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Enhancing Teaching and Learning through Computer Network Simulator: A Study in a Self-financing Undergraduate IT Course

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Overview

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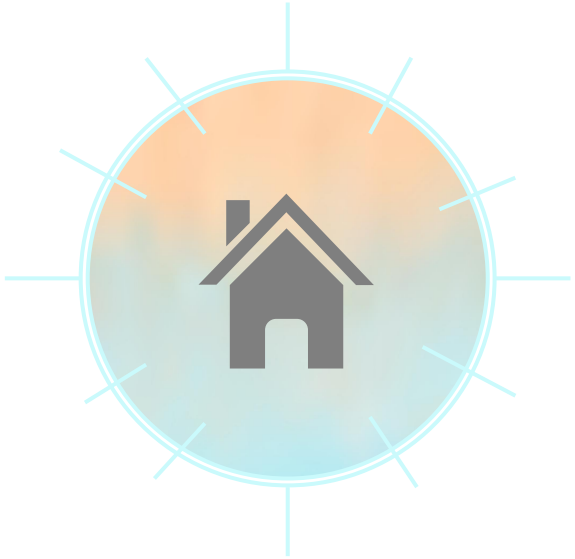


Section 1

Background and Literature Review

Background

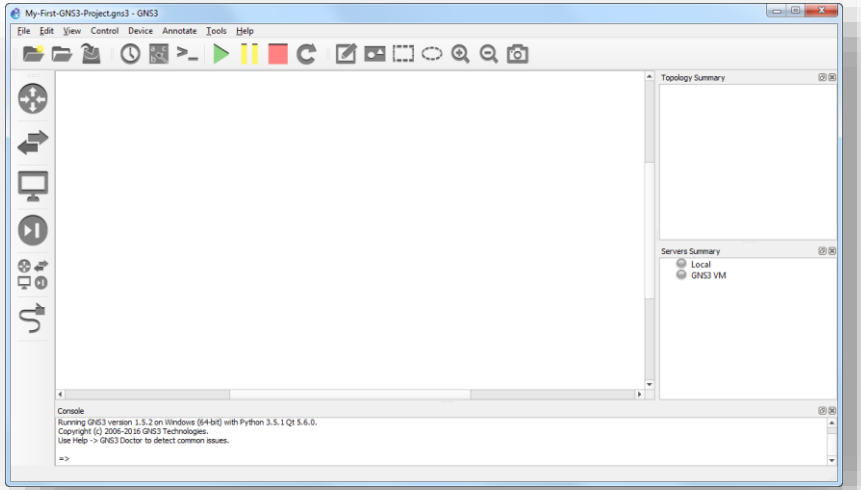
Teaching and Learning

- Sabin *et al.* (2015)
  - Both faculty and industry consider networking and networking-related knowledge and skills are important attributes of IT graduates
  - For instance, networking, cyber-security, cloud…etc.
- Employability is considered as KPI in Higher Education (Chan, 2015)
- Lin, Chen & Nien (2014)
  - The definition of e-learning, the essence of e-learning is learning with the “e” as the only learning tool; that is the way of electronic learning, online learning or the Internet learning.
  - Through the “e” learning method, learners can find understanding anytime and anywhere

Introduction to Network Simulators

Graphical Network Simulator-3 (GNS-3)

- Is used by hundreds of thousands of network engineers worldwide to emulate, configure, test and troubleshoot virtual and real networks.
- Allows you to run a small topology consisting of only a few devices on your laptop, to those that have many devices hosted on multiple servers or even hosted in the cloud.



