*Journal of Engineering Education Transformations,*
*Volume No 36, January 2023, Special issue, eISSN 2394-1707*

*10.16920/jeet/2023/v36is2/23081*

# Magic in Computer Networks Class

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***Abstract*— Many institutions have been pushed by the recent economic crisis to reduce expenses by cramming students into huge lecture groups. Large auditoriums have the drawback of discouraging student-faculty interaction and limiting participation. Additionally, students typically discover that the discipline of computer science is replete with theoretical and technological notions. They get disinterested and/or unmotivated when there is a lack of understanding. The lecturer should use alternate teaching techniques, particularly for first-year undergraduate students, to pique their attention and introduce fundamental ideas, according to classroom experience. This paper has outlined a few strategies for engaging students and fostering a sense of ease while they learn fundamental ideas about computer networks.**

***Keywords*— Dynamic teaching; Engineering Education; Flipped classroom; JIGSAW; Lecture improvement.**

## I. INTRODUCTION

THE conventional form of instruction is the lecture. A lecture allows the teacher to impart the most information possible to the class in a managed and well-organized setting. This process works best in big auditoriums with little opportunity for one-on-one interaction or hands-on learning. A lecture gives the instructor the chance to precisely decide on the presentation's goals, substance, structure, pace, and direction. It also exposes students to previously available material and can supplement and clarify text material. Furthermore, teachers can anticipate and prepare for practically anything that might occur in a classroom with carefully organised lectures.

Technology has significantly advanced over the past few decades, and as a result, it is now an important component of the educational process. The introduction of inexpensive data storage networks, the efficiency of cutting-edge computers, and new gadgets like smartphones have given students new digital experiences, changing the way they live and learn. Students in the new millennium are less tolerant of traditional educational patterns and more dependent on digital technologies. Students of this era have different requirements and demands from the educational systems. The needs of the students are no longer satisfied by conventional educational approaches. The teachers should provide the learners more chances to participate in that regard. This idea necessitates a transformation in the way traditional teachers engage students in active learning, which actively involves them in the learning process (Qiang, 2018).

So why do we need to lecture? The majority of teachers learn about teaching from their personal experiences as students. Traditionalism continues to use lectures as a passive, one-way source of teaching. The lecture's primary problem may not be the methodology per se, but rather the dearth of faculty training in effective lecture delivery (McIntosh & Sullivan, 1996). Another important concern is the variety and complexity of students' learning processes. Students have various learning preferences, and a teacher may have to manage a challenging mix of students in a single class. Students have a wide range of learning preferences, which were described in (Felder & Silverma, 1988). Students are segregated into five categories: "visual learners," whose preference is to study through graphs, models, and pictures etc.; "verbal learners," whose emphasis is to learn from written materials; "interactive" and "kinaesthetic learning" learners, who need real-world discussions to the topic rather than theoretical approaches; and "sensing learners," The one who prefers subjects in which they can implement things with their hands since they are tactile learners. Another split is made based on how well students comprehend a subject. There are "active learners," who tend to remember material better by applying it, talking about it, or explaining it to others, and "reflective learners," who prefer to think about something first before speaking about it. Additionally, "global learners" succeed in synthesis and appear more likely than others to view a project as a whole, whereas "sequence learners" improve at concept analysis because they learn in a linear fashion.

These three psychological needs (competency, autonomy, relatedness) lead to the learners' engagement. However, when teachers, who are a part of the student's external environment, have major control over the learning process, students' sense of autonomy and competence diminishes (Narendran et al., 2018). Instead, in active learning environments, when students properly do what they have learned independently, teachers encourage and support them, facilitating the learners' independence. Furthermore, the feeling of competence, which is the feeling of being efficient and having control over behavior, is created following the positive feedback towards improving the way of thinking and skill level of learners during

team assessment in a significant and particular manner. The communication also demonstrates a sense of belonging to social society. Students are likely to experience higher communication levels in small groups' participatory classroom learning activities; Hence, they have more chances to satisfy this need (Fassbinder et al., 2015).

