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EFFECT OF CISCO-PACKET-TRACER SIMULATOR ON SENIOR SCHOOL STUDENTS' COMPREHENSION AND SKILL ACQUISITION IN COMPUTER NETWORK TOPOLOGY IN NIGERIA

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Effect of Cisco-Packet-tracer Simulator on Senior School Students' Comprehension and Skill Acquisition in Computer Network Topology in Nigeria

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Abstract

*Excellent performance in network topology cannot be achieved without adequate comprehension of the concept and experimenting with real-life or simulated environment. Cisco packet tracer simulator as a tool for teaching and learning computer science concepts, provides simulation, visualization, authoring, collaboration capabilities, and assessment experiences for both teachers and students. Thus, this study determined the effect of using CISCO-packet-tracer on senior school students' skill acquisition and comprehension of network topology designing, configuration and troubleshooting skills when taught using CISCO-packet-tracer simulator. A quasi-experimental research design was adopted with a purposively-sampled intact class of 26 computer studies students' in a senior secondary school in Ilorin.. Three research questions were answered with the use of validated research instruments (an adopted software (CISCO-packet-tracer simulator; a network topology skill acquisition observation checklist; and an adopted standardized network topology comprehension test (NTCT). It was found that there is a significantly positive effect of CISCO-packet-tracer simulator on students' skill acquisition (**95.2%**) and comprehension (**61.5%**) of network topology, (**95.2%**) of the students acquired a substantial level of skills (software initiation skill - **98.5**%; configuration skill - **93.1**%; redirection skill - **92.3**%; simulation skill - **98.7**%; and connection skill **94.2**- %) and students' comprehension of network topology concept was averagely high (**61.5%**). The study concluded that the CISCO-packet-tracer simulator is an effective tool for fostering students' skills acquisition and comprehension of computer science concepts, while also recommending that educators should use the Cisco packet tracer to allow students gain practical and cognitive skills in computer science concepts.*

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Introduction

Teaching is a way of inculcating or causing a learner to learn and acquire the desired knowledge, skills, attitude, and other acceptable values in society using an appropriate instructional material (Akubue & Chukwu, 2016). In this context Olakanmi, Gambari, Gbodi, & Ab, (2016) in a study to establish the effects of computer-assisted instruction in promoting intrinsic and extrinsic motivation among senior secondary students, found that the students who were taught with computer-assisted instruction had higher extrinsic and intrinsic motivation as well as an achievement than those in conventional teaching methods.

Computer studies is a science subject believed to be practically oriented that involve skill and experience. Therefore, the teaching of computer studies should be practical and exploratory for students to acquire more skills that will improve their understanding and life-long experience (FRN, 2013). This study, therefore, found its basis in employing a Cisco- packet-tracer simulator for teaching the students' network topology in a simulated environment. Cisco Packet Tracer Simulator is an effective educational software that supports students to experiment and practice computer studies' concept in a simulated environment. Cisco Networking Academy Program (CNAP) introduced the Cisco packet tracer simulator as a tool for teaching and learning computer network courses by providing simulation, visualization, authoring, collaboration capabilities, and assessment (Noor Mohamad, Yayao, & Sumazly, 2018).

CPTS usually are based on interactive graphics which gives the learner the ability to visualize a process or an activity. Teaching network topology in real class required teachers to provide either singly or in groups with the materials and equipment as well as the instructions to be followed in performing the activities. Practical work allows students to acquire process skills and manipulative skills. However, this method is expensive in terms of materials and equipment as well as time consuming (Julius, 2018). Cisco-packet-tracer simulator can further be

