International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 33 العدد
Part 1 المجلد
October 2023 اكتوبر
المجلة الدولية للعلوم والتقنية
ISTJ
تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Cisco Packet Tracer Simulation as an Effective Teaching Tool in Computer Networking Classes for Undergraduate Students at Tobruk University

www.doi.org/10.62341/alcp2431

Aziza Lamien Helal
Computer Science Department, Tobruk University
a.almnfe@gmail.com, aziza.lamien@tu.edu.ly

Abstract

Technologies related to computer networks have been expanding rapidly. Computer networks need to be understood theoretically as well as practically, hence network simulation tools should be recommended to address this challenge. Students may use networking simulation tools to build, tune, and evaluate networks while strengthening their understanding of networking theory.On the market, there are several network simulation programs that enable users to simulate LANs, MANs, and WANs such as Ns3, OPNET and Packet Tracer.The objective of this research is to investigate the effectiveness of utilizing Cisco Packet Tracer as an educational tool. In addition, this paper aims to study what extend Packet tracer tool enhance student's understanding of computer networks theoretically and practically. Respondents of the study were the 41 second and fourth year students from Computer Science department at University of Tobruk who took Network course. The questionnaires were used as the research instruments in this stud. Data collected from questionnaire was analyzed using software program The Statistical Package for the Social Sciences (SPSS). In brief, Cisco Packet Tracer has been provena powerful simulation and visualization tool for aiding in theteaching and learning of Computer Networking courses.

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 33 العدد
Part 1 المجلد
October 2023 اكتوبر
المجلة الدولية للعلوم والتقنية
ISTJ
تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Keywords: Learning approaches, computer network, Simulation, Packet tracer tool.

الباكت تريزر كأداة فعاله في تعلم مادة شبكات الحاسوب لطلبة المرحلة الجامعية في جامعة طبرق

اسم المؤلفة : أعزيزة لامين هلال
قسم الحاسوب/ جامعة طبرق
a.almnfe@gmail.com

الملخص

نظرا للتطور السريع في التقنيات المتعلقة بشبكات الحاسوب ازداد الاحتياج إلى أن يتم فهمها نظريًا وعمليًا، وبالتالي أصبح استخدام أجهزة محاكاة الشبكة لمواجهة هذا التحدي ضروريا. يمكن للطلاب استخدام أدوات محاكاة الشبكات لبناء الشبكات وضبطها وتقييمها مع تعزيز فهمهم لنظرية الشبكات. يوجد حاليا العديد من برامج محاكاة الشبكات التي تمكن المستخدمين من محاكاة شبكات LAN وMANs وWAN مثل Ns3 وOPNET وPacket Tracer. الهدف من هذا البحث هو التحقق من مدى فعالية استخدام برنامج المحاكاة Cisco Packet Tracer كأداة تعليمية. بالإضافة إلى ذلك، يهدف هذا البحث إلى دراسة مدى تأثير أداة Packet Tracer في تعزيز فهم الطلاب لشبكات الحاسوب نظرياً وعملياً. المشاركون في الدراسة هم 41 طالبًا من طلاب السنة الثانية والرابعة من قسم علوم الحاسوب بجامعة طبرق والذين درسوا مادة الشبكات. وتم استخدام الاستبيان كأداة البحث في هذه الدراسة. تم تحليل البيانات التي تم جمعها من الاستبيان باستخدام برنامج الحزمة الإحصائية للعلوم الاجتماعية (SPSS). أثبت نتائج البحث أن Cisco Packet Tracerأداة محاكاة وتصور قوية للمساعدة في تدريس وتعلم أساسيات شبكات الكمبيوتر.

الكلمات المفتاحية: طرق التعلم، شبكات الحاسوب، المحاكاة وPacket tracer tool.

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Introduction

In the increasingly rapid development of technology and the change of learning approach, teaching computer network is very challenging Routing, mobility, load balancing, dependability, capacity, latency, and other advanced computer network topics are taught in such a way that students learn both theoretical knowledge and practical abilities for configuring and managing real machines. Computer networks are considered a significant field of knowledge. In multiple degree programs, such as computer engineering, computer science, and information engineering technology all educators aim to deliver effective lessons [1]. Studying computer networks is a difficult task as there are several different features and functions. Therefore, Students must invest a lot of time and effort into their education as a result. Consequently, studying computer networks is more difficult for teachers and students due to the inability to understand theoretical lectures [2]. Because of this, practical lessons are crucial for helping students connect theory with practice. Additionally, restricting instruction to theory may prevent undergraduate students from engaging in a deeper learning process that might have a lasting impact. In contrast to practical workshops on topics like programming, which frequently simply need a computer, teaching computer networks requires additional resources like networking equipment, which can be expensive and take up a lot of room. Simulation techniques are useful in circumstances like these to get around these problems. Chang. [3], stated that using network simulation software is critical for reducing the complexity of teaching computer networks to students.

