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Quantitative analysis of comprehension and skill acquisition of engineering students from the cybersecurity virtual internship program

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Abstract—Cybersecurity is a vital part of a secure digital world. This paper is about quantitative analysis of the case study of the 8-week virtual internship program in Cyber Security recognized by AICTE and NASSCOM. The program's main objective was to train future professionals to possess good knowledge and skills in cyber security, specifically applying the skills to real-time scenarios. The internship constituted for Cisco Networking Academy institutions' 2nd & 3rd year engineering students for the academic year 2020-21. Students completed the instructor-led, online self-paced courses: Introduction to Cyber Security (1.5 weeks), Introduction to Packet Tracer (1.5 weeks), and Cyber Security Essentials (2 weeks). Further, the students were invited to attend 5 sessions (1 week) conducted by industry experts to help students become career-ready and understand the career path in the cyber security industry. Furthermore, students worked on a project under the guidance of their instructor to design a secure network for their institution on the Packet Tracer simulation tool (2 weeks). On completion and submission of their project work, students completed the final quiz. Eligible 72 students who completed all the criteria received a virtual internship certificate from AICTE, NASSCOM, and Cisco. Students were evaluated before and after every step of the internship process. It was evident that there is a significantly positive effect of this internship on students' skill acquisition (98.5%) and comprehension (92.2%) of network topology, (98.2%) of the students acquired a significant level of skills (software initiation skill - 98.7%; configuration skill - 92.3%; redirection skill - 93.1%; simulation skill - 98.7%; and connection skill 95.2- %) and students' comprehension of network topology and cyber security concept was averagely high (98.85 %). The analysis concluded that the cyber security internship activity is a pertinent mechanism for stimulating students' skills acquisition and comprehension of cyber security concepts, while also recommending that educators should use the Cisco packet tracer to allow students to gain practical and cognitive skills in the areas of computer networks and cyber security

Keywords—Cybersecurity; Internship; Comprehensive skills, Cisco Packet Tracer; Internet; AICTE

