The use of TAM in evaluating the effectiveness of network simulation tools in internet technologies subject

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Abstract

Technology has immensely influenced the educational space around the globe by using educational tools to assist students with practical work. This became evident when higher learning institutions reached a standstill due to the COVID-19 pandemic. However, the effectiveness of these educational tools in teaching and learning remains unknown. This research aims to use the technology acceptance model to guide the analysis of the effectiveness of a network simulator called a packet tracer. This study was conducted in November 2022 with 82 Internet technology students. A quantitative method was used in this study. Data were collected through observations and survey questionnaires. Cross-tabulation was used to analyze the data. The results revealed that Packet Tracer, as a virtual learning tool, has proven to be an effective software for supporting the teaching and learning of Internet technology students. This contributes to the body of knowledge and technology in the education discipline.

Keywords: Education; evaluation; Packet Tracer; TAM; virtual learning; technology.

1. Introduction

The shift in technology has impacted the socioeconomic world; this simply means that Higher Learning Institutions (HLIs) have also been impacted (Štrbo,2021). Higher learning Institutions face various challenges during the teaching and learning of computer-related subjects (Ambiyar, Yondri, Irfan, Putri, Zaus, & Islami, 2019; Sudarsana, Armaeni, Sudrajat, Abdullah, Satria, Saddhono & Ekalestari, 2019), causing both students and teachers to participate and interact less in the learning process. This was specifically observed in Internet Technologies (a computer networking subject). Some of the impediments encountered in the subject include (1) the limitations of network devices, so students have to take turns in a group practice, causing some students not to participate; (2) the high price of network devices needed for practice; and (3) the practice process should take considerable time, because students must physically configure the network, in addition to the minimal amount of practice equipment.

Teachers can now use virtual learning technology (V-learning) to overcome problems experienced by students. As a result, V-learning can strengthen HLIs to become more competent and prepare students for the global market (Janal, Jalil, & Ahmad, 2020).

Visual learning technology uses visual aids such as videos to deliver educational content more effectively (Du, Dai, Tang, Hung, Li, & Zheng, 2022). In the same line of argument, Abdrabou and Shakhatreh (2021) emphasized that V-learning greatly benefits and enhances the learning process, as interactive effects are used to reinforce the material being studied. It is therefore considered a great way of learning as it aids in increasing a learner's interest in a certain subject, which makes the learning process more enjoyable and keeps the student's interest for longer periods.

Packet Tracer (PT) software is a visual tool utilized around the globe. Packet Tracer is a comprehensive learning software application for teaching skills and concepts related to computer networks (Muniasamy, Ejlani, & Anadhavalli, 2019). The software can perform computer network simulations or is often called a computer network. As mentioned by Abdrabou and Shakhatreh (2021), the software makes learning more comfortable by providing a realistic network simulation and visualization of the environment. In addition, this packet tracer software can simulate ongoing real-time updates that highlight the logic and network activities.

In this study, the researcher used Technology Acceptance Model (TAM) to guide the analysis of the effectiveness of PT. The technology Acceptance Model is a theoretical framework used to explain how people accept and use technology. It was developed by researchers at the University of Massachusetts in the late 1980s and is based on prior work by researchers in the fields of organizational behavior, cognitive psychology, and information systems (Isaac et al, 2018)

The rest of the paper is organized as follows: Section 2 provides work related to this research. Section 3 discusses the methodology of this study. Section 4 highlights the theory underpinning this study. The results are presented in Section 5. The last section provides the conclusions of the study and recommendations for future research.

2. Related work

Packet Tracer software has been used around the globe to enhance students learning. Especially during the COVID-19 pandemic (Allison, 2022). A recent review of the literature found that, since the outbreak of the pandemic, more and more institutions have adopted PT as a teaching tool to foster remote learning. The review also highlights the importance of providing adequate training for teachers on how to effectively use the tool to facilitate learning. Other studies have examined how the use of PT can help to improve student engagement and performance, as well as its potential to provide hands-on experience to students who are unable to access physical networking equipment. Finally, there is also research into the challenges faced by educational institutions when using PT, including the need for better student support services and more resources to enable effective teaching.