Several networking simulation tools, including Cisco Packet Tracer, Boson NetSim, and GNS3, have recently been developed by various businesses. Cisco Systems created the Cisco Packet Tracer, which is being utilized extensively at universities all around the world.

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Objectives of Study.

1-The main target of this study is to investigate the effectiveness of packet tracer on teaching computer networks to undergraduate students at the University of Tobruk.

2- Study to what extent students understanding the theoretical concept of computer network subject better after performing the Packet tracer lab exercise and helps student's self-development.

3-Investigate to what extent Packet tracer helps students to understand the fundamental network configuration.

Network Simulation

Network simulation is a technique whereby a software program replicates the behavior of a real network. This is achieved by calculating the interactions between the different network entities such as routers, switches, nodes, access points and, links. Simulators are often used in computer network education because they give flexibility and availability [4]. Computer networking topic is difficult for educators to teach because of the intricate and abstract ideas and protocols.

The need for a network simulator arises from the fact that the majority of students find computer networking to be a challenging subject and that, at times, this perception makes them less motivated to learn the material. In the learning of computer networking, network simulation is best used to improve "experiential" learning among students. Students would utilize simulation in addition to lectures and lab sessions to comprehend the abstraction of computer networks, including the connections between the levels. Students had the opportunity to check all of the information they had learned from the books in the simulation that employed a customized computer. Currently, students may practice the majority of crucial network protocols while utilizing simulations as part of their educational process, including Internet Protocol (IP), Address

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Resolution Protocol (ARP), Domain Name System (DNS), and Transmission Control Protocol (TCP). There are different types of network simulators/ network simulation tools that open source and commercial such as (NS-2), Ns3, OPNET and, Packet Tracer.

Utilizing Packet Tracer to enhance computer network education.

Packet tracer is a tool that is regarded as one of Cisco System's computer network simulations; it allows computer network students and other users to create topologies that are similar to real computer networks. In addition, Cisco Packet Tracer is a comprehensive, networking technology teaching and learning program that offers a unique combination of realistic simulation and visualization experiences, assessment and activity authoring capabilities, and opportunities for multiuser collaboration and competition. Moreover, Cisco Packet Tracer is a sophisticated visualization and simulation computer network software application that students enrolled in a Cisco Network Academy class can use for free. On the other hand, persons outside the school might still utilize the instrument for educational reasons only. Packet tracer provides an open lab environment to usersand students, which is an opportunity to helpthem to finish thelab in a relatively reasonable time immediatelyto do the same work needed in a physical network [5].[6] Conducted a study **to** investigate the benefits of using Packet tracer as a tool, the result was Packet tracer tool help computer network students to learning and understanding the material easily. Therefore, the Cisco packet tracer enables learner to design and organize devices in real-time, solidifying their grasp of network architecture [7].

[8]stated that The contrast between the Cisco Packet Tracer as a virtual experiment technology and the real experiment employing physical equipment was examined; He found that the Cisco Packet

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Tracer offers several advantages, including safety, economy, convenience, flexibility, and ease of expansion.
Strategies were created for simulating the gap between theoretical lectures and laboratory experience, resulting in improved student learning outcomes; the study's findings revealed that when students used the Cisco Packet Tracer, their abilities in designing network topology and problem-solving increased significantly[9].

Research methodology.

Fourth- year students from thedepartment of ComputerScience whotook thecomputer Network courses at the University of Tobruk participated in this study. The questionnaire was sent to the student via email.41 students ware answered all questions about the effectiveness of packet tracer simulation tool. Three research questions have been established in order to assess the efficiency of utilizing the Cisco Packet Tracer as a learning aid. The data collected from the questionnaire will be analyzed usingthe software program The Statistical Package for the Social Sciences(SPSS).

Research Questions

1 Is the packet tracer tool considered as an effective tool for studying computer networks?
2 To what extent students understanding the theoretical concept of computer network subject better after performing the Packet tracer lab exercise which helps students' self-development?
3 To what extent do packet tracer enhance and improve students' practical knowledge of computer network principles?