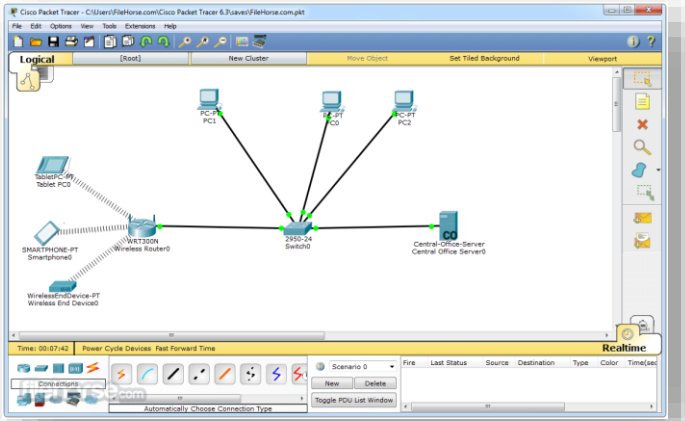
Source: https://docs.gns3.com

Introduction to Network Simulators

Cisco Packet Tracer (CPT)

- Cisco developed Packet Tracer to help Networking Academy students achieve the most optimal learning experience while gaining practical networking technology skills.
- Packet Tracer is a powerful network simulation platform inspiring students to experiment with network behavior and ask 'what if' questions. It supplements physical equipment in the classroom by allowing students to create a network with an almost unlimited number of devices, encouraging practice, discovery and troubleshooting.

Source: https://www.netacad.com



Literature Review

Perceived Self-efficacy

- Bandura (1986) defined self-efficacy as "*belief of the individual in his/her own capacity to effect a specific behaviour*"
- Self-efficacy also refers to "*beliefs in one's capabilities to organize and execute the course of action required to produce given attainments*" (Bandura, 1997).
- Sharma et al. (2007) also state that perceives self-efficacy is an essential factor to increase learners' self-regulation in e-learning environments.
- Perceived self-efficacy positively affects both Ease of Use and Usefulness (Hernandez, Jimenez & Martin, 2008)
- Learners' self-efficacy influences the learner attitudes and ability to acquire skills, choice of activities, and willingness to continue in a course of action (Liaw & Huang, 2013).

Literature Review

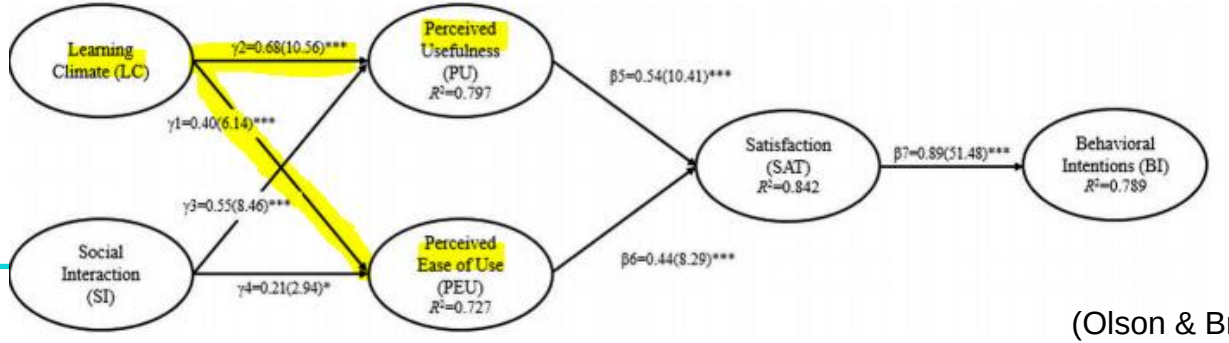
Technical System Quality

- Technical system quality measures technical success (DeLone & McLean, 2003).
- Technical system quality is related to presence and absence of a bug in system (Rabaa'i, 2009).
- Technical system quality refers to the performance of the system in term of reliability, ease of use and other indicators of systems (Petter & McLean, 2009)
- System quality has positive impacts on both Perceived Ease of Use and Perceived Usefulness

Literature Review

Learning Climate

- “Climate for e-learning” is focused on the overall level of support provided by the organization to employees in regard to the use and availability of e-learning resources (Brown & Charlier, 2013)
  - The study posits that “Individual perceptions of the ease of use and usefulness of e-learning technology will have a stronger effect on e-learning usage when the learner works in a climate that is supportive of e-learning than when the learner works in a less supportive environment.”
- Learning climate refers to the course content as well as the environment in which students learn