For instance, Ojugo and Eboka (2021) used PT to improve service delivery and performance dependability by conducting standardized tests, such as throughput tests, application response-time tests, and availability tests on a campus network in Nigeria.

Another scholar used PT as an effective pedagogy in computer networking courses in Malaysia. Their study revealed that PT successfully helped their students to understand several key concepts of computer networking and, at the same time, quash some abstractions they faced in the course (Noor, Yayao, & Sulaiman, 2018).

A study conducted in Malaysia by Allison (2022) developed a Survey on the Challenges Faced by the Lecturers in Using PT in Computer Networking Courses. Their idea was to identify the problems faced by teachers throughout the teaching and learning process, even with the help of instructional simulations. In their conclusion, the authors proposed that laboratory work activities need to be improved by employing an engagement taxonomy as its preparatory guidelines.

Thus, an environment in which any technology or educational tool is adopted or used provides different results depending on how it is used, who uses it, and their location. Therefore, it is important to evaluate the usefulness and ease of use of PT software to evaluate its effectiveness in the context of Internet technology students.

3. Underpinning theory

This study applied TAM as the underpinning theory. TAM is a useful theoretical model for predicting how technology or a system is used and its effectiveness (Isaac et al, 2018). According to Allison (2022), TAM is a widely accepted concept that explains the relationships between users and technology. It is based on the notion that users' attitudes towards technology are based on their beliefs regarding the utility and convenience of the technology. According to the TAM, user opinions of usefulness and ease of use are the major factors in determining if a user will adopt and use a system. The TAM has been used to understand and anticipate the behavior of users in a range of scenarios, such as technology acceptance, software engineering, and e-commerce (Isaac et al, 2018).

The technology Acceptance Model assisted the author by guiding the evaluation of the significant effects of student perceptions, student motivation, perceived ease of use, and perceived usefulness of the adopted virtual technology in enhancing the accuracy of students' performance and learning.

It is worth noting that the author only used two constructs from the TAM model. These two constructs–perceived ease of use and perceived usefulness–allowed the researcher to evaluate the effectiveness of PT.

4. Methodology

This quantitative research was conducted at a public university in South Africa (SA), where 82 respondents were asked to complete a questionnaire survey. Questionnaires were prepared using Likert scales with five options from Strongly Agree to Disagree Strongly. Aspects evaluated include aspects of Internet Technologies, learning, and communication. The questionnaire before being used for data collection is validated by an expert (expert judgment). Four experts validate the questionnaire. After the expert validated the questionnaire, a tryout was conducted.

The researcher also used observations to collect data. The author observed students during lab sessions and noted their level of engagement with the network simulation tools. 2. students were asked to complete a questionnaire to assess their level of satisfaction with the PT. 3. The author monitored the students' interaction with PT and took notes of their performance. 4. students were asked to provide feedback on their experience with PT. 5. The amount of time students spent on the PT was measured. 6. The quantity and quality of the student's work completed with PT was assessed. 7. The author monitored the student's progress in using the network simulation tools by tracking the grades they receive.

The collected data were from October 2022, as Internet Technologies (INT) is a second-semester subject. The response rate of the study was 100%, which is good compared to other studies found in the literature.

A Technology Acceptance Model (TAM) was used to guide the data analysis. The following two TAM constructs were validated: 1. perceived ease of use of PT and 2. Perceived usefulness of PT.

4.1. Perceived ease of use of Packet Tracer

Perceived ease of use refers to how easy it is for users to learn and use Packet Tracer (Vinay & Rassak, 2015). It is an important factor in determining user adoption, as users are more likely to use a technology if they find it easy to use. Packet Tracer is a powerful network simulation tool that can be used to design, configure, and troubleshoot networks (Janal et al, 2020). Users have reported that the software is intuitive and easy to use, making it a good choice for those new to network simulation (Isaac et al, 2018).