Results and Discussion

This section presents the feedback and perception of the students regarding the effectiveness of the Packet Tracer tool in improving their learning performance in computer networks subject. From Table 1 and Figure 1 below, it is evident that the two questions

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

received a high degree of agreement based on the arithmetic mean of the two questions. The first question, which advises people interested in the field of networking to use Packet Tracer to develop their skills, received a mean score of 4.62 out of 5. The second question, which asks about the extent of developing Packet Tracer simulation program to enhance students' practical skills and increase their knowledge of most networks, received a mean score of 4.30 out of 5.

TABLE 1. Shows the effectiveness of the packet tracer tool to develop student's skills in computer network course.

Paragraph		Strongly agree	Agree	Disagree	Strongly disagree	Standard deviation	The mean	Degree of approval
The Packet Tracer simulation program developed my skills in the practical field and increased my knowledge of most network commands	Repetition	15	24	0	1	0.72	4.30	High
	The ratio	%37.5	%60	0 %	%2.5			
I recommend people interested in the field of networking to use Packet Tracer to develop their skills	Repetition	25	15	0	0	0.49	4.62	High
	The ratio	%62.5	%37.5	0 %	%0			
The general mean							4.46	High

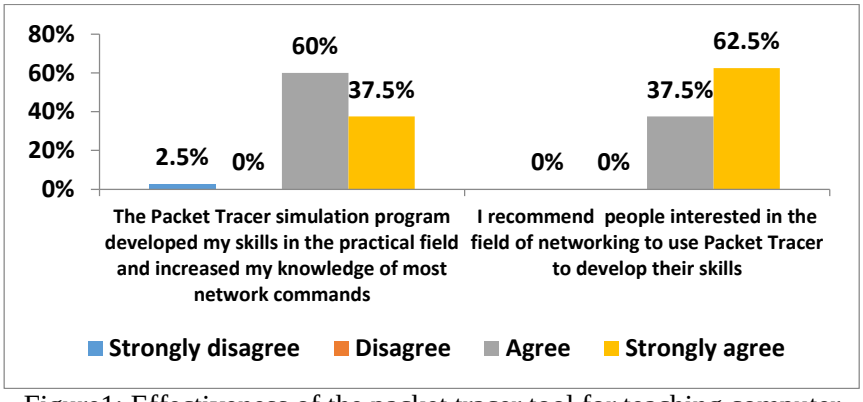

Figure1: Effectiveness of the packet tracer tool for teaching computer networks.

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Based on the general mean score of 4.46 out of 5 for the two questions, it is evident that there was a high degree of agreement with both questions. Table (1) and Figure (1) provided an answer to the first question of the study, which was whether the packet tracer tool was effective in studying computer networks. The high frequencies and percentages obtained from the study lead us to agree with the previous question. This result is consistent with a study conducted by [6]**,** which also concluded that using a packet tracer tool in a computer network course has significant benefits such as better understanding of key concepts that might be challenging to comprehend in theory.

TABLE 2. Packet Tracer Lab activities improve students' understanding of the theoretical concepts of computer networks.

Paragraph		Strongly agree	Agree	Disagree	Strongly disagree	Standard deviation	The mean
I feel confident to configure a real LAN after using Cisco packet tracer (CPT)	Repetition	12	27	1	0	0.58	4.25
	The ratio	%30	67.5 %	2.5 %	%0		
I am able to configure switches and Routers	Repetition	16	20	2	2	1.02	4.15
	The ratio	%40	%50	%5	%5		
Packet tracer gives me opportunities to create different network scenarios	Repetition	12	21	6	1	1.07	3.92
	The ratio	%30	52.5 %	15 %	2.5 %		
Using packet tracers in networking lectures in the computer department expanded my understanding of the basics of networking	Repetition	17	22	1	0	0.62	4.37
	The ratio	42.5 %	%55	2.5 %	%0		
Using Packet Tracer helped me develop myself in the field of networking because I can work on it and create different scenarios even at home and I do not need real network devices in order to develop myself	Repetition	13	22	4	1	0.98	4.05
	The ratio	32.5 %	%55	10 %	2.5 %		
The general mean							4.14