(Olson & Brown, 2018)

Literature Review

"Perceived Ease of Use" and "Perceived Usefulness"

- Perceived Ease of Use
  - The degree to which a person believes that using a particular system would be free of effort (Davis, 1989)
- Perceived Usefulness
  - The degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989)
- Prior studies proved that "Perceived Ease of Use" and/or "Perceived Usefulness" played a critical role on the intention/attitude towards the use of e-learning
  - English vocabulary learning system (Huang *et al.*, 2012)
  - Web-Based Classroom Response System (Ke, Sun, & Yang, 2012)
  - A lifelong e-learning course (Liao, & Liu, 2012)
  - Adoption of e-book (Letchumanan & Muniandy, 2013)

Literature Review

"Perceived Ease of Use" and "Perceived Usefulness"

- A lifelong e-learning course

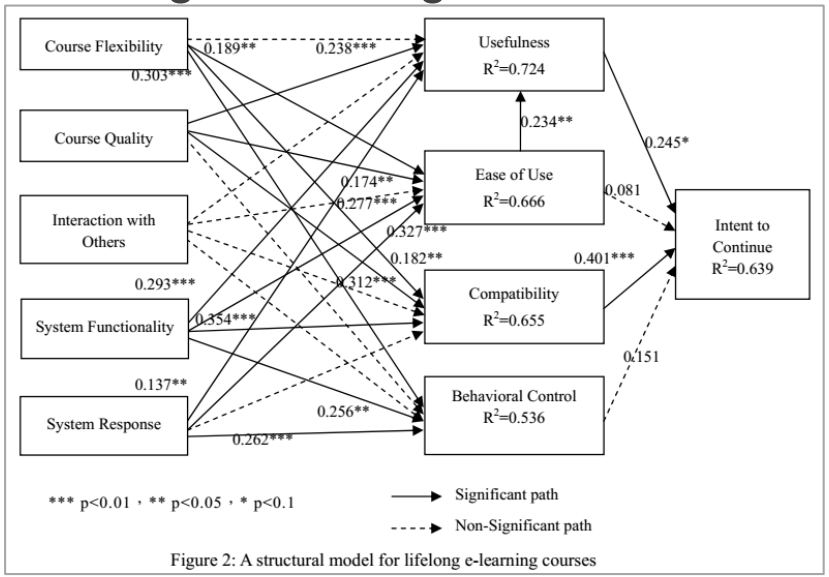


Figure 2: A structural model for lifelong e-learning courses

Perceived Ease of Use is a significant **mediator** for Perceived Usefulness and Intent to Continue in a life e-learning course study (Liao, & Liu, 2012).

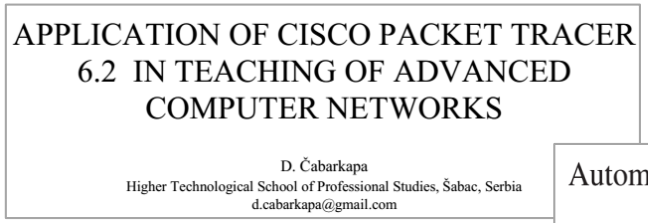
Literature Review

Learning Satisfaction

- Zhao & Yuan (2010)
  - Learning Satisfaction (LearnSat) represents the pleasant feelings or attitudes towards learning:
    - Pleasure or positive attitude means satisfaction.;
    - On the contrary it is dissatisfactory.
  - Therefore, the learning satisfaction can be used to explain the motivation and learning results of learners.
- Dominici & Palumbo (2013)
  - The concept of student satisfaction is derived from that of customer satisfaction
  - Students' happiness is an index of their satisfaction. Thus, students' satisfaction can be seen as a key outcome of education and as a quality-enhancement tool designed to improve the quality of the student experience

Research Gap

- Most of the previous studies put the focus on the technical aspects of network simulators in teaching & learning