4.2. Perceived usefulness of Packet Tracer

Perceived usefulness is the extent to which a user believes that using Packet Tracer will enhance their job performance (Sudarsana et al, 2019). It is based on the belief that Packet Tracer will help the user become more efficient, accurate, and productive in their work. Additionally, perceived usefulness may also be based on the user's belief that Packet Tracer will improve their understanding of networking concepts, as well as increase their overall knowledge of networking (Isaac et al, 2018).

5. Results

To efficiently evaluate the effectiveness of PT for INT students, it was necessary to determine whether the V-learning tool was useful. The analysis of PT's perceived ease of use is shown in Table 1, using the following determinants: installation, connection, addressing, configuration, and simulation. Based on each determinant, participants were asked questions, and a yes or no answer was expected.

Numerous studies have demonstrated that perceived ease of use is crucial in the context of information systems (IS). According to Isaac et al (2018), the definition of perceived ease of use refers to how much a person believes using a given system or technological equipment will need little to no effort. Students' experience of installing PT was 89%, which means that most of the students were able to install the tool, and 84% of the students were able to connect the devices. What was interesting about perceived ease of use was the addressing determinant. The questionnaire revealed that only 67% were able to address the topology and 33% could not. This means that addressing is an element that requires students' attention.

The configurations and simulations were 74% and 77%, respectively. This implies that for PT to be more effective, these elements need to be considered so that they can be improved.

Table 1: Perceived Ease of Use of Packet Tracer.

Determinants	Question	Yes	%	No	%
Installation	Was installation easy?	73	89%	9	11%
Connection	Did you manage to connect your devices?	69	84%	13	16%
Addressing	Were you able to address your topology?	55	67%	27	33%
Configuration	Were you able to do the configurations?	61	74%	21	26%
Simulation	Was simulation understandable?	63	77%	5	23%

Furthermore, Table 2 shows the perceived usefulness of the packet tracers. There is a claim made in the literature that perceived usefulness improves with perceived ease of use. The allegation appeared to be true based on the results of this study. Abdrabou and Shakhatreh (2021) stated that perceived usefulness is the extent to which a person thinks that employing a specific system or piece of technology will improve their performance.

According to the results presented in Table 2, all students obtained a new skill, and their knowledge was improved by using PT for teaching and learning. Although 5% of the students felt that PT did not save time, they all agreed that it was cost-effective, with a percentage of 100. Additionally, 91% felt that the information provided about PT was complete and adequate, while 9% believed that the information was incomplete. Thus, efforts should be made to enhance the information provided.

Table 2: Perceived usefulness of Packet Tracer.

Determinants	Questions	Yes	%	No	%
Skill acquired	Did you obtain any new skills?	82	100%	0	%
Knowledge improvement	Did your practical knowledge improve?	82	100%	0	0%
Save time	Does using a packet tracer save time	78	95%	4	5%
Cost-effective	Is it cost-effective to use a packet tracer?	82	100%	0	0%
Information completeness	Do you think you have all the information you require about the packet tracer?	75	91%	7	9%

6. Conclusion and recommendations

Using V-learning tools like Packet Tracer as an instructional aid in computer network courses is beneficial. Packet Tracer is an advanced teaching platform that provides an interactive and fun environment for both students and teachers. The findings of the study suggest that most students believe that using this type of tool can facilitate a better understanding of computer networking concepts, make studying technical concepts simpler, and enhance their networking abilities. Furthermore, the ability of Packet Tracer to demonstrate network algorithms proves its worth as a resource to learn networking principles, concepts, and routing protocols, which are known to be the most difficult and important topic in this subject.

TAM has been proven to be an effective method of assessing the efficacy of network simulation tools in Internet Technologies courses. The research indicates that these tools have been successful in helping students comprehend and apply network theories, as well as giving them practical experience in designing and testing networks. The results also point to the

benefits of the tools in terms of developing problem-solving skills and improving general analytical thinking. TAM has also been beneficial in providing feedback on the satisfaction and engagement levels of students in terms of the tools' effectiveness. Ultimately, TAM has provided an overall measure of the impact of the tools on student learning and performance. In conclusion, PT is an effective tool for studying computer network topics, such as technical and routing protocol principles, and students' exam results can be used to measure the effectiveness of the Packet Tracer for future use.

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