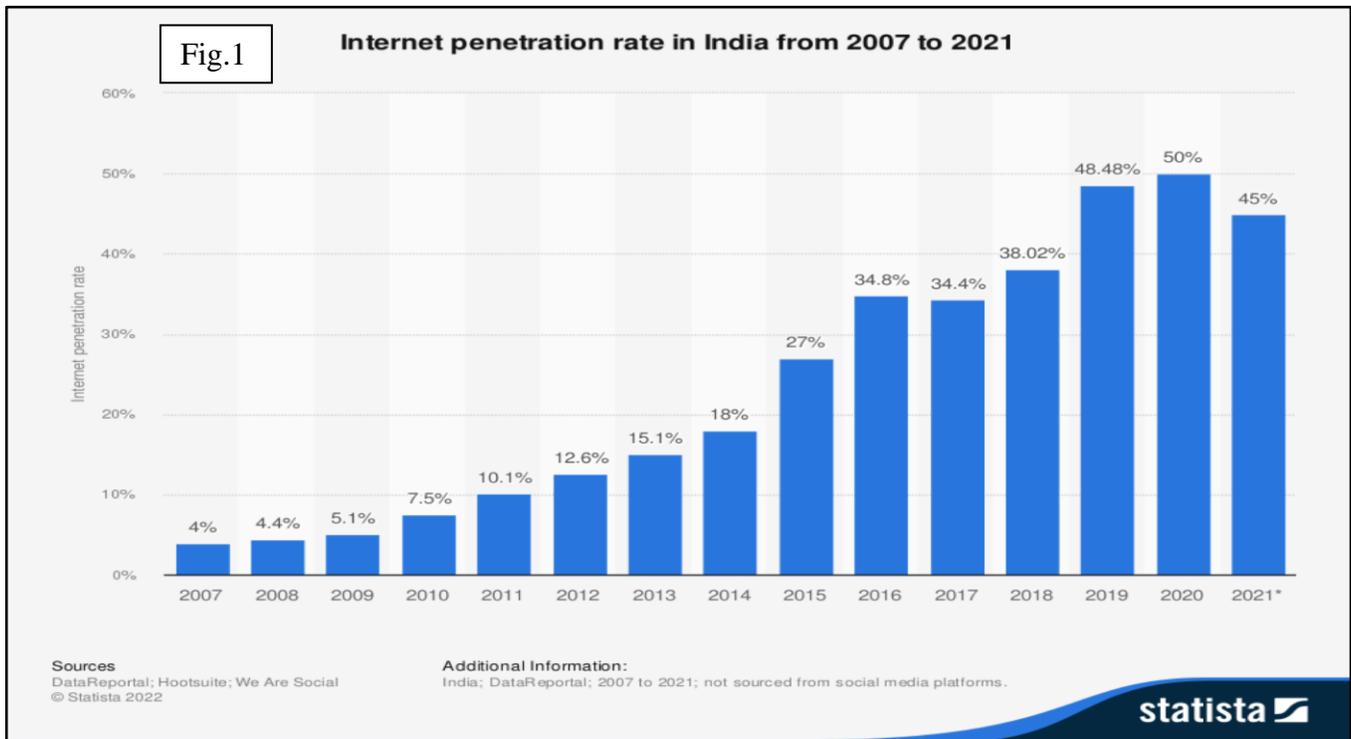
I. INTRODUCTION

THE Internet has revolutionized our era. Hardly any sphere of human life is excluded from the benefits of the Internet. Interestingly, the Internet is owned by none and used by all as it is public see Figure 1 and Figure 2. The sole reason that the Internet is a public platform has made it vulnerable from a security perspective. Cybersecurity awareness is an essential Ingredient for everyone and Internet penetration is very high in India and ignorance is not bliss in cybersecurity. No one thought of a career in cyber security in the 1980s, which is a reality now.

Secondly, the research work in this paper is associated with internship opportunities for exclusive women technical undergraduates. In India, women are consciously choosing STEM careers, and encouraging women professionals in cybersecurity career internships is pertinent. AICTE portal states that there isn't enough of them to go around; the number of available cybersecurity professionals would need to grow by a whopping 145% just to meet the global demands of the market.

As a continuous effort to set skilling as a national priority and transform India into a digital talent hub, Cisco, All India Council of Technical Education (AICTE), and NASSCOM launched a virtual internship program to provide 20,000 virtual internships in cybersecurity during the academic year 2020-21, through Cisco's Networking Academy program. The purpose of this distinctive partnership between the government and the IT industry was to help build a pool of adept talent important for future jobs relevant to the IT industry. According to the AICTE (a national level apex body in India since 1945 for the promotion of the development of the nation),

According to the AICTE (a national level apex body in India since 1945 for the promotion of the development of the nation), the objectives of internship policies were, first, to provide the students with a short time or duration, supervised industry experience with a focus on cybersecurity and defined timelines. Otherwise, regular classroom teaching cannot simulate an industry environment that brings students in contact with competent industry professionals. The opportunities for interns were to learn and understand the application of knowledge in real-time industry scenarios [1].