APPLICATION OF CISCO PACKET TRACER 6.2 IN TEACHING OF ADVANCED COMPUTER NETWORKS

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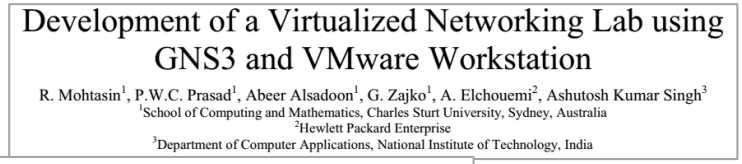

Development of a Virtualized Networking Lab using GNS3 and VMware Workstation

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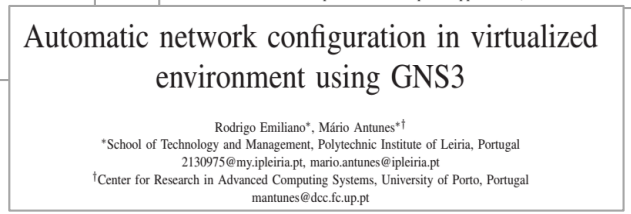

Automatic network configuration in virtualized environment using GNS3

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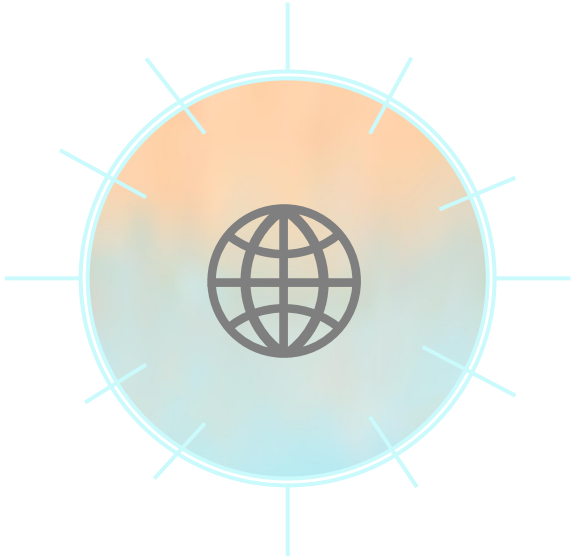
- Research Gap
  - Limited studies evaluate learners' satisfaction in the adoption of network simulators
  - Limited studies address the relationships between antecedents of Perceived Ease of Use and Perceived Usefulness, and their relationships with Learning Satisfaction in network simulator context.

Research Question

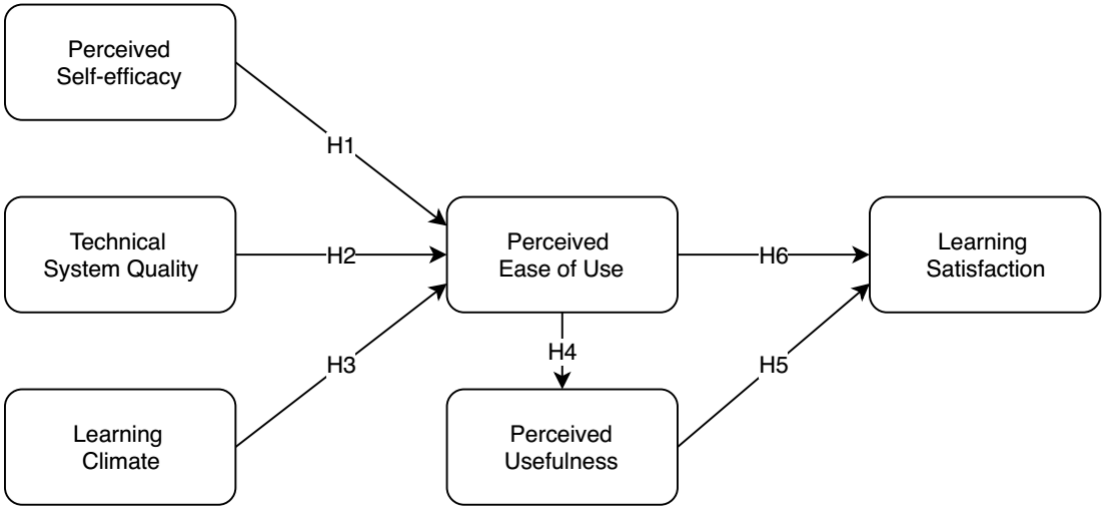
- This study aims to address the following questions:
  1. What are the key antecedents of Perceived Ease of Use?
  2. What are the relationships between Perceived Ease of Use, Perceived Usefulness and Learning Satisfaction?



