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ICT Tools for Hybrid Inquisitive Experiential Learning in Online Teaching-a case study

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***Abstract*:** The quality of engineering education plays a major role in the sustainable development of society. Efforts in designing and using interactive Information Communication Technology (ICT) tools help for stimulating curiosity among students, in particular in online teaching. It helps in creating an effective learning environment and drives students towards inquisitive and experiential learning. During COVID pandemic, it is inevitable to teach everything online and is difficult to involve student actively in learning. This paper presents a case study of designing a hybrid inquisitive experiential learning approach using teacher specific ICT tool for creating curiosity about the topic that is being learnt and its effectiveness to involve the engineering students better in learning the fundamental concepts of engineering. The end survey and assessment performance demonstrated that the use of such ICT user interface usage improved learning outcomes. However, it requires more careful design and proper planning.
***Keywords*—** Experiential learning, ICT tools, Inquisitive learning, Online teaching during COVID.

I. INTRODUCTION

The whole world is in crisis due to COVID pandemic and every field including education, is affected severely and online teaching is being inevitable. As we are witnessing many COVID waves, how long will be the online teaching we need to focus on challenges in online teaching and the ways to overcome the challenges. One of the major challenges is in grabbing the attention of the students and teachers need to innovate new methods and can use ICT for involving the students in active learning. Even in traditional offline teaching also now the millennial students being techno-origins teachers need to invent new methods of active learning.

For years an engineering education is more driven towards the response from engaged students with engaging content rather than curiosity driven. If the student engagement is coupled with curiosity, the student gets empowered with thinking towards new ideas and new directions with an open mind through inquiry-based questioning. Terry Heick, an education expert, said that "Questions driven by curiosity can be extraordinary learning tools. A good question that stimulates curiosity can open minds, shift paradigms, and transform into cognitive learning that can help create thinkers". In engineering education, enhancing the students ability to question and critically think of every concept is more important than valuing a student's ability to answer the questions (Abdelhak et al.,2017). The challenge of stimulating curiosity in a learner is a challenging task, in particular millennium students. It requires more efforts in the design of ICT tools that attracts them in getting prior knowledge and in creating curiosity among their technology driven minds and then proper instructional, lesson and curriculum design.

Curiosity is the driving force for active learning (Doug et al.,2021). A teacher with focus on progressive learning systems should be aware of what leads to and doesn't lead to stimulating curiosity and how it affects the overall learning experience. Curiosity can be seen as an inherent quality of the student and for every student is unique and the patterns of his/her self-direction for understanding a concept are unique. However, this uniqueness can be stimulated at different paces by integrating ICT into teacher's teaching methodologies as technology integration has made a breakthrough in education field in 21st century.

Experiential learning is the practice of encouraging the students to have preliminary experiences with the topic being learned and feel its use, thereby drawing more attention of the students in learning that topic rather than just teaching. This learning style has been studied in vast numbers for decades, and is proven to be more outcome-oriented. The major activities of the students in experiential learning are one or more of experience, observation, analysis, experimentation and there by learning. Certainly ICT tools helps the teachers to create the environment required for experiential learning (Paola, F et al.,2000).

Integration of Information, Communication, and Technology (ICT) helps teachers to meet the global requirements and to supplement traditional teaching methods with technology-based teaching and learning tools (Saravanakumar,2018). Recent findings reveal that teachers' well-planned and well-

equipped supplemented with ICT tools and facilities is the major influencing factor in the success of technology-based active learning (Simin et al.,2015).

In this study, in this paper we present a case study of stimulating curiosity using a hybrid inquisitive experiential active learning method to teach a topic and its effectiveness. In section II, we write the findings made by various researchers and educators in inquisitive and experiential learning, an ICT tools for active learning and in particular engineering education. Section III describes our methodology used for stimulating curiosity among first year engineering students as a case study by the use of ICT user interface created for teaching a specific topic STACKs in the course DATA STRUCTURES that is being taught for almost all streams. Section IV presents our case study results and demonstrates its effectiveness in learning. Section V concludes our observations and inferences that can be carried out from our proposed methodology.

II LITERATURE SURVEY:

Curiosity is one of the strong motivators of the better and active learning. Though the scientific research in curiosity has persisted for decades and evident from the work of many researchers (Berlyne,1950), (Loewenstein,1994), and (Kang et al.,2009) the recent research shows that curiosity is more associated with better learning outcomes (Gruber et al.,2014), (Stahl & Feigenson, 2015).(Jonna et al.,2017).