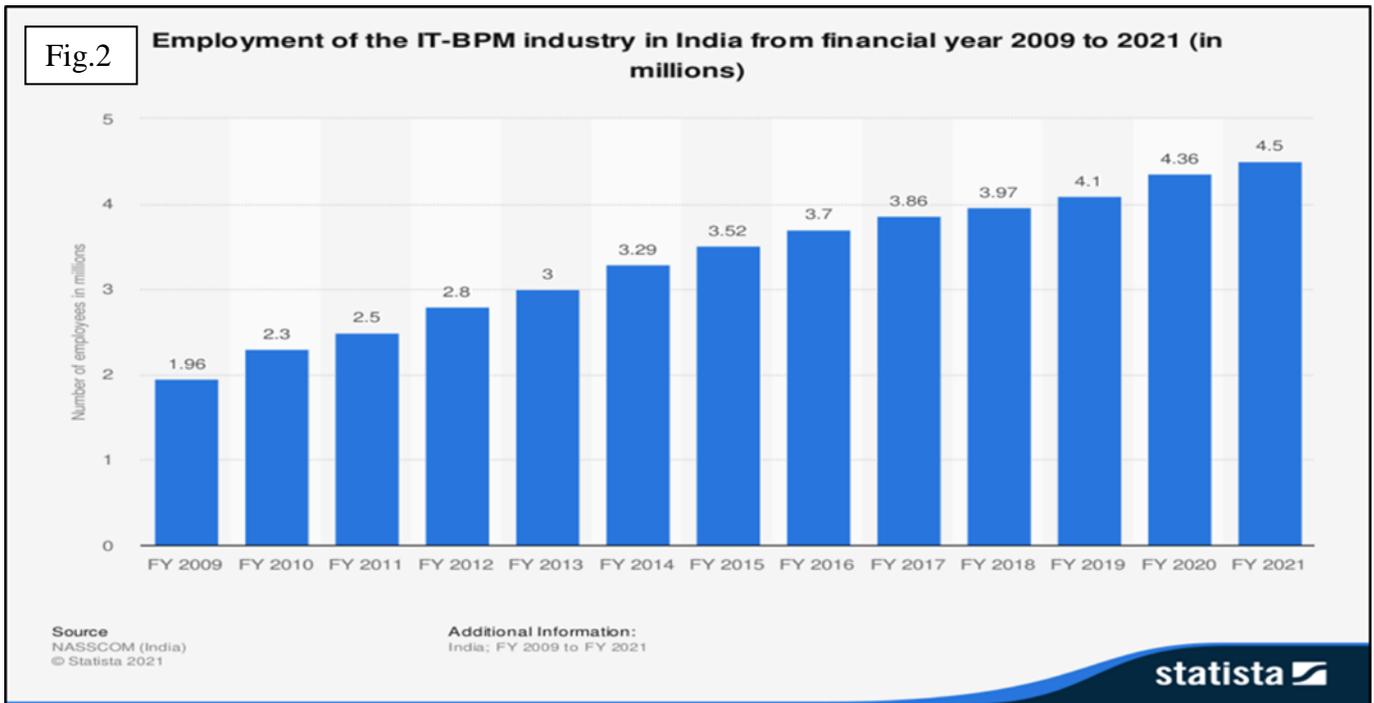
Report writing skills, engineering ethics and responsibilities, understanding cultural constraints of the working environment, and academic and personal growth are also some objectives of providing internships. Internships not only benefit students, but also the industry. Industry benefits are they have the opportunity to groom, train and evaluate potential employees for the industry in a cost-effective way. The organization's visibility and employer's image (brand) are enhanced. Fresh and new perspectives are available from the students and the placement process becomes simple and easier. The student community also benefits from internships. Unique opportunities like the potential possibility of getting hired, deciding and evaluating the right career options, learning new skills of time management, networking, teamwork, and practicing communication [1] are a few tangible benefits for the interns. There are tremendous benefits of cyber security internships by Cisco network academy specifically for students opting for cybersecurity careers. Along with the knowledge and skills, the internship immerses the student in real-time experience which is helpful in cybersecurity. Regarding the cybersecurity internship experience for students, Grant Collins [2] writes that students are exposed to great learning opportunities because students are not seasoned employers and results similar to employees are not expected from interns at the same time interns are disciplined informal working environment and are expected to

keep business momentum rolling. No slacking off in a professional environment.

Rashid [2019] and Shittu [2013] both agreed that learning from good visualization simulators helps with abstract concepts. Cisco Packet Tracer, a powerful visual simulator helps students understand the abstract concept of layering model and encapsulation and decapsulation in the TCP/IP protocol suite. Akuble [2016] and Julius [2018] have inferred in their work that interns are disciplined and understand working in corporate culture. Interns are not penalized heavily for mistakes. Kainz[2016], [2012], and Williams [2013] have explored the advantages of industry and institute relationships through internship activities.

Appendix A gives the mapping of the Internship activity for NBA graduate attributes. Figure 1 and Figure 2 reiterate the significance of Cybersecurity by the Internet penetration in India from 2007 to 2021 and the sheer number of employees in the IT industry.

From the brief literature review, it is evident that the internship activity is a pertinent activity for a student of a professional course.



II. METHODOLOGY

AICTE and Cisco Commerce India Private Limited signed a Memorandum of Understanding in February 2021 regarding cybersecurity internships for students through Cisco network academies in India. See Figure 3.

