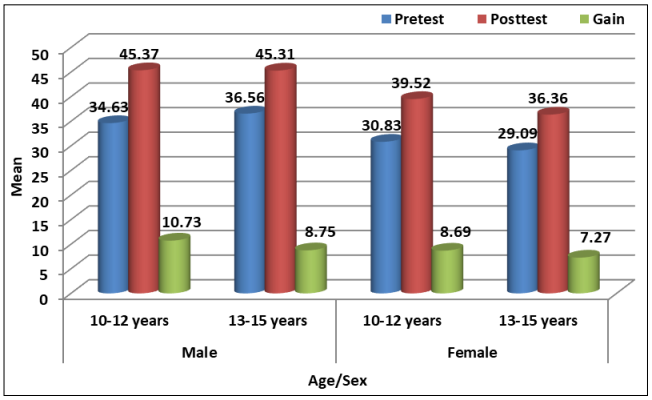

Fig 3: Interaction of sex and age over logic-gate achievement between stuents taught using TTC and those taught without TTC.

$H0_1$: No significant difference exist amid the logic gate learning achievement between students educated with TTC and those taught without TTC.

Table 3: Summary of ANCOVA on the significant difference in the logic gate learning achievement amid students taught with TTC and those taught without using TTC in PH-M.

Source	Type III sum of squares	df	Mean square	F	Sig.
Pretest	13252.687	1			
Treatment	325.804	1	13252.687	430.117	.000
Error	3296.866	107	325.804	10.574	.002
Total	215957.000	110	30.812		
Corrected total	19829.318	109			

R squared = .834 (adjusted R. squared = 831).

Table 3 above denotes the ANCOVA summary on the significant difference amid the logic gate learning achievement amid scholars taught using TTC and those taught without TTC. From the table (F1, 107 = 10.57, P <.05). Thus, the null hypothesis was rejected at .05 alpha level.

$H0_2$: No significant difference exist in sex and age in the logic gate learning achievement between students taught using TTC and those taught without TTC

Table 4: Summary of ANCOVA on age and sex on logic gate learning achievement of students taught using TTC and those taught without using TTC

Source	Type III sum of squares	df	Mean square	F	Sig.
Pre-test	15152.593	1	15152.593		
Sex age	.293	1	.293	.009	
Error	3435.378	105	32.718		925
Total	215975.000	110			
Corrected total	19829.318	109			

R squared = 8.27 (adjusted R squared = .820).

Table 4 above depict that no significant difference amid age plus sex of students on logic gate learning achievement of students taught using TTC and those taught without using TTC in JSS (F1, 105 = .009, P > .05). The null hypothesis was retained at .05 alpha level.

Discussion of Findings

The outcomes arising from research question one denotes that the mean pretest score (Table 1) of students in the investigational category taught using TTC was 36.96, SD = 14.39 whereas that of those taught without using TTC was 28.70 and the SD = 10.29. Also from the table the mean of the post test scores of students taught with TTC was 47.59 and SD = 14.65 whereas that of those taught without using TTC was 36.67, and SD = 9.47. The mean learning gain of those taught using TTC was 10.61 and 6.61 as the SD whereas those taught without using TTC was 7.96 as mean and 4.61 as SD. This result reveals no existence of significant difference in the logic gate learning achievement between scholars educated using TTC and scholars educated in the absence of TTC. This result is in consistent with an earlier finding of Patrick (2004) who reported the effect of instructional resources on the 'AA' of senior secondary school biology. The latter revealed a significant difference, meaning that scholars educated using instructional material achieved more than scholars educated without instructional material.

The result of research question two and hypothesis two also revealed that the mean as well as SD of the interaction effect of sex plus age on the logic gate learning achievement shows that the mean learning gain of male scholars within 10-12 years age bracket was 10.73 and the SD = 5.87 whereas that of scholars at 13-15 years age range was 10.73, and the SD = 5.87. Similarly, the result displayed the mean learning gain of male students within the age bracket 13-15 years to be 9.75 with 5.63 as SD. The result of the female scholars within 10-12 years age bracket was 8.69 and 5.95 as SD; whereas scholars within 13-15 years age bracket was 7.27 and 5.18 as SD. The result also reveals existence of no significant difference in the interaction effect of age and sex on logic gate learning achievement of students taught using TTC and those taught without (TTC). This result confirms the null hypothesis which was retained at 0.05 alpha level.

Conclusion

Arising from the above discussion of outcomes, it can be concluded that the use of TTC on academic achievement of logic gate in computer studies promotes teaching and learning of logic gate. The students taught with TTC had a learning gain higher than those without TTC. The male students taught with TTC had a gain more than the female counterparts. The male scholars within 10-12 years age range taught with TTC achieved more in the study. Thus, there was a significant difference in the logic gate learning achievement amid scholars educated with TTC and scholars educated in the absence of TTC.

Recommendations

On the basis of the findings as well as the conclusion reached, the corresponding recommendations were made:

1. Computer science educators must be trained and retrained on the use of TTC to computer logic gate to scholars.
2. The government and other stakeholders should monitor the utilization of TTC and make it available for teachers use.
3. Colloquia, conferences in addition to workshops must be prearranged for effective and efficient use of TTC.
4. A resource centre should be created for storage of truth table charts which will enhance individualized learning among the teachers and students.

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