In the words of Researcher (Todd Kashdan , 2009), curiosity is not a single trait; but has multiple dimensions. They are Joyous exploration, need to know, social, accepting the anxiety and thrill seeking curiosities. After understanding his findings, it can be understood that as a teacher we need to tap the students for stimulating their joyous exploration, need to know and thrill seeking dimensions. This can be done by creating fascinating classrooms, by letting the students to experience in real time with the help **of** Model demonstration or user interface design and usage to drive them towards enhancement of their academic interest.

Experiential learning is applying the theoretical academic content to real-world experiences either in the classroom, in the community, in the workplace or in the industry, that helps to improve reflection and course-based learning outcomes Experiential education (Abdelhak A., et al.,2017). It focuses on performing an activity and then drawing inferences from that activity content wise and also from a personal perspective (Yonghui.C,& Hui,L.,2009) . Researchers claim that youth who could not do well with problem solving completely change their behavior and are actively involved when they are given opportunities to process "hands-on" or action information (Hutchings . P.,1988). Almost all experiential models similar stages of engaging learners emotionally, cognitively and /or socially (N. W. Steinaker,1979). In 2021 Li (Li et al., 2021) applied Game Design and Development as part of experiential learning for undergraduates of Yunnan Normal University, and claimed that their method resulted in improved learning outcomes. In 2020 Rithvik (Rithvik etal,2020) applied an Analogous student centric Learning methodology to create a vibrant and active classroom and results were shown to be promising.

ICT can be used in a variety of ways to help the teachers' fraternity in designing and implementing the active learning methods in an effective manner and as well as students community to have better understanding of the subject. A technology based teaching and learning can be integrated in traditional teaching in many ways that include educational videos about the topic, being taught, stimulation of any concept, data storage and retrieval in the databases, mind-mapping, and in brainstorming sessions. Internet now a day has become next to teacher in providing resources and in making the learning process (Finger, 2002). The research study presented by researchers (Jorge et al, 2003) and (Edriss Ahmed Ali.,2014) has proven that the use of ICT in teaching will improve the learning outcomes and maximizes the students' abilities and involves them better in active learning process.

Many papers are focusing on using existing ICT tools for teaching. But those tools may not be suitable for teaching all courses and do not match with the teachers mindset and methodology to teacher a particular topic. This paper focuses on how a teach can create a very simple user interface to use and play with it by the students that creates interest in them in the topic that is being taught. This exposure can help teachers to think innovatively and design different methodologies teach different topics. The Next section explains our methodology to teach online and involve students more effectively with the aid of ICT.

III HYBRID INQUISITIVE EXPERIENTIAL LEARNING METHODOLOGY:

Hybrid Inquisitive Experiential learning is an active learning methodology in which faculty first create enthusiasm in the students by engaging and exposing them to have direct experience using ICT or some other tools and thereby grab their attention and interest to learn the topic being taught. First, we need to design a pedagogical scenario for creating a hybrid inquisitive experiential learning method that stimulates the curiosity in learning the course.

Under this approach we took two class scenarios. The First one is how the freshmen engineers of different streams respond to this proposed method used, while learning a topic STACK in the most important logical programming course DATA STRUCTURES. Second one is how the pre final year students of Computer Science and Engineering stream respond for learning a topic NETWORK Layers in the core course COMPUTER NETWORKS. In both the scenarios the students were divided into two equal sized groups and were taught selected topics with and without aid of ICT tools, and results of the study are presented in the next section in detail.

In both the scenarios we implemented our proposed Hybrid inquisitive driven experiential learning methodology. The steps for the proposed methodology are shown in Figure 1.

