

# Leveraging Packet Tracer as a Common Assessment Tool in a Virtual Learning Environment: A Case Study

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**Abstract:** *Virtual learning environment is a must for remote learning. Nowadays with the COVID-19 pandemic, the education paradigm has shifted to adopt distance learning approaches, thus, a virtual learning environment is preferred as a learning platform. Assessment is one of the important parts of the learning process. This study shares the experience of adopting Packet Tracer (PT) as a common assessment tool for computer networking subjects, namely Routing and Switching Technologies (ITT532). This course is a skill-based subject that ideally teaches face-to-face. However, due to COVID-19, remote learning was adopted. PT is a skill-based assessment that focuses on configurations of network devices to simulate network scenarios and environments. By leveraging the Learning Management System (LMS), specifically uFuture, PT has been employed to execute skill-based evaluation. Several network configurations such as VLAN, trunking, Inter-VLAN routing, port security, and static routing (IPV4) are discussed in this study case.*

**Keywords:** *Common assessment, Packet Tracer, virtual learning, skill-based assessment*

## 1. INTRODUCTION

Virtual learning allowed educators to deliver instructional content remotely, eliminating the need for physical classrooms. Students could access course materials and lecture materials from any location with an internet connection, providing flexibility and overcoming geographical barriers. Teaching Computer Networking courses remotely is challenging. One of the difficulties is to cater to the hands-on activities for the real networking equipment configuration (Abdul Rashid et al., 2019). But, with the adoption of a Learning Management System (LMS), teaching remotely has become convenient and manageable. LMS is a teaching platform that caters to the communication between lecturers and students in conducting teaching activities remotely (Saidi et al., 2021). There are free LMS available such as Google Classroom, but University Teknologi MARA (UiTM) has developed its own LMS known as uFuture ([www.ufuture.uitm.edu.my](http://www.ufuture.uitm.edu.my)). uFuture has become an excellent platform that caters features for Online and Distance Learning (ODL) and Blended Learning (BL), such as forums, chat, video, assessment, and assignment. This has made uFuture an excellent LMS platform for a virtual learning environment.

Undoubtedly, the pandemic has led to a transformation in teaching and learning approaches, shifting towards virtual or online learning, which encompasses the practical evaluation aspects (Gamage, K. A. A et al., 2020). Since hands-on learning involves active engagement and physical involvement of students in practical activities that directly relate to the subject matter (Miriam, 2021), the process of teaching and assessing computer networking courses has become very challenging (Wang et al, 2020), especially during the pandemic as it requires hands-on activities, such as cabling, configuring and troubleshooting the network devices and network scenarios. The course Routing and Switching Technologies (ITT532) is one of the core subjects in Bachelor of Computer Science (Hons) Computer Network (CS255) and this program is offered in three UiTM campuses, namely UiTM Shah Alam, UiTM Jasin, and UiTM Arau. In order to maintain consistency and object measure of students' performance across different campuses, a common approach of assessment, specifically for a skill-based was used to standardize the evaluation of the students' skills for this course. For the purpose of achieving the desired learning outcomes of the course, it is crucial to emphasize practical skills. Thus, the inclusion

of Packet Tracer software as a component of the hands-on or skill-based assessment has been implemented to evaluate students' practical abilities. This skill-based assessment involves configuring devices according to different requirements, for instance, VLANs, Inter-VLAN routing, switch security, and static routing, and also troubleshoot problems if they arise during the assessment. This skill-based assessment approach was initially introduced during the period of the pandemic and continues to be practiced even during the post-COVID year.

Packet Tracer (PT) is a network simulation software developed by Cisco Systems. Simulation software is one of the tools that can be deployed for a virtual learning environment (Gamage, K. A. A. et al, 2020). PT is a standalone program that can be installed and run on various operating systems and it allows users to simulate and practice networking concepts and scenarios, making it a valuable tool for networking education and training. ([www.netacad.com](http://www.netacad.com)). According to Noor Maizura Mohamad Noor, Yayao, and Sulaiman (2018), Cisco Packet Tracer is an all-inclusive educational software that incorporates inventive functionalities to enhance the enjoyment and fascination of computer network learning for students and instructors alike. A few researches have proven that PT can be an effective medium of teaching and learning network-related courses as it has many features to simulate common network devices, concepts, and environments (Abdul Rashid et.al, 2019), (Ambiyar et.al, 2019).