used, to understand the difference between different networking devices like hubs, switches, routers, etc., and their appropriate use while connecting various Computers to design networks (Kainz, Cymbalak, Lamer, Michalko, & Jakab, 2016). Checking connectivity between different networking devices by running various networking tests. Basic networking concepts like a simulation of emails small one pc to another, FTP - File Transfer Protocol: that takes care of the transmission of files between computers, routing, etc. can be easily explained by using packet tracer and students can build, configure and troubleshoot networks using packet tracer. It also makes teaching easier; students can create their own scenario based labs and provides real simulated and visualization environment (Abdul Rashid , Zaharbin , & Othman, 2019).
Tu (2012) analyzed the comparison between the cisco-packet-tracer simulator for teaching concepts and the real experiment using physical equipment. He concluded that CPTS has many benefits such as economy, convenience, flexibility, safety, and easy explanation. In teaching computer studies subject, the process of real network equipment practice should be added after the completion of virtual experiment teaching to enhance students' skills. Cisco packet-tracer simulator provides a computer model of an experiment that engages students' critical thinking, save the burden of materials and equipment required for real experiments. It also helps the students to improve their communication skills, especially when writing the reports, one is required to use suitable technical terms (Julius, 2018). CPTS is an interactive tool, through which the students could develop a clearer and more complete understanding of concepts taught. In this manner, the quality of interactivity that students perceived could affect their overall impression which could further influence their use.

Moreover, the Cisco-packet-tracer simulator as a complementary part of the hands-on training would increase the capacity to teach networking skills to larger groups. The number of times students would require to practice, using scarce networking equipment, would be reduced if practicing in a virtual environment contributed toward the acquisition of the target skills. The Cisco-packet-tracer simulator could be installed on school computers on which students would have more access time. This would enable students to actively practice procedures learned in theoretical sessions. CPTS has been found useful for teaching for some reasons including, remote access for distance education, low cost, reliability, security, flexibility, and convenience to the student (William , John , Daisy , & Barbra , 2013).

Network topology being a Computer studies concept requires more than the abstractive chalk and talk strategy that is currently used in teaching the concept in Nigeria. This chalk and talk practice entail teachers drawing networking arrays on the chalkboard and explaining system configuration and simulation abstractly. This model of teaching as revealed in the West Africa Examination Council Chief Examiners' Report (2014-2018) indicated that it does not aid students' learning and is identified as a major contributory factor to the poor performance in Computer studies in general, and network topology specifically. Excellent performance in network topology cannot be achieved without adequate comprehension of the concept. Thus, newer instructional and technological approaches that embrace active, immersive, and self-paced learning through simulation tools such as CISCO-Packet-Tracer need to be adopted in teaching and learning network topology. Hence, this study examined effect of CISCO packet tracer simulator on students' skill acquisition and comprehension of network topology by answering two research questions:

1. What are the skills acquired by computer studies students' in network topology when taught using a cisco-packet-tracer simulator?
2. How do students comprehend network topology concepts when taught using the cisco –packet-tracer simulator?

Research Methodology

This study adopted a quantitative research design of experimental and survey methods. The pre-experimental design of intact/static post-test non-equivalent and non-randomized experimental design. The researcher-designed questionnaire was used for the survey method. Three research instruments were developed and validated: (i) An adopted software (Cisco-Packet-Tracer Simulator - CPTS) downloaded from (cisco academy.com link). The software was installed on the school computers and serves as the treatment used to teach network topology to the experimental group; (ii) A researcher-designed students' network topology skill acquisition observation checklist, the teachers and the researchers observed how the students carried out each task and recorded each labelled checklist for easy identification; and (iii) A standardized network topology comprehension test (NTCT) extracted from past questions on Network topology in WAEC computer studies' examinations between 2014 and 2018. Each student was given a corresponding labelled question with their checklist . The NTCT test instrument was subjected to test-retest and all instruments were expert-validated for face, content and construct validity. **Results**

Data obtained after administration of the instruments were analysed under two research questions using statistical tools of frequency counts, percentage, range and mean difference.

Analysis of Research Question One: What are the skills acquired by computer studies students' in network topology when taught using CPTS?

In order to determine students' skills acquisition in network topology when taught using the CPTS, an observation checklist on students' skills acquisition in network topology was employed. Table 1 shows the analysis of the skills acquired by the students in network topology when taught using the CISCO-packet-tracer simulator. The key skills were software initiation; connection; redirection; configuration; and simulation.