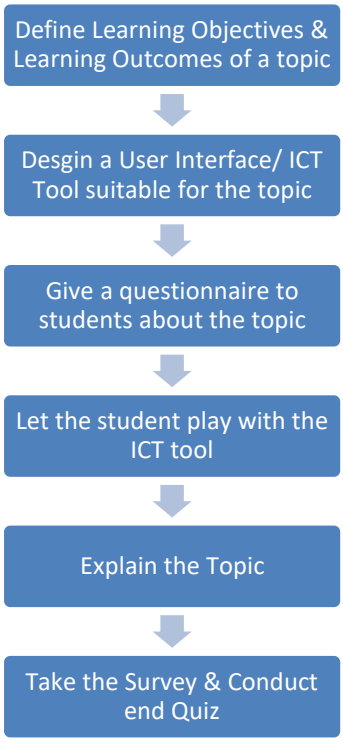

Fig 1: Hybrid inquisitive driven experiential learning methodology Flow Chart

1. Define Learning Objectives of a particular learning concept and respective Learning Outcomes.

2. Design a user interface or identify an existing ICT tools that can explore the usage or application of the learning concept.

3. Probe the questions into the students that help them to identify what is happening, what should be inside and how it works to meet the learning objectives and let the students answer the questionnaire. This step doesn't expect the exact and correct answers from the students but aims to enhance the students' inquisitiveness.

4. Use the inferences made by the students from their experience they obtaining ed while using the designed user interface specific to that topic / ICT tool, introduce the concept to be taught.

5. Evaluate the level of students understanding either by taking the student experience survey and/or assessment done on the topic , and take necessary steps to further enhance the level of understanding and involvement if required.

The main motto of experiential learning is learning through the experience or the process, though learning content is important. The students engage with the learning content, teacher and each other through the following steps of experiential learning. The steps include "Experiencing/Exploring via Doing", Sharing/Reflecting on "How its possible?", Processing/Analyzing/Inferring "What's there and what is important?", Generalizing on "So What?" and Application of "What next?" as part of process of experiencing, self reflection and application . (Haynes, 2007, and UC Davis, 2011). We designed our methodology to simulate those steps of experiential learning as described below.

1. Experiencing/Exploring via "Doing": Students get hands-on/minds-on experience while interacting with the ICT tool/ user interface designed with little support from the teacher. This step aims to create curiosity and excitement for the student to learn about the concept being taught.

2. Sharing/Reflecting on "How it's possible?": Students share their observations with the teacher and their peers. Students get a chance to know about the experiences and observations of peers and it helps to make the session interactive. It results in them reflecting on what they observed.

3. Processing/Analyzing /Inferring "What's there and what is important?" : Students discuss, analyze and identify the internal process and reflect upon the experience. They identify what might be the internal steps and internal theme/blocks present in the process and ultimately they come up with the requirements that relate with the topic being taught. Now the teacher can introduce and teach the topic in detail. Naturally, by the time a teacher starts teaching the concept, the students are curious to know what's happening and how it's happening. Students can further analyze issues that emerged as a result of the experience.

4. Generalizing on "So What?": Students connect the experience with the respective topic taught by the teacher in depth and are ready to explore the topic further.

5. Application of "What next?" : Students will be able to apply what they learned in this experience to similar or different applications/situations. They will even be in a position to think and design new applications. The teacher should help students to feel a sense of ownership for what was learnt.

IV RESULTS AND DISCUSSION:

In the first scenario, we considered 256 freshman engineers of an engineering college affiliated to Jawaharlal Nehru

Technological University Kakinada, belonging to CSE and its allied branches. We divided them into two equal sized groups of students having similar demographic information i.e. family background, educational track record and gender ratio etc.

In first year second semester, DATA STRUCTURES course is selected for this study. In particular a linear data structure called STACK is the concept to be taught. The STACK has many applications in compiler design and operating systems. To create curiosity about STACK one of its applications EXPRESSION EVALUATION that is widely used in any computer is chosen. When we give any arithmetic expression to evaluate by any computer, the system internally first converts the given Infix expression into Postfix expression and then evaluates that postfix expression. This is required as the system doesn't have intelligence to identify the expression that resides in the innermost parentheses and to evaluate it and to proceed further just like the way humans do. Then the interface is created to simulate the sequence of steps in the evaluation of the expression and is shown in Figures 2, 3 and 4.

In order to know the effectiveness of an ICT tool designed with reference to a specific topic STACK, the end survey was taken from the students after the completion of the topic using a Google form. A questionnaire with the items "Do You understand the topic", "How well you enjoyed the topic while practicing the tool", "Could you elaborate the topic and think some more applications of the topic " was given to the students group who experienced the tool. For the second group of students who were directly taught the topic STACK without the help of the interactive tool, designed the questionnaire with items "Do You understand the topic", "How well you understood and enjoyed the topic", "Could you elaborate the topic and think some more applications of the topic ".