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10 /2023م

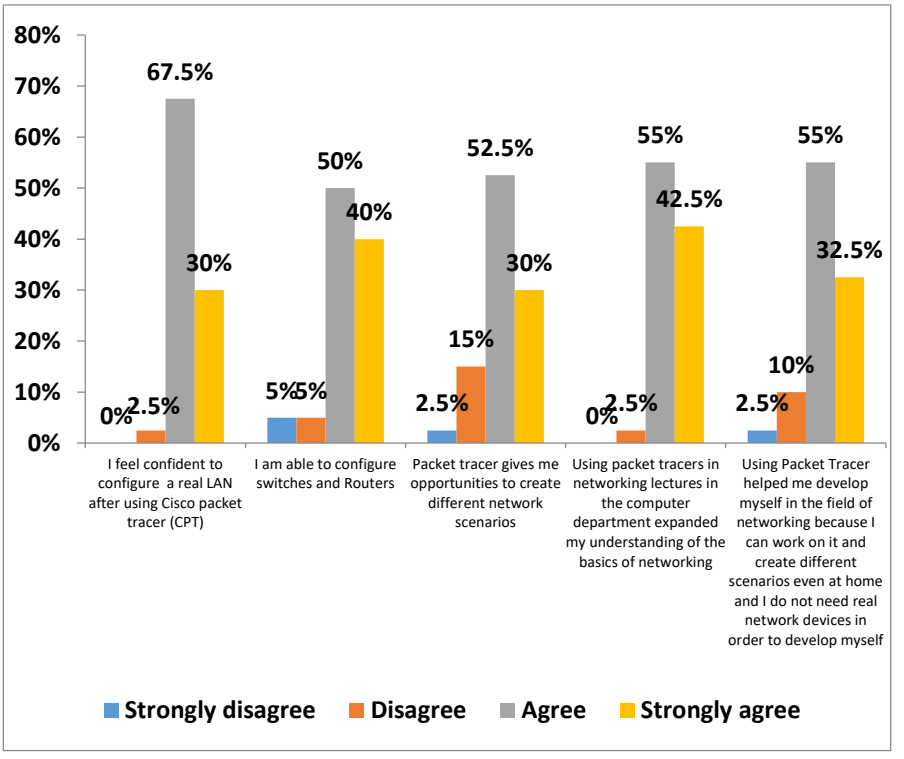

Figure2: Packet Tracer Lab activities improve students' understanding of the theoretical concepts of computer networks.

It is obvious that from Table (2) and Figure (2), the degree of agreement for all items was high, and they are arranged from highest to lowest as follows:

1. Using packet tracers in computing department networking courses improved my comprehension of networking fundamentals with a mean (X=4.37).
2. I feel confident to configuring a real LAN after using a Cisco packet tracer (X= 4.25).
3. I am able to configure witches and Routers the mean (4.15).
4. Using Packet Tracer helped me develop myself in the field of networking because I can work on it and create different

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

scenarios even at home and I do not need real network devices in order to develop myself (X =4.05).

5. Packet tracer gives me opportunities to create different network scenarios x= (3.92).

It is understandable from Figure.2 that "Using packet tracking tools in networking lectures in the computer department increased my understanding of networking basics" had the highest mean with a high degree of agreement, 4.37 out of 5.

From Table.2 and Figure.2 can confirm a research objective and question 2 " packet tracer performing lab exercise facilitated understanding of the theoretical concept of a computer network".

From previous data can conclude that the majority of Students agreed that packet tracer increased their understanding of computer fundamentals and they felt confident to configure real LAN after using packet tracer tool.

Additionally, from table 2. Can demonstrate that 76% of students who participated in this survey acknowledged that after utilizing packet tracer, they were able to setup switches and routers and construct diverse network scenarios without the need for real network equipment. This result emphasizes the finding of [5] that Packet Tracer provides users and students with an open lab environment, allowing them to complete lab assignments quickly and effectively similar toa real network.

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 33 العدد
Part 1 المجلد
October 2023 اكتوبر
المجلة الدولية للعلوم والتقنية
ISTJ
تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

Table 3. Students to understand the fundamental network configuration.

Paragraph		Strongly agree	Agree	Disagree	Strongly disagree	Standard deviation	The mean
I understand basic network configuration skills	Repetition	12	27	1	0	0.58	4.25
	The ratio	%30	%67.5	%2.5	0 %		
I am able to draw network topology	Repetition	19	20	1	0	0.63	4.42
	The ratio	%47.5	%50	%2.5	0 %		
I can use different commands such as ping & hostname	Repetition	14	22	4	0	0.86	4.15
	The ratio	%35	%55	%10	0 %		
The general mean							4.27