Section 2

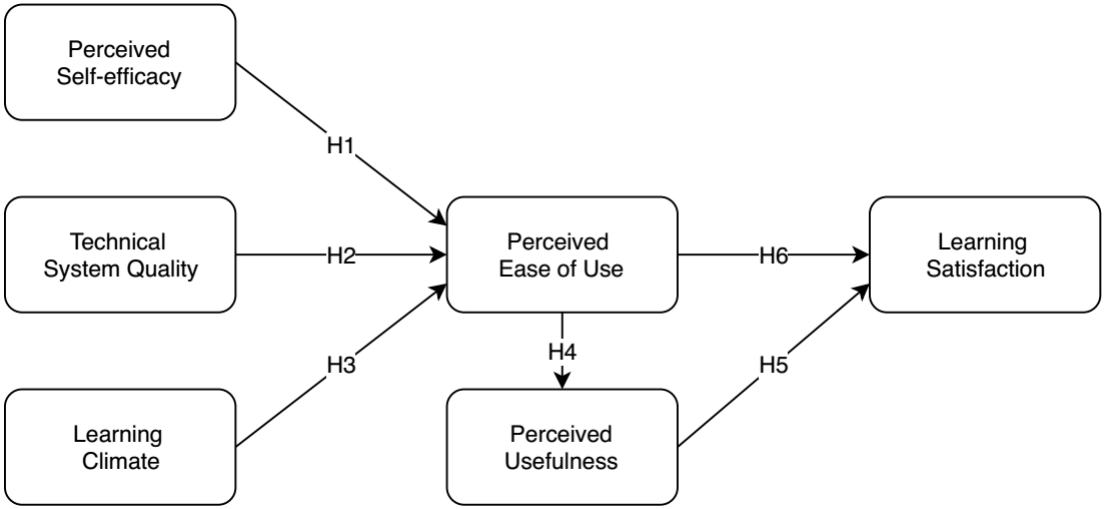
Research Framework and Hypotheses

Research Framework & Hypotheses



- H1: Perceived Self-efficacy will *positively* influence Perceived Ease of Use
- H2: Technical System Quality will *positively* influence Perceived Ease of Use
- H3: Learning Climate will *positively* influence Perceived Ease of Use

Research Framework & Hypotheses



- H4: Perceived Ease of Use will *positively* influence Perceived Usefulness
- H5: Perceived Usefulness will *positively* influence Learning Satisfaction
- H6: Perceived Ease of Use will *positively* influence Learning Satisfaction

Section 3

Implementation, Data Collection and Data Analysis

Implementation of network simulators

- A 3-credit undergraduate course was chosen:
  - With 2-hour lecture and 1-hour laboratory session
  - Approximately, 12 to 13 hours were assigned in the semester
- During the laboratory session, the following topics were delivered:
  - Router Configuration
  - Static Routing
  - Dynamic Routing
    - Routing Information Protocol Version 2 (RIPv2)
    - Enhanced Interior Gateway Routing Protocol (EIGRP)
    - Open Shortest Path First (OSPF)
  - Dynamic Host Configuration Protocol (DHCP)
  - Virtual Local Area Networks (VLANs) with 802.1Q Trunk…