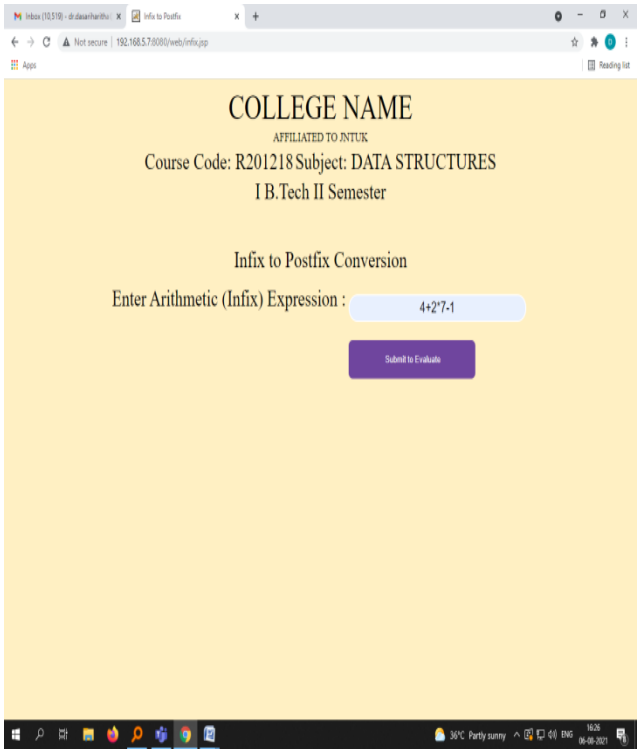

Fig 2 : User Interface to enter Infix expression

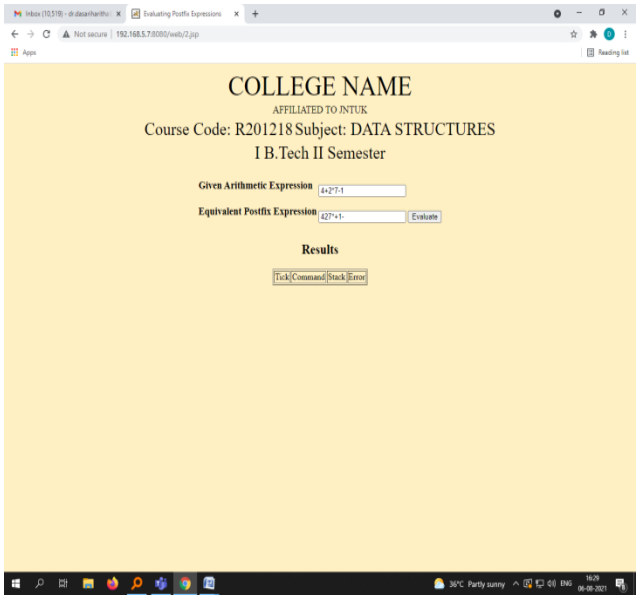

Fig 3 : User Interface that shows equivalent Postfix expression

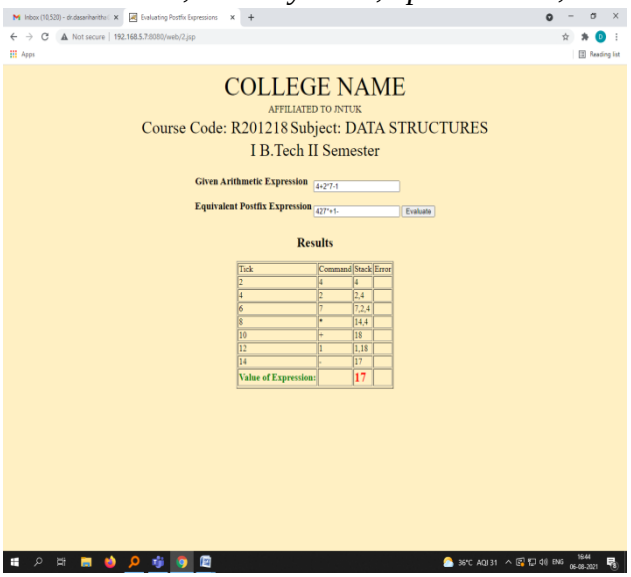

Fig 4: User Interface that shows evaluation steps of Postfix expression

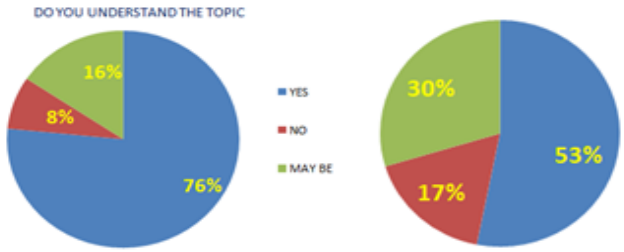

Fig 5: Percentage of students understood using ICT Tool (left) without using ICT Tool (right)