PT, with the feature of the activity wizard, can assist the lecturer to design a skill-based assessment that focuses on configurations of network devices and simulates network environments. Michel Bakni et. al (2018) has concluded that PT can be used to aid certain educational purposes, and continuous assessment is part of it. Skill based assessment is one of the compulsory continuous assessments to achieve the course learning outcome.

## **2. THE ASSESSMENT SCOPE**

The skill-based assessment covered half of the topics in the syllabus. Five areas were identified for this skill-based assessment. All the tasks were arranged in a manner that students can answer step-by-step. The topics were divided into 5 parts as depicted in Fig. 1.

The screenshot displays a 'PT Activity' window with a timer at 00:00:00. It contains five sections of instructions for a network configuration assessment:

- Part 1: Configure VLANs and Assignment Ports to VLANs**  
You will create VLANs as specified in the table above on switches in Head Quarters only. You will then assign the VLANs to the appropriate interface. The show vlan brief command is used to verify your configuration settings. Complete the following tasks on each switch:
  - Create and name the required VLANs on each switch from the table above.
  - Assign used ports to the appropriate VLAN (specified in the VLAN table above) and configure them for static access mode. Verify that the VLANs are assigned to the correct interfaces.
  - Configure the management interface and default gateway on each switch using the IP address information in the Addressing Table.
- Part 2: Configure Trunking**  
You will manually configure interface between switches as a trunk in Head Quarters's network.
  - Configure manually an 802.1Q Trunk Between the Switches.
  - As a part of the trunk configuration, set the native VLAN to 99 on the three switches. You may see error messages temporarily while the two interfaces are configured for different native VLANs.
  - As another part of trunk configuration, specify that only VLANs 10, 20, 30, and 99 are allowed to cross the trunk. Issue the show interfaces trunk command to verify trunking ports, the native VLANs and allowed VLANs across the trunk.
- Part 3: Configure Inter-VLAN Routing**
  - Configure the HQ\_Central router: Activate interface G0/1 as necessary on the router.
  - Configure sub-interfaces for each VLAN as specified in the IP addressing table. All sub-interfaces use 802.1Q encapsulation. Ensure the sub-interface for the native VLAN does not have an IP address assigned.
  - Verify the sub-interfaces are operational.
- Part 4: Configure Port Security**  
In this activity, you will configure and verify port security on a switch HQ\_Sud and HQ\_North only. Port security allows you to restrict a port's ingress traffic by limiting the MAC addresses that are allowed to send traffic into the port.
  - Access the command line for HQ\_Sud and HQ\_North and enable port security on Fast Ethernet ports fa0/9, fa0/10 and fa0/20.
  - Set the maximum so that only one device can access the Fast Ethernet ports fa0/9, fa0/10 and fa0/20.
  - Secure the ports so that the MAC address of a device is dynamically learned and added to the running configuration.
  - Set the violation so that the Fast Ethernet ports fa0/9, fa0/10 and fa0/20 are not disabled when a violation occurs, but a notification of the security violation is generated and displayed from the unknown source is dropped.
  - Disable all the remaining unused ports. Hint: Use the range keyword to apply this configuration to all the ports simultaneously.
- Part 5: Configure Static Routing (IPv4)**  
In Part 4, you will configure static on HQ\_Central, BR\_South and BR\_North to enable full connectivity between the routers using IPv4. Once again, the static routing being used here is not meant to represent best practice, but to assess your ability to complete the required configurations. Please use next-hop address during the configuration. \*Notes: Use next-hop address instead of using exit interface of your routers for metric calculation.
  - On HQ\_Central, configure a static route to BR\_South network using the next-hop address.
  - On HQ\_Central, configure a static route to BR\_North network, using the next-hop address.
  - Continue using the same method to configure static routing for BR\_South and BR\_North router using next-hop address.

At the bottom, there is a 'Time Left: 00:00:00' indicator, a 'Completion: 0%' indicator, and navigation buttons: 'Top', 'Dock', 'Check Results', 'Back', '1/1', and 'Next'.

Fig. 1 The five areas covered in the assessment

The questions are based on the elements that the students will be assessed on. The completion marks percentage at the bottom-right will increase every time the student completed each configuration correctly. The timer on the bottom-left shows the duration before the assessment expires. Once expired, the configurations will be locked and the student needs to close and submit the file to any means of channel instructed by the lecturer. The five areas covered about 70% of the whole syllabus, in terms of configuration skills. The rest of the configuration skills were covered during the lab assessments.