Table 1: Network Topology Skill Acquisition Using CISCO-Packet-Tracer

Categorisation	Item	Yes		No	
		Freq.	%	Freq.	%
Software Initiation	Double click to open the CISCO-packet-tracer simulator app	26	100	0	0
	Select the logical Tmode	26	100	0	0
	Drag and drop 3 PCs on the workspace	26	100	0	0
	Assign different name to the PC	26	100	0	0
	Drag and drop 1 switch	24	92.3	2	7.7
	Software initiation Skill Acquired (%)	**128 (98.5)**		**2 (1.5)**	
Connection	Select copper straight-through cable	25	96.2	1	3.8
	Connect each PC to switch with copper straight- through	24	92.3	2	7.7
	Connection Skill Acquired (%)	**49 (94.2)**		**3 (5.8)**	
Redirection	Create an IP address for each PCs	22	84.6	4	15.4
	Assign IP address for the first pc: 192.168.2.2 and Generate subnet mask automatically	23	88.5	3	11.5
	Assign IP address for the second PC :192.168.2.3, generate subnet automatically	25	96.2	1	3.8
	Assign IP address for the third PC :192.168.2.4, generate subnet automatically	25	96.2	1	3.8
	Drag and drop router on the workspace	25	96.2	1	3.8
	Redirection Skill Acquired (%)	**120 (92.3)**		**10 (7.7)**	
Configuration	Configure the router Ethernet	26	100	0	0
	Connect pc with switch	26	100	0	0
	Select the appropriate connection	24	92.3	2	7.7
	Connect the switch with a router	24	92.3	2	7.7
	Create a building background	21	80.8	5	19.2
	Configuration Skill Acquired (%)	**121 (93.1)**		**9 (6.9)**	
Simulation	Select the simulation mode	25	96.2	1	3.8
	Create e-mail	26	100	0	0
	Simulate the e-mail	26	100	0	0
	Simulation Skill Acquired (%)	**77**	**(98.7)**	**1 (1.3)**	

All the 26 participants (100%) demonstrate the software initiation skills (Double click to open the CISCO-packet-tracer simulator app, Select the logical mode, Drag and drop PCs on the workspace, assign different name to the PC) perfectly, with the exception of just 2(7.7%) who were not able to drag and drop 1 switch on the workspace. On the connection skill, nearly all participants mastered the skills. 25(96.2%) were able to

Select copper straight-through cable and 24(92.3%) were able to Connect each PC to switch with copper straight. Three of the Redirection skills - (Assign IP address for the second PC :192.168.2.3 generate subnet automatically; Assign IP address for the third PC :192.168.2.4 generate subnet automatically; Drag and drop router on the workspace) were mastered by 25(96.2%) participants. The other two skills (Create an IP address for each PCs; Assign IP address for the first pc: 192.168.2.2 and Generate subnet mask automatically) were mastered by 22(84.6%) and 23(88.5%) participants respectively.

On the configuration skill, all the participants (100%) were able to configure the router Ethernet and connect the PC to the switch while 24 out of 26 of the participants (92.3%) were able to select appropriate connection and connect the switch to the router. However, only 21 (80.8%) of the participants were able to create a building background. All the simulation skills were mastered by all participants (100%) with them being able to create and simulate emails but an exception of just one participant (3.8%) was unable to select the simulation mode.

The summary of each of the cumulative skill acquisition is presented in table 2 below with Simulation skill having the first ranking of 98.7% while redirection skill has the least ranking of 92.3% skill acquisition level.

Table 2: Cumulative Skills' Acquisition Level

Skill Acquisition Level	Yes (%)	No Freq. (%)	Rank Ordering
Software Initiation	98.5	1.5	2nd
Connection	94.2	5.8	3rd
Redirection	92.3	7.7	5th
Configuration	93.1	6.9	4th
Simulation	98.7	1.3	1st
Summary	**95.2**	**4.8**	-----

In summary, the following skills were acquired sequentially: software initiation skill; configuration skill; redirection skill; simulation skill; and connection skill. Cumulatively, the percentage level of Skills Acquisition of **95.2%** as against the No skill acquired level of **4.8%** indicated that a larger proportion of the students acquired a substantial level of skills to utilise CISCO-packet-tracer simulator to learn network topology.