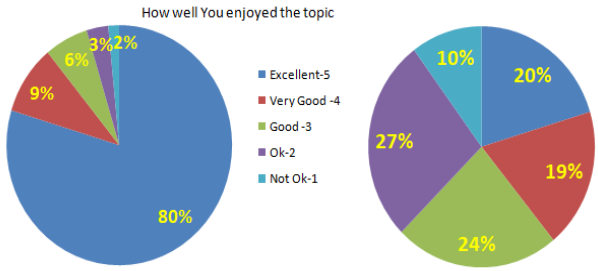

Fig 6: Understanding levels of the topic using ICT Tool (left) without using ICT Tool (right)

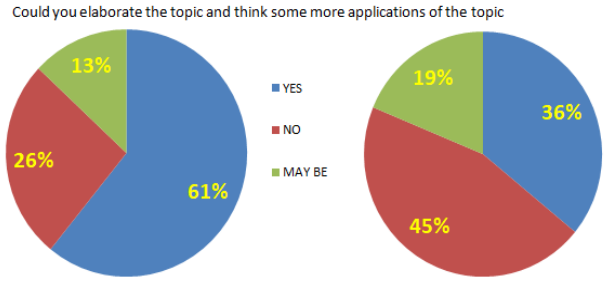

Fig 7: Percentage of students can elaborate and think additional applications using ICT Tool (left) without using ICT Tool (right)

Figures 5, 6 and 7 show the results of the survey collected from students after completion of the topic. From the figures it is evident that the ICT user interface helped the students to understand the topic in a better way and drawn the attention of the students and enhanced the participation levels of the students in the classroom. The performance of the students in the quiz conducted after covering the topic STACK for both the sets of students is shown in Figure 8, and the performance improvement for the set of the students who were experienced with the tool is clearly evident.

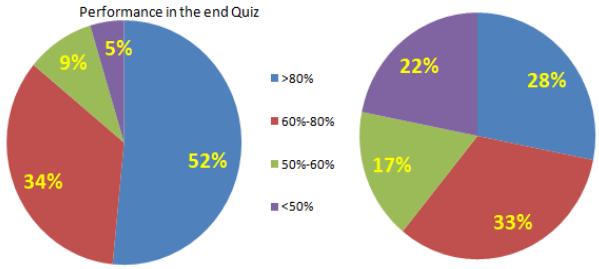

Fig 8: Performance Percentage of students in the end Quiz using the ICT Tool (left) without using the ICT Tool (right)

In the second scenario we considered 128 pre final year students of an engineering college affiliated to Jawaharlal Nehru Technological University Kakinada, belonging to CSE branch. We divided them into two equal sized groups of students having similar demographic information i.e. family background, educational track record and gender ratio etc. In third year second semester COMPUTER NETWORKS core course is selected for this study. Traditional teaching procedure is to teach with importance of Networks concept and then OSI model. But for this case study we selected an objective of sending email from our institute (i.e. SRK domain) to our sister institute of another domain (i.e. VIJAYA domain) using an existing ICT tool CISCO Packet Tracer. It helps in identifying the role of computer networks, internal steps in email process and various layers using an existing ICT tool CISCO Packet Tracer. It requires the following steps and are demonstrated in Figures 9-14.

1.Network is created by taking laptop,PC,Switch,Router and DNS Server.

2.SRK Domain:PC and laptop are connected to Email-Web-DNS-Server via Switch.

3.VIJAYA Domain:PC is connected to Email-Web-DNS-Server via Switch.

4.Configuring SRK Domain:SRK domain consists of PC, Laptop and DNS Server.