## **2.1 PART 1: CONFIGURE VLAN AND ASSIGNMENT PORTS TO VLANS**

VLAN is one of the main topics for the course, whereby it covers the concepts of VLANs and how to implement VLAN in an enterprise network. The configuration skill that students should grab is VLAN creation, port membership assignment, type of switch ports, and switch virtual interface IP assignment.

## **2.2 PART 2: CONFIGURE TRUNKING**

Trunking is a part of VLAN concepts and it is needed when two or more switches are connected to form a LAN in an enterprise network. Trunking protocol enables two or more VLANs to be carried by a specific trunk link. The students need to understand the trunking protocol and different types of VLANs. The assignment suggests that students might encounter error messages, which aims to help them remain composed and avoid panicking throughout the assessment period.

## **2.3 PART 3: CONFIGURE INTER-VLAN ROUTING**

Inter-VLAN routing is needed when connecting two or more VLANs. Basically, there are two methods for inter-VLAN routing, either using a router or a multi-layer switch. As for this assessment, a router is used, and the students need to enable inter-VLAN routing using the router-on-a-stick concept. Both switch and router need to be configured for this purpose.

## **2.4 PART 4: CONFIGURE PORT SECURITY**

LAN security falls under one of the topics in the syllabus. It is undoubtedly a very important topic as this topic is the foundation of security implementation in a LAN, therefore the students are required to have sound knowledge of this topic. Port security is one of the few switch security measures in the data link layer.

## 2.5 PART 5: CONFIGURE STATIC ROUTE (IPV4)

Routing is one of crucial topics in computer networking. As for the theoretical concepts, dynamic and static routing were introduced. Yet as for the practical exercises, only static routing was embedded in this course. The assessment covers static routes using different next-hop options.

## 2.6 THE ASSESSMENT INTERFACES

After completing the design process in the PT, it was carried out as a Packet Tracer Activity (PKA) using the functionality provided in the Activity Wizard. The activity wizard is one of the features in PT that allows the lecturer to create detailed networking scenarios for the assessment. Fig. 2 below shows the activity wizard interface used to design the assessment.



**Fig.2** The Activity Wizard Interface

Once executed, the file will be saved as a Packet Tracer Activity extension (.pka). Fig. 3 illustrates the mandatory user profile interface that students must enter, thereby ensuring that they cannot plagiarize or copy the work of other students. Meanwhile, Fig. 4 displays the addressing tables for students' reference. The information in this table reflects the pre-configured items in the network topology.

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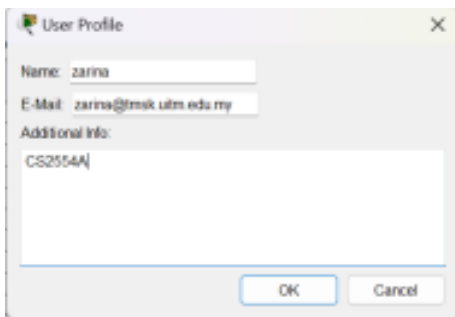


Fig.2 The Activity Wizard Interface

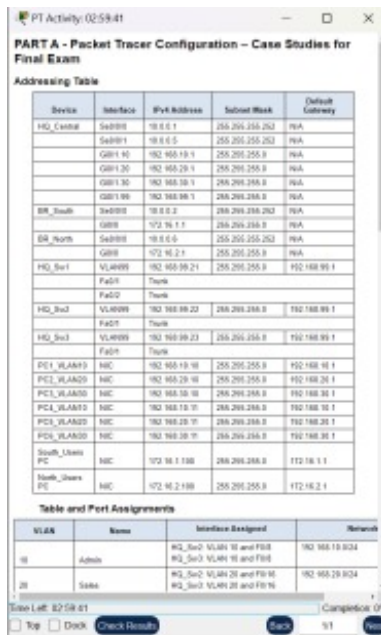


Fig. 4 Addressing Table

The following figure shows the assessment in the topology view. Students may click the respective device and the command line interface will be opened for her/him to start completing the assessment according to the respective question.



Fig. 6 The assessment in a bigger view

After a student finishes a section, he/she can observe the increase in marks at the bottom-right. If the completion percentage does not increase, it indicates that the configuration was incorrect. Otherwise, he/she can move to the next part.