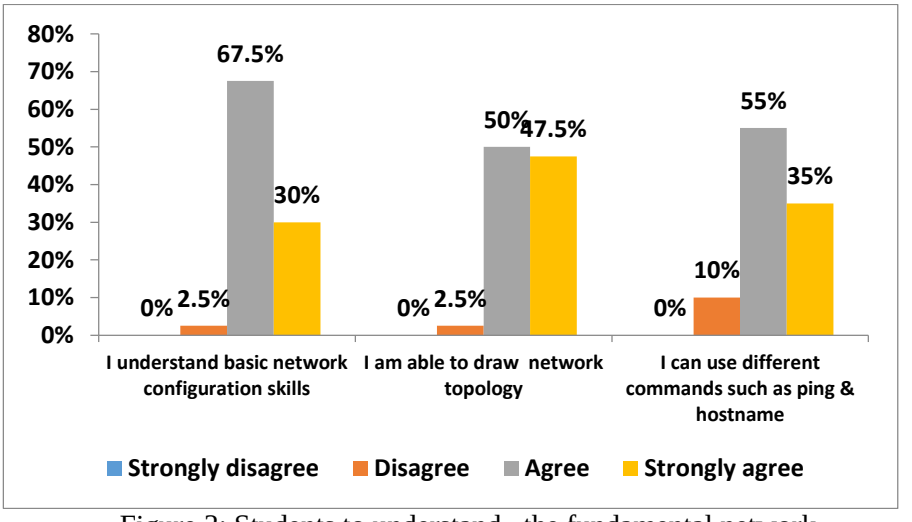

Figure 3: Students to understand the fundamental network configuration.

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

From Table (3) and Figure (3), it is clear that the degree of agreement for all items was high, and they are arranged from highest to lowest. I am able to draw network topology got the highest rank (x= 4.42) followed by I understand basic network configuration skills (x=4.25) and I can use different commands such as ping & hostname has mean (x=4.15).

Based on these results, we can confirm research objective 3 and answer research question 3. The study found that utilizing the Cisco Packet Tracer enhanced and improved students' practical knowledge of computer network principles. This outcome is similar to a previous study [9], which found that students' capacity to solve problems and build network topologies greatly improved when they used the Cisco Packet Tracer. Also, the outcome aligns with the findings of another study [7], which stated that the Cisco Packet Tracer helped students build and organize devices in real-time, strengthening their understanding of network architecture.

Conclusion

The objective or the purpose of this study was to investigate the effectiveness of the packet tracer tool in learning computer networks from students' perspective. All research objectives in this study were achieved. in short, could conclude from the results that there are significant advantages of using packet tracer in computer network courses such as they are learning important and basic concepts of computer networks which can be difficult to understand in theory. Therefore, the Packet Tracer simulation program develops students' skills in the practical field and increases their knowledge of most network commands. In conclusion, the Cisco Packet Tracer is an effective learning tool that can be used to improve the learning experience of computer network courses.

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

REFERENCES

[1] Crichigno, Jorge, and Ivan Lopez Hurtado. "An alternative model for computer networks education in computing disciplines." *2012 ASEE Annual Conference & Exposition*. 2012.doi:10.18260/1-2-20909.

[2] Prvan, Marina, and JulijeOžegović. "Methods in teaching computer networks: a literature review." *ACM Transactions on Computing Education (TOCE)* 20.3 (2020): 1-35.

[3] Chang, Rocky KC. "Teaching computer networking with the help of personal computer networks." *Proceedings of the 9th annual SIGCSE conference on Innovation and technology in computer science education*. 2004.

[4] Ruiz-Martínez, Antonio, et al. "Teaching advanced concepts in computer networks: Vnuml-um virtualization tool." *IEEE Transactions on Learning Technologies* 6.1 (2013): 85-96. doi: 10.1109/TLT.2013.2.

[5] Sun, Liangxu, et al. "Comparison between physical devices and simulator software for Cisco network technology teaching." *2013 8th International Conference on Computer Science & Education*. IEEE, 2013.

[6] S. R. Javid, Role of Packet Tracer in learning Computer Networks, Int. J. Adv. Res. Comput. Commun. Eng., vol. 3, no. 5, pp. 6508–6511, 2014.

[7] Adedokun-shittu, NafisatAfolake, et al. "Effect of Cisco-Packet-tracer Simulator on Senior School Students' Comprehension and Skill Acquisition in Computer Network Topology in Nigeria." Nigerian Online Journal of Educational Sciences and Technology 3.2 (2021): 9-14.

تم استلام الورقة بتاريخ:24/ 9 /2023م وتم نشرها على الموقع بتاريخ: 31/ 10/2023م

[8] Gomez Gaona, J.A. et al, A survey on network simulators, emulators, and testbeds used for research and Education [Preprint], 2023. doi:10.2139/ssrn.4457366.

[9] V. Shanmugam, L. Gopal, Z. Oo, and P. M. Viswanathan, "Enhance student's learning with an aid of simulation software to understand computer networking undergraduate courses", Enhancing Learning: Teaching & Learning International Conference, 2011.

.