Implementation of network simulators

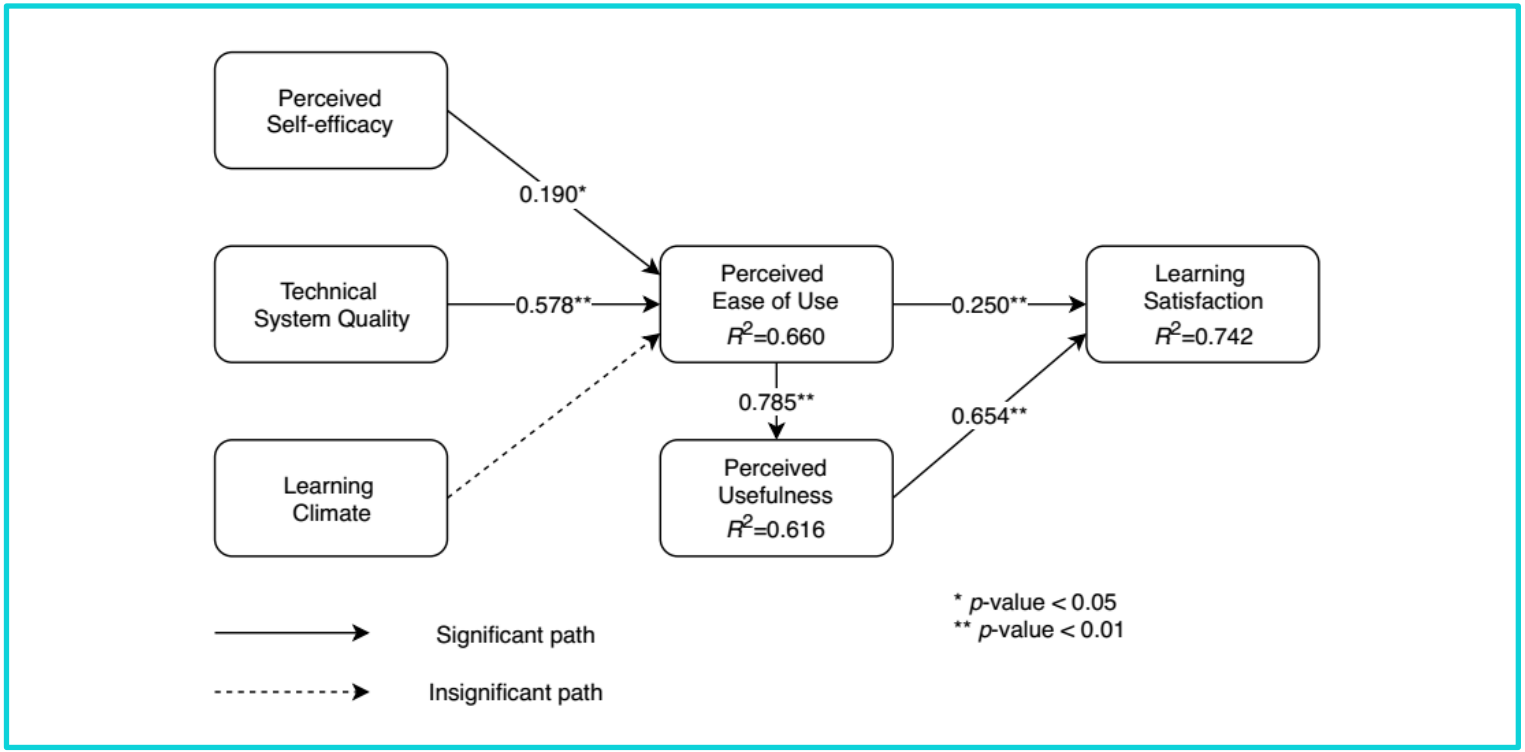
- During the laboratory session, the following topics were delivered:
  - IPv6 address and IPv6 Static Route
  - Dynamic Routing for IPv6 address
  - RIP Next Generation (RIPng)
  - OSPFv3
  - EIGRPv6
- For the one-hour lab sessions,
  - Explanation & Demonstration: 40 mins
  - Introduction to Exercise: 15 - 20 mins
- Students are expected to install network simulators at home and practice the lab exercises.
  - Lab questions were also included in the closed-book final examination.