In today's globalized market economy, innovation is the key to enhancing a company's competitiveness. Businesses anticipate that colleges will supply them with innovative human resources to help them maintain a competitive edge in the market. Teaching innovation and creativity has been the subject of much research. One approach is to use sustainability as a driving force in transdisciplinary courses. Understanding innovative teaching methods and creative thinking is beneficial for teachers (Fixson, 2009). Teaching innovation and creativity can fail for the various reasons, including problem-setting, students, and the lack of resources. Each subject has its own peculiarities, just as every university is unique (Bremer, 2010). Teachers must learn how to impart innovation in their own courses and unique settings. In this paper, we'll discuss about how to teach with innovation to undergraduate students taking a course on computer networks. This paper discusses what useful or meaningful computer network learning is and how it can be accomplished. The topic is grounded in actual research on the understanding of network protocols by upper-division university students enrolled in a project-based course. Conclusions about the learning of network protocols are reached by examining how students comprehend network protocols and by fusing the findings of this investigation with recent work in learning theory. A step further from here can be taken and apply these findings to the actual work done in a software development project.

## II. LITERATURE SURVEY

It takes a very creative educator to create an engaging learning environment. Numerous unconventional teaching strategies have been created. The typical lecture would be at one end of a continuum with all these modalities, while active student group projects like theatrical productions that demonstrate how machines or protocols operate would be at the other. The 21st century educator must be sensitive to the needs of each individual student given the numerous changes that have occurred in how kids learn and teachers impart knowledge. ICT literacy is a fundamental need that has evolved into a fundamental instrument for meeting educational demands. ICT literacy must adapt to a student-centric pedagogy in order to expand learning outside of the classroom. Teachers required a good eco system to encourage students to think more critically. However, the dynamics of the classroom and factors like: traditional classrooms with a large number of students, set class times, varying learning needs of students from different backgrounds, scarce resources, and students' attitudes expecting teachers to cover everything present the greatest challenge to educators. We developed a methodology that best fits the classroom dynamics, learning objectives, assessment techniques, and teaching-learning activities by recognizing the situational aspects in order to overcome these obstacles and encourage higher order learning (Dontham et al., 2016)

Due to the widespread usage of computer networks and the significant demand for computer networking expertise in business and industry, computer networking courses are becoming more and more popular at universities (Shifroni & Ginat, 1997). Numerous studies have concentrated on developing various techniques or tools to aid students in learning network protocols (Sarkar & Petrova, 2009; Pan 2010; Kulkarni, 2011). Students can better understand network protocols thanks to these pedagogical techniques and resources. However, in the real world, industry requires workers who can configure network devices like routers and switches in addition to understanding protocols. Additionally, it is necessary to use ingenuity while developing network solutions for small and medium-sized businesses.

The three aspects of self-determination theory that are fundamental prerequisites for students are expertise, independence, and relatedness. Competence is linked to the desire for students to feel capable and in direction of their education. The urge to participate in personal chores independently is a requirement for independence. The demand for learners to participate in activities that enable them to interact and communicate with their peers is linked to relatedness (Sergis et al., 2017). These three psychological demands (expertise, independence, and relatedness), promote learners' involvement. However, students' sense of expertise and independence is reduced when teachers, who are a part of the student's external environment, have significant control over the learning process. Instead, teachers encourage and assist students in active learning environments when they apply correctly what they have learned on their own, fostering the learners' independence. Additionally, after receiving constructive criticism for raising learners' skill level and way of thinking during team assessment, the sense of competence which is the feeling of efficiency and control over behavior is produced in a considerable and unique way (Narendran et al., 2018).

Engaging students as active learners is one of the objectives of interactive teaching techniques. In course of computer networks, we can employ student-led theatre to teach three different reliable data transmission protocols. These three procedures are Alternating Bit, Go Back-N, and Selective Repeat. Graphs, finite state machines, and simulations are commonly used teaching aids for introducing networking protocols (McGuffee, 2004). Class experience suggests that presenting a finite state machine diagram to a typical student could be disastrous. In order to provide students, the chance to actively investigate the difficulties associated with reliable data transport, the three distinct protocols can be presented in a spectacular fashion.

Despite wanting student participation, educators should lecture. Therefore, it is essential for them to employ innovative teaching techniques to involve the class and advance students' knowledge. Before introducing the concept of extended analogy as a confluence of the two, the instructor will first go over the common uses of analogy and exaggeration (McIntosh & Sullivan, 2011). When a teacher creates an extended analogy for a subject, the exaggeration helps students remember the material by relating it to well-known ideas. As a result, the parallel is turned into a memorable story rather than being a technical subject. A lengthy analogy presentation calls for some

acting and improvisation skills. These cutting-edge teaching strategies engage pupils, reinforce concepts, and make them easy to recall.