### **3. THE METHODOLOGY AND RESULT**

#### **3.1 PURPOSE OF THE STUDY**

This study case was conducted to get the instructors' perceptions towards the implementation of common skill-based assessment using PT on the uFuture platform as the virtual learning environment. The result is discussed in the following section.

#### **3.2 DISCUSSION**

A simple open-ended survey has been distributed to five instructors from UiTM Shah Alam, UiTM Jasin, and UiTM Arau who are teaching this course, querying their perception(s) towards the use of Packet Tracer Activity as a common skill-based assessment. The following lists all the responses:

- a) “Clear evaluation of items to test” – *Lecturer 1, Lecturer 5*  
The skill-based assessment could be done either during the lab hour or during the skill-based exam duration. PT allows the lecturer to select which area or topic or subtopic to be assessed. The physical hands-on can be assessed during the lab hour, while the network configurations can be done during the skill-based exam
  
- b) “Standardised answer scheme/rubrics” – *Lecturer 1, Lecturer 2, Lecturer 3*  
A rubric is very essential in a common assessment or examination, especially if it to be taken by students across different campuses. The auto-calculation of marks will eliminate the marking discrepancy or deviation by different lecturers, moreover from different campuses.



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- c) “Fast response/feedback from and to students” – *Lecturer 1, Lecturer 3*  
The students do not need to establish the network from scratch by themselves. The assessment is focusing on the configuration and troubleshooting of selected network issues, and it was pre configured with the network topology and some initial settings in the network devices. Students may ask questions during the assessment and the lecturer may provide fast responses to them.
- d) “Ease of grading process” – *Lecturer 3*  
The automated marking calculation feature in PT has rendered it a valuable assessment tool for lecturers during the grading process. As some campuses may have nearly 100 students per lecturer, this feature definitely may reduce the lecturer’s burden on grading the assessment.
- e) “Solve the issue of too many students in a physical lab and limited resources” – *Lecturer 3, Lecturer 4, Lecturer 5*  
For some campuses, the number of students that registered for this course may reach 100 students per lecturer, and the number of students per group may exceed 33. Scheduling a 100% hands-on skill-based assessment will be very challenging, as the number of network devices cannot support the number of students per group. Therefore, skill-based using PT is highly advantageous throughout the assessment week. Furthermore, the uFuture platform was utilized to standardize the assessment time and duration across a few campuses.

Besides the above perceptions, some guidelines have been recommended if common skill-based assessments are to be conducted using PT on different campuses to achieve desired learning outcomes. These include:

- a) Clearly define learning outcomes by clearly articulating the specific learning outcomes that need to be achieved through the Packet Tracer activity. This will help guide the design process and ensure that the activity is aligned with the educational objectives.

- b) Incorporate real-world scenarios; design PT activities that simulate real-world networking scenarios. This can include scenarios like setting up a small office network, troubleshooting network issues, or designing a secure network architecture. By presenting practical challenges, students can apply their theoretical knowledge in a realistic context.
- c) Gradual complexity; structure the activities in a way that gradually increases in complexity. Start with basic tasks and gradually introduce more advanced concepts and configurations. This allows students to build their skills and confidence incrementally.
- d) Integrate with theoretical concepts; connect the PT activities to the theoretical concepts taught in the classroom. Ensure that the activities align with the curriculum and reinforce the topics covered in lectures or readings. This integration helps students bridge the gap between theory and practice.

#### **4. CONCLUSION**

Despite being introduced during the pandemic, the common skill-based assessment utilizing PT received unanimous approval from all the lecturers to be deployed even in the post-pandemic year. It is undoubted that students should be exposed to real network devices and practice physical network implementation (Noor Maizura Mohamad Noor, Yayao, and Sulaiman, 2018) in parallel with the use of network simulators like PT in order to engage the students with real network scenarios. It is also undoubted that PT can be used as an assessment tool for any network-related course, due to the advantages discussed in the previous section. Based on the discussed perceptions and guidelines, this practice could be one of the common skill-based assessment solutions for the students that are distributed across different campuses. Overall, incorporating Packet Tracer activities as part of assessments provides a comprehensive evaluation of students' networking knowledge and practical skills. It enables instructors to assess their ability to apply concepts, configure network devices and troubleshoot issues. Moreover, it prepares students for real-world networking scenarios by providing them with hands-on experience in a simulated environment.

## 5. ACKNOWLEDGEMENT

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