Data Collection and Data Analysis

- A questionnaire survey was conducted in 2017.
  - Variables were modified from prior studies (Law, 2008; Mohammadi, 2015)
  - Items were measured using 5-point Likert Scale
    - 5: Strongly Agree; 1: Strongly Disagree
- Questionnaire were distributed to student who took the networking course Students came from two undergraduate programmes:
  - Information Systems and Web Technologies – Core course
  - Statistics and Data Science – Core course
- The sample size is 114 with male = 89 (78%) and female = 25 (22%)
- PLS-SEM (with SmartPLS 3.0) was adopted to test the hypothesis in the refined hypothesis model.

Results

PLS Structural Model



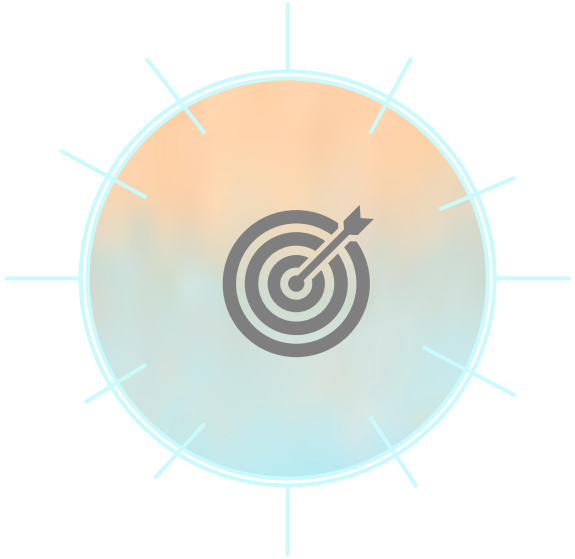
Results

Results of hypotheses testing

Results of hypotheses testing

Hypothesis	Casual Path	Path coefficient	*t*-values	Supported
H1	PSE → PEoU	0.190	2.320*	Yes
H2	TSQ → PEoU	0.578	5.994**	Yes
H3	LC → PEoU	0.135	1.331	No
H4	PEoU → PU	0.785	16.907*	Yes
H5	PU → LS	0.250	2.822*	Yes
H6	PEoU → LS	0.654	8.214*	Yes

* denotes significance at the .05 level; ** denotes significance at the .01 level.



Section 4

Findings and Discussion

Discussion

Hypothesis 1 to Hypothesis 3

- H1 is supported
  - Perceived Self-efficacy has a *positively* impact Perceived Ease of Use
  - Brown (2002) suggested that "…*students should then be encouraged to practice and use the tools on their own, with positive feedback being given when this has been done. This will help build self-efficacy…*"
- H2 is supported
  - Technical System Quality has a *positively* impact on Perceived Ease of Use
  - The higher the quality of the network simulator, the higher the level of the perceived ease of use, ultimately, enhancing the learning satisfaction
  - Navigation, interactivity, bugs free, response time, limitations in simulation…etc.

Discussion

Hypothesis 3

- H3 is not supported
  - Relationship between Learning Climate and Perceived Ease of Use is not significant
  - Further investigate the direct relationship between Learning Climate and Learning Satisfaction (Wu, Tennyson & Hsia, 2010)

Discussion

Hypothesis 4 to Hypothesis 6

- From the results obtained, the relationship between Perceived Ease of Use and Learning Satisfaction was partially mediated by Perceived Usefulness
  - Dataset was collected from Year 3 students from IT-related programme and the majority would seek jobs in the industry
  - Perceived Usefulness (PU) - the degree to which a person believes that using a particular system would enhance his or her job performance
  - So, an increase in Perceived Ease of Use cannot solely enhance the Learning Satisfaction of undergraduate students
  - Provide practical Implications for Educators, IT vendors, and Practitioners

References

- Available upon request

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Thank You!