TABLE I
STRUCTURING CONTENT TO USE ARCS MODEL

| Component | Implementation Strategies |
|---|---|
| Attention | The complexity and diversity of students' learning processes and styles is a significant concern. Students have various learning preferences, and a teacher may have to manage a challenging mix of students in a single class. The author makes multiple attempts to illustrate how games, analogies, and even "magic" might be used in a computer networks course to help students understand technical concepts, maintain their interest, or even enjoy technical lectures. When used effectively, these techniques will improve students' engagement, focus, and comfort. While accommodating their individual learning preferences, these unique teaching techniques can keep student's attention. |
| Relevance | Ethernet protocol can be directly compared to a friendly and open human communication. For example, a group of people gathered in a conference table with no leader and equal opportunity to speak. One has freedom to speak whenever he/she wishes, as soon as the thought occurs to him/her. The prospect that someone else will also be prepared to speak is, of course, always present. When two persons are speaking at once, they should both pause for a second before continuing. Likewise connecting each protocol will create relevance in their day-to-day life in addition to technical connection with Industry. |
| Confidence | Make the students draw several graphs showing the routes they could take from their homes to the university in their local city as part of a lesson on the routing algorithm. Make them compute the expense, time, and energy expended. Students gain confidence in what they learned in class when the same routes are connected with different routing techniques. |
| Satisfaction | Curiosity is largely linked to the desire to learn and is unrelated to any pursuit of objectives or fantasy fulfillment. Only if the issue has an ideal level of informational complexity can the learner's curiosity be aroused. In other words, the environment or job used as an example should be just right—not too easy, not too difficult. The task should be fresh and unexpected but not patently unreasonable. Take students input in lesson planning while explaining lesson plan in first class of subject. |

## III. TEACHING METHODOLOGIES FOR COMPUTER NETWORKS

### *A. ARCS Model*

### *B. Flipped Classroom*

The flipped classroom offers a number of advantages, including the chance for teachers to spend more time applying their knowledge to go deeper into subjects and further explore concepts. The removal of a significant portion of lecture-style instruction and the opening up of class time to a range of group-based activities where students can take a more active role in their learning have made this new method popular with both teachers and students.

Various flipped classroom studies exist. To tackle the complexity of the existing studies, important is to understand the students as per the thinking and group them accordingly for the same we propose "Six thinking Nets" approach as an analytical guide. Six directions make up this model, which is a methodical approach to thinking: facts, emotions, positivity, creativity, reflection on reflection, and challenges. The six nets each stand for a distinct way of thinking. We are able to identify the region of flipped classroom research that requires additional research thanks to this systematic thinking methodology. Informational problems are raised by the white net. Most research made clear reference to the flipped classroom strategy. For instance, some academics (Bhagat et al., 2016) conducted quasi-experiments to see whether the flipped classroom technique is effective. This research improves our knowledge of the results and current applications of the flipped classroom strategy.

1) *White Net*
   Emphasizing information and facts (Logical mind group)
2) *Red Net*
   Considering students' feelings and emotions. (Group of Emotions).
3) *Green Net*
   Ingenious for incorporating fresh components (Creative students' group)
4) *Yellow Net*
   Class standards for constructive design (Strictly following rules students' type)
5) *Black Net*
   Highlight difficulties with flipped learning (fun-loving students' group.
6) *Blue Net*
   Flipped classes require students to reflect on their opinions (Skeptical thinking group).

It is rather common in flipped classrooms for some students to choose to sit out and not engage. The teacher can deal with this scenario by posing questions that motivate students to assess, examine, compare, and contrast, debate, or reflect. By using technology to move the lecture outside the classroom and learning activities to bring homework and exercises with concepts into the classroom, it is possible to increase student engagement and performance.

### *C. Value Line activity and Think Pair and Share*

One of the methods to teach partitioning algorithm in computer network is, use Value Line activity and Think pair and share activity to make students understand.

*1) Value line activity will be helpful for following:*

a) Promote interaction among students.
b) Open-ended questions can be asked on algorithm linking with country policies.
c) It will allow reflection time for everyone.
d) *Use real-life problems*.
e) Activate critical thinking and enhances analytical skills.