Research Question Two: How do students comprehend network topology when taught using the CISCO-packet-tracer simulator?

In order to examine the students' comprehension of the network topology concept when taught using the CISCO-packet-tracer simulator, an experiment was conducted. The participants were exposed to the use of the CISCO-packet-tracer simulator to learn network topology. Thereafter, a performance test was administered to ascertain the concept comprehension. Data collected were analysed with frequency, percentage, range, and mean difference. The overall students' comprehension performance was determined based on a benchmark of ranges: 0-39, 40-44, 45-49, 50-59, 60-69, and 70-100 to represent fail, poor, fair, good, very good, and excellent respectively.

Table 3: Students' Comprehension Performance in Learning Network Topology Using CISCO-Packet-Tracer Simulator

S/N	Grading Value	Comprehension Level	Comprehension Rate	
			Freq.	%
1.	0-39	Fail	2	7.7
2.	40-44	Poor	1	3.8
3.	45-49	Fair	3	11.5
4.	50-59	Good	5	19.2
5.	60-69	Very Good	11	42.3
6.	70-100	Excellent	4	15.4

Table 3 shows the comprehension performance of students in learning network topology using the CISCO-packet-tracer simulator. The experiment indicated that 2(7.7%) of the participants had grade between 0-39; categories into failure performance, 1(3.8%) of the participants had grade between 40-44; categories into poor comprehension performance, while 3(11.5%) of the participants had grade between 45-49; categories into fair

performance. Positively on the other hand, 5(19.2%) of the participants had grade between 50-59 categories into good comprehension performance, 11(42.3%) of the participants had grade between 60-69;categories into very good comprehension performance and 4(15.4%) of the participants had grade between 70-100,categories into an excellence comprehension performance. More than 50% **(76.9%)** of the participants had grades higher than 50-59, indicating that most of the students performed above average. As novel as the CISCO-packet-tracer simulator is, few students (23.0%) had less than 50%.

Table 4: Summary of Students' Comprehension Performance in Learning Network Topology Using CISCO-Packet-Tracer Simulator

Comprehension Difference Rate	Average Comprehension Performance	Score Range	Summary of Comprehension Performance
53.9%	**61.5%**	**Very good**	**76.9%**

Table 4 shows the summary of students' comprehension performance in learning network topology using CISCO-packet-tracer simulator. Comparing the pass rate to the failure rate, a difference of 53.9% indicated that more students passed than those who failed when taught using a CISCO-packet-tracer simulator. Cumulatively, an average comprehension performance analysis of 76.9% categorised into the **Good** category revealed that students were able to comprehend network topology when taught using a CISCO-packet-tracer simulator. Though, there is room for improvement as the other students who scored below average could be further retrained to comprehend the concept better.

Discussion

The result obtained from the data gathered and analysed indicated that a larger proportion of the students acquired a substantial level of skills to utilise cisco packet tracer to learn network topology. The findings of this study agree with the finding of (Alnoukari, 2014), which posited that the Cisco packet tracer encourages students to engage in active learning and enables them to participate in inquiry-based learning. It also allows them to have higher-order thinking tasks as problem-solving analysis, synthesis, and evaluation. Therefore, Cisco packet tracer allows them to create and arrange devices in a real-time mode, thereby concretizing their understanding of network topology.

Conclusion

This study concludes that Cisco packet tracer simulator is an effective tool for fostering students' understanding and skills acquisition in network topology irrespective of gender. Increase understanding of network topology could lead to an improvement in students' achievement in the computer studies subject if the Cisco packet tracer simulator is adopted and utilized in teaching and learning processes. Noor Mohamad, Yayao, & Sumazly (2018) claimed that skills in problem-solving, designing and troubleshooting have greatly improved when students using Cisco packet tracer simulator. Cisco packet tracer simulator activities can be considered as a form of experiential learning as they allow students to either reinforce or discover knowledge and skills through personal interaction.

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