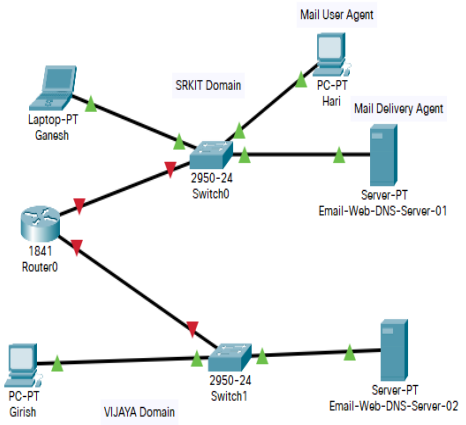

Fig 9. Topology for sending mail by usnig Email and DNS

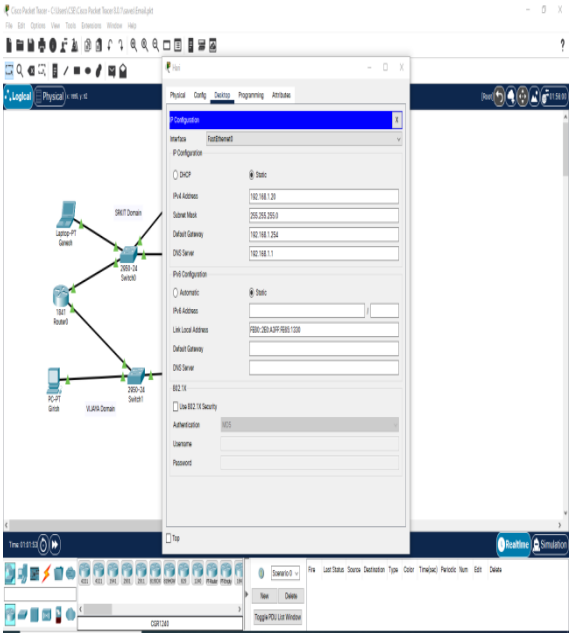

Fig 10. IP Configuration Contains IPV4 address, Subnet Mask, Default Gateway, DNS Server

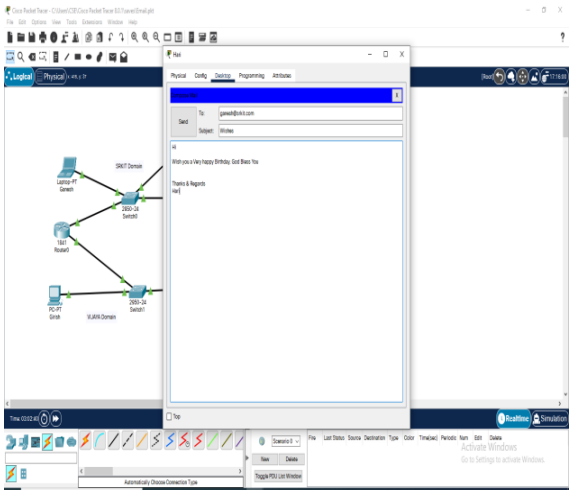

Fig 11. Go to Email and create mail credentials such as mailid and password

5.Like wise repeat steps for setting IP configuration and mail credentials in the other domain also.

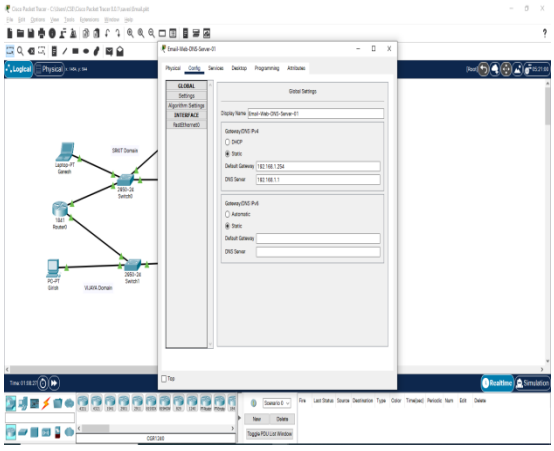

Fig 12. Open configuration and save Default Gateway, DNS Server

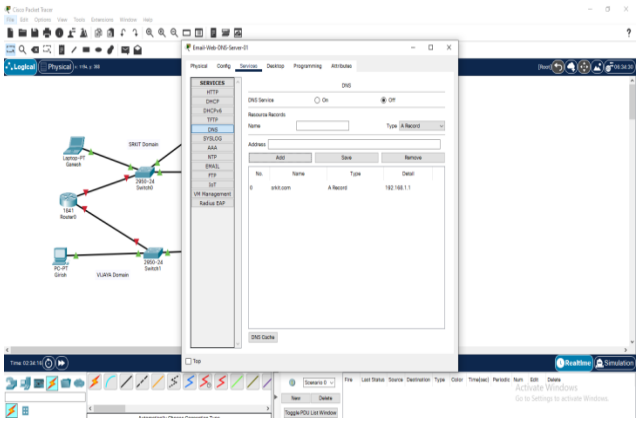

Fig 13. Open Services ,go to DNS turn on DNS Save the domain name as **srkit.com** and address as 192.168.1.1

6.Then In Services go to Email turn on SMTP service and POP3 service, add users present in the network with username and password.(two users present in our network).

7. Click on Compose and write receiver id, subject and actual message and send mail .

8.After successful submission received message (successfully sent)..At the receiver end open Email and go to Recive here the recived message will appear.

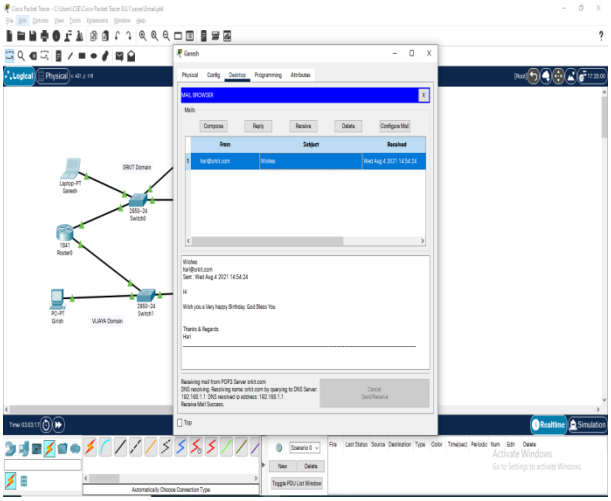

Fig 14. Checking received mail on a system on the other domain

The students were asked to practice the tool with different possible settings in the process with different topologies. They were given task to identify the role of domain, email Id, DNS server, router, IP settings and role of each OSI layers. Figure 15 shows the results of their end survey about their understanding levels of the various steps involved in email communication between two computers in different domains. Figure 16 shows the performance of the students in the end quiz conducted.

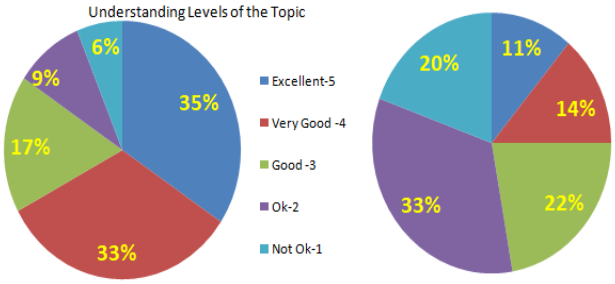

Fig 15: Understanding levels of the topic using the Packet Tracer (left) , without using Packet tracer (right)

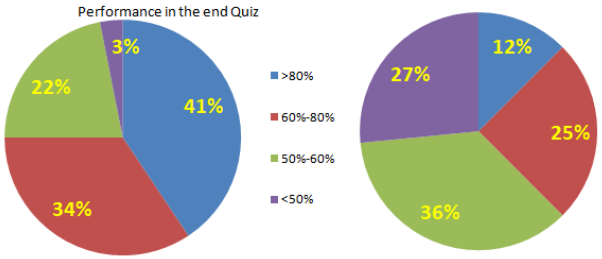

Fig 16: Performance Percentage of students in the end Quiz using the Packet Tracer (left) , without using Packet tracer (right).

V CONCLUSION:

This paper emphasizes the need for the shift from traditional teaching methods usage to active teaching learning methods usage to grab the millennial students' attention to make them actively involved in the classroom particularly in online teaching. It requires getting insights of the learning process and–designing every class concept with the help of more appropriate specific user interface tools or existing ICT tools. In this paper, we proposed a hybrid inquisitive experiential learning approach using teacher specific ICT tools for creating interest about the topic before the class. From the case study we did in COVID pandemic time, this methodology implementation and the end survey and assessment performance, it is demonstrated that the use of such ICT user interface usage improved learning outcomes.

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