*2) Think Pair and Share will be helpful for following:*

The target for the Think-Pair-Share technique is to differentiate instruction by giving students the space and framework they need to reflect on a particular subject, develop their own ideas, and then present those ideas to a peer. Instead of employing the traditional recitation method, when a teacher asks a question and one student responds, this learning style fosters classroom participation by encouraging a high-level response from students.

Additionally, this approach gives every student the chance to discuss their ideas with at least one other student, which heightens their sense of engagement with the lessons being taught in the classroom. Think-Pair-Share can also be used as a strategy for information assessment. The instructor can go around the classroom, listen to the students' dialogues, and then react.

*3) Time allotted for this activity:*

(a) Value Line activity will be given 35 minutes. Student segregation- 05 mins, Thinking- 05mins, Discussion in homogenous groups-10mins, regrouping heterogeneously-05mins, heterogeneous group discussion-10mins.

(b) Think Pair and Share will take 15mins. Posing the problem-01mins, Individual thinking- 03mins, Pair discussion-03mins, Representative from each pair sharing idea rest-08 mins.

*4) Implementation:*

Describe the strategy and its purpose with your students, and provide guidelines for discussions that will take place. Explain to students that they have to do in strategy. Allow time for students to ask questions that clarify their use of the technique

(a) Implementation plan for Value Line activity

Present a question to the class and ask them to think about how they feel about the issue. Students will line up according to their opinion using the option, the issue is set for the students. Like for clustering groups are made based on characteristics and similarity of data.

Say them to make a group of 3-4 and justify why they have selected that option. Now from each group take one student and make a group of students with both options. Give time to discuss on their point of view for clustering based on the characteristics of partitioning algorithm.

(b) Implementation plan for Think Pair and Share

i) Think: Initiation is done by posing a specific, high-end question regarding the topic or subject the class will be debating. For a predetermined period of time, students "think" on what they already know or have learned about the topic (usually 1-3 minutes).

ii) Pair: Students ought to be matched up in pairs. Teachers have the option of pairing up their students or permitting them choose their own partner. While forming pairs, keep in mind the demands of the learners (reading comprehension, focus, and language skills). Students discuss ideas, express their perspectives with their companion, and query their partner about their opinions on the topic (2-5 minutes).

iii) Share: Reconvene as a class for a debate as a whole in this part. One individual from each duo can either share with the class, or the conversation can be more open. Additionally, students can report back to the class what their buddy said. (5-7 minutes)

## *D. JIGSAW*

Through the group project JIGSAW, computer network routing protocols will be taught. The jigsaw technique is a cooperative learning strategy that encourages both individual responsibility and team goal achievement. Students who are given the chance to participate in a group also learn practical skills like communication and adhering to a schedule. Along with encouraging dialogue and cooperation, this approach also supports self-directed learning techniques. When students collaborate, they develop the skills of asking questions to clarify their understanding and giving constructive criticism in the right context.

Additionally, the jigsaw style of education successfully boosts students' academic performance in the crucial cognitive skills of problem-solving and analysis.

*1) Implementing JIGSAW*

Preplanning: A questionnaire must be created for each of the shortlisted protocols before they can be deployed. A week prior to the activity, students should be notified about it and taught what they need to study to participate. Before beginning a collaborative activity, all students must be informed of the entire process a day before.

a) The Collaborative activity will be implemented using five protocols (JIGSAW with few assumptions).
b) Five groups of four students each will be selected. -05Mins
c) During the scheduled lecture, each group will be given 30 minutes to illustrate the protocol utilizing role plays and posters.
d) With the aid of chits and cards, the group members should serve as nodes and demonstrate the protocol.
e) Rest of the class will be permitted to ask questions, to which the group members must respond-15Mins.
f) The realistic setup and demonstration will be more encouraging (use of tools like NS-3/2)-30Mins.

*2) Create a brief questionnaire to collect student feedback*

a) Rate your learning for the topic using this collaborative teaching methodology?
b) Can we implement JIGSAW in each and every topic of computer networks?

c) How well is the topic planned and assessment plan of the topic designed?
d) How well did you enjoy by participating in this activity?
e) Did the questions asked in the beginning motivated you to read at home?
f) Is JIGSAW implementable in your topic well?

## IV. EVALUATION OF THE NEW LECTURING APPROACH