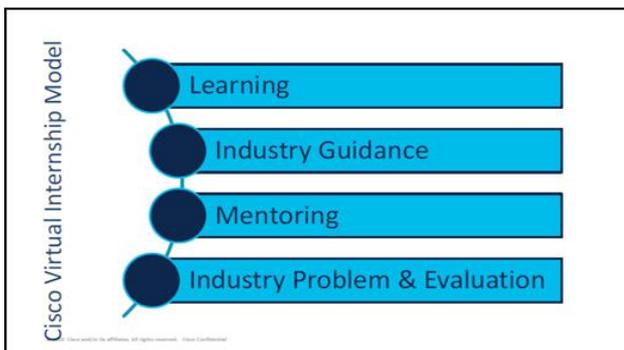


Fig. 3: Cisco Virtual Internship model

Criteria for application for the internship were

- Students currently pursuing B.Tech can participate in the program.
- Students must be available for two months.
Internship Process Flow: 2 Months (8 Weeks)
- Students need to register for this program through the AICTE Internship Portal
- The selected students' list will be sent to the concerned network academy institute authorities.
- Shortlisted students will be enrolled on Cisco Network Cybersecurity Academy Portal and will be given Course, access to Introduction to cybersecurity, cybersecurity

- Essentials, and Introduction Packet tracer
- Students need to complete the course within 4 weeks by giving online assessments.
- Students who complete the online course will be assigned a project.
- Students, with the help of their faculties need to complete the project within 4 weeks and submit it as per the format.
- During the project duration, Students will attend 4 days (8 Hours) of mentoring sessions by Industry experts. Students will get a 1 day (2 Hours) career advancement session by Corporate HRs.

After successful completion, interns received

- Course Completion Certificate
- Internship Certificate by AICTE
- Internship digital badge

The student's journey is shown in figure 4.

Outcomes on the pan India level

26,051 students registered

- Applications from 31 States/UT
- 19,830 students shortlisted
- 12,835 students completed & received an internship certificate

For our institute (all women are from Information Technology Dept.). Cisco network academy instructor is the mentor for the internship.

- 91 Applications
- 72 students shortlisted
- 72 students completed & received an internship certificate

Following are the Cisco internship courses which students have to complete as part of the Internship. The First Cisco course is Introduction to Cybersecurity, a beginner-level, instructor-led, online, and self-paced course. In this interconnected susceptible world of cyber-attacks, everyone, be cyber security professionals, or any user who needs protection on social media or being online the first course addressed his or her needs. The outcomes of this course are learning what cybersecurity is and its potential impact, understanding the common threats, vulnerabilities, and attacks, protection of businesses from attacks, and the latest trends in cybersecurity. The succeeding course is Cybersecurity essentials. This course helps interns to learn about security goals (Confidentiality, availability, and integrity) and their implementation, principles of security and its compliances, understanding of cybercrime, and technologies and procedures to defend against cyberattacks and crimes. This course helps interns to decide on how to proceed on the career path to becoming a cybersecurity professional by developing critical thinking and problem solving using a packet tracer simulator. A unique packet tracer course is also offered to interns. The packet tracer is a very powerful visual simulator for practicing networking, IoT, and cybersecurity labs that too virtually are redirection skills - 94.3%; simulation skills - 98.8%; and connection skills 95.2-%) and students' comprehension (97.2%) of the students acquired a significant level skill (software initiation skill - 98.7%; configuration skill - 94.1%.

III. RESULTS AND DISCUSSION

For the quantitative analysis, the exercise conducted was feedback and a skill test before and after the internship. The results and discussion are as follows.

The analysis of the research question was:

What are the skills acquired by interns in a network topology for applying security when taught using a Cisco-packet-tracer simulator?

The skills like software installation and initiation (Installation of the software, learning the modes of operation, selecting the devices from the pool, etc. Connecting the devices with appropriate cables. Designing the IP addressing scheme with subnetting and applying the addresses to the devices. Configuring the network devices like routers, switches, routers with switches, etc. Selecting the mode of operation say simulation mode or physical mode then testing the entire network's expected to function with appropriate security concerns.

A skill test exam was conducted to ascertain the comprehension skills of students using the Cisco Packet Tracer. Students were evaluated before and after every step of the internship process.

It was evident that there is a significantly positive effect of this internship on students' skill acquisition (98.5%) and comprehension (92.2%) of network topology, (98.2%) of the students acquired a significant level of skills (software

initiation skill - 98.7%; configuration skill - 92.3%; redirection skill - 93.1%; simulation skill - 98.7%; and connection skill 95.2-%) and students' comprehension of network topology and cyber security concept was averagely high (98.85%).

Next research question: How do interns comprehend network topology when taught using the CISCO-packet-tracer simulator for securing the network?

The result obtained from the data gathered and analyzed indicated that a larger proportion of the interns acquired a substantial level of skills to utilize Cisco packet tracer to learn, network topology for applying security. The findings of this study agree with the finding of, which posited that the Cisco packet tracer encourages students to engage in active learning. See Table 1 and Table 2 below. The feedback regarding the internship program is in Figures 4,5 and 6.

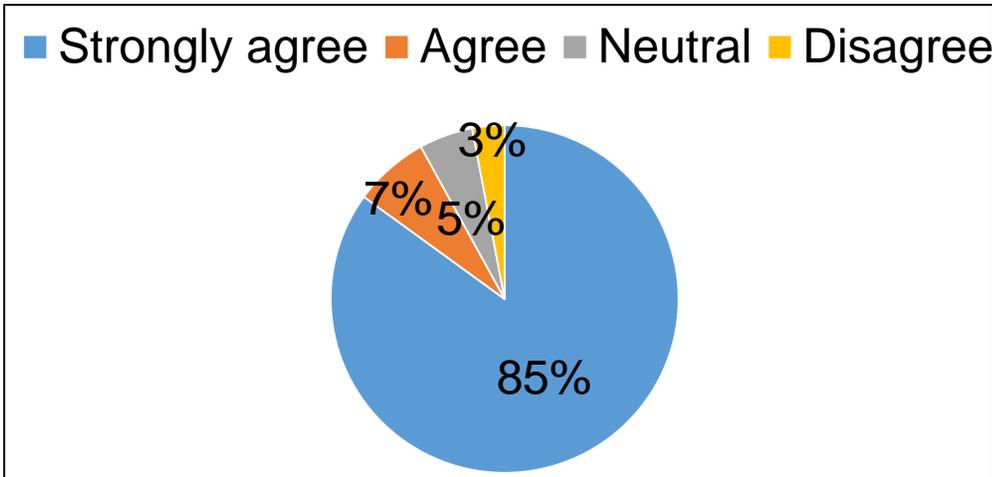
Table 1: Skill Acquisition

Skill acquisition level	Yes (%)	No (%)	Order
Software initiation	98.5	1.5	2
Connections	98.5	1.5	3
Redirection	93.1	6.9	4
Configuration	92.3	7.7	5
Simulation	98.7	1.3	1

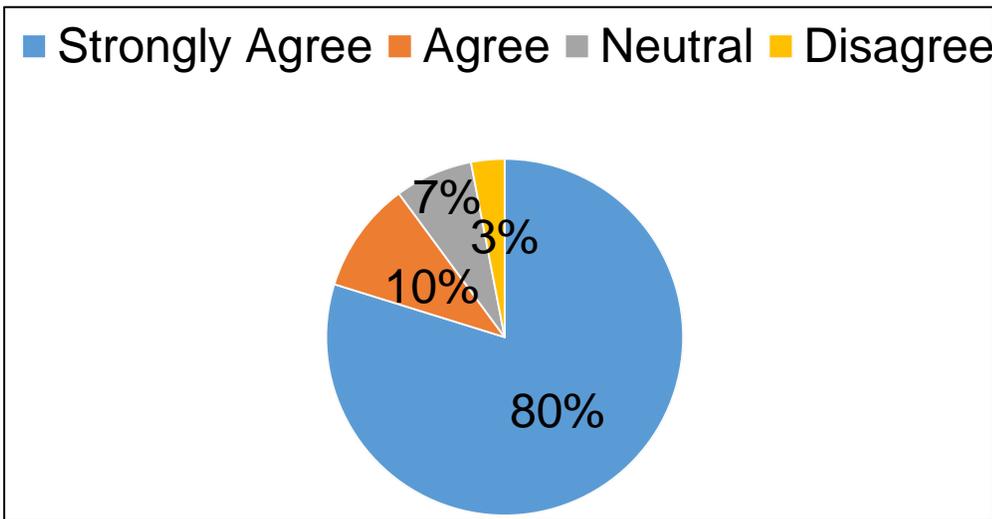
Table 2: Comprehension

Serial no	Grades	levels	Comprehension (%)
1	0-39	Fail	3.8
2	40-44	Poor	7.7
3	45-49	Fair	11.5
4	50-59	Good	19.2
5	60-69	Very Good	42.3
6	70-100	Excellent	15.4

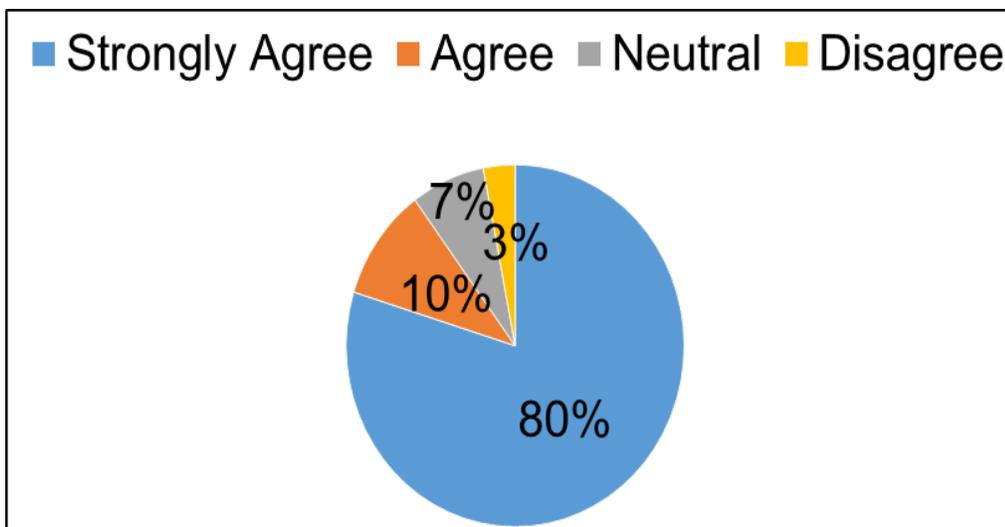
Figures 4, 5, and 6 Feedback on Internship activity by Interns



Online examinations show that they are a fair and reliable tool for assessing student ability.



The online content and laboratory exercises, online assessment, and instructor-centered activities provided how I progressed through the program.



The curriculum would enhance my practical skills and theoretical knowledge as well as improve my prospects for employment.

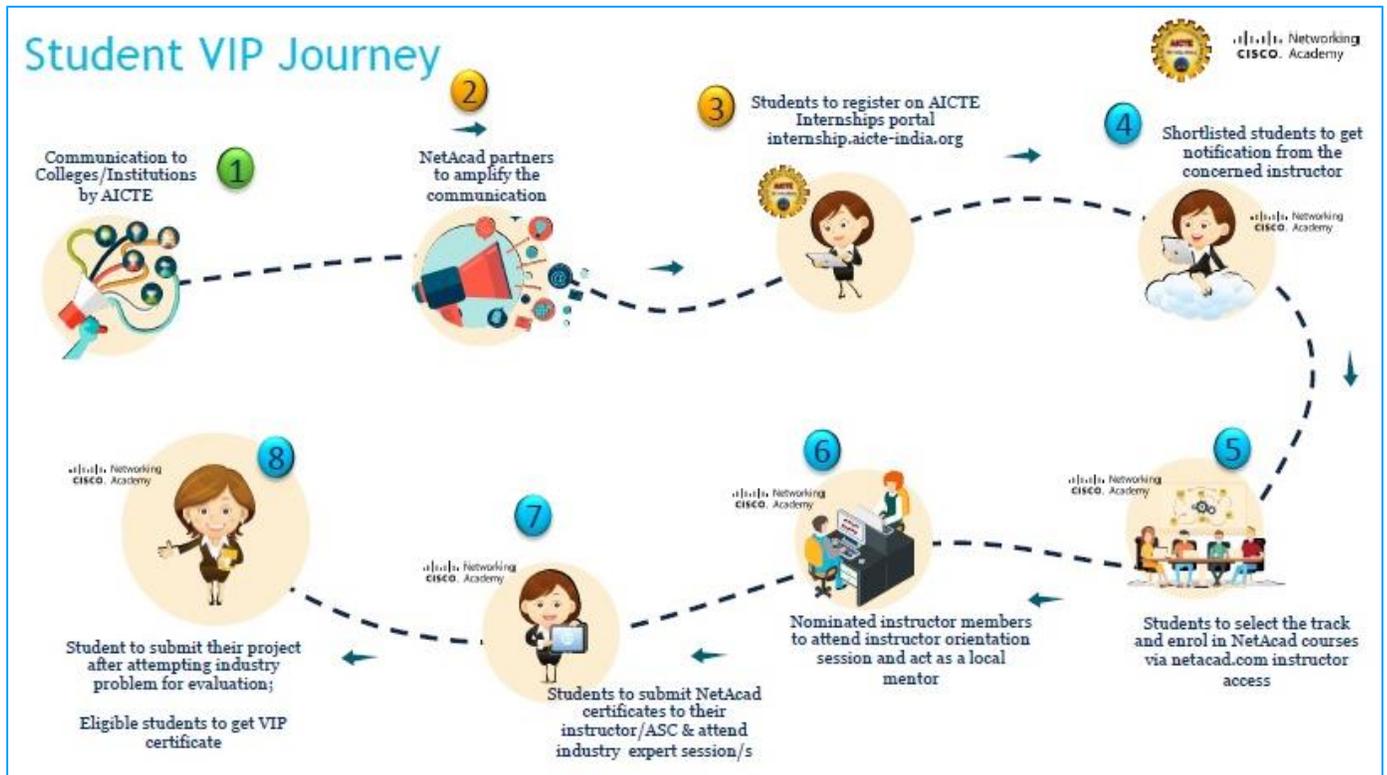


Figure 7. Student virtual Internship journey

IV. Conclusions:

This study concludes that the Cisco packet tracer simulator is an effective tool for enriching interns' understanding and skills acquired in network topology. An increased understanding of network topology could lead to an improvement in student's 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 use the Cisco packet tracer simulator. Cisco packet tracer simulator activities can be considered a form of experiential learning as they allow students to either reinforce or discover knowledge and skills through personal interaction.

Also, internship objectives are achieved as inferred from the results. The interns have received placement offers from the industry is the pertinent outcome of the internship. The confidence of interns was evident during the placement process. Along with interns, college and industry also benefit from the internship activity.

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APPENDIX A

MAPPING OF INTERNSHIP PROGRAMME OUTCOME WITH NBA GRADUATE ATTRIBUTES

Sr.No	Graduate Attributes from NBA	Activities proposed	Outcomes
1.	Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.	Practical experience during an industrial internship.	An ability to apply knowledge in the application of engineering techniques, tools, and resources to the project. The application of systems engineering design processes appropriate to the internship program.
2.	Problem analysis: Identity, formulate, research literature, and analyze complex engineering problems reaching a substantiated conclusion using the first principles of mathematics, natural sciences, and engineering sciences.	Working on projects in the internship activity.	Interns learn research methodologies and analytical tools and will develop an ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems to reach substantiated conclusions.
3.	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and cultural, societal, and environmental considerations.	Participation in Internship activity	An ability to assist experts during design solutions for complex, engineering problems and to design systems, components, or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural, and societal considerations in real-time.

4.	Conduct investigations of complex problems.	Internships or advanced engineering courses are considered for meeting internship credit requirements	Global competitiveness and employability of students will be enhanced.
5.	Modern tool usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling of complex engineering activities, with an understanding of the limitations.	Work on the modern tools, and processes being used in the industry. Where possible interns should expose themselves to advanced tools like simulation and modeling.	Will be able to use modern tools and processes to solve live problems. Ex. Cisco Packet Tracer
6.	The engineer and society: Apply to reason informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	The AICTE Activity Point Program focuses on supporting all sections of society.	Students will learn their social responsibilities and use their professional engineering knowledge to assess societal, health, safety, legal and cultural issues in the cybersecurity domain
8.	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	The intern will learn to demonstrate honesty and punctuality and obey Company's business practices and procedures.	Learning professional ethics and accountability will make students ready for the future.
9.	Individuals and teamwork: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.	Interns are required to help the experts in their professional work.	Students will develop the ability to work effectively as a member and leaders in teams, preferably in a multi-disciplinary setting.
10.	Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.	Interns improving Communication Skills, report writing, presentation skills, etc.	The student will develop an ability to communicate effectively (oral and written communication, report writing, and presentation skills).

11.	Project Management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	The industry should make sure to include interns in brainstorming sessions and also be allowed to understand Project Management and finances.	These competencies will help the student's horizontal and vertical mobility.
12.	Lifelong learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	Students will learn to implement knowledge into practice and innovate.	Interns' ability to identify and address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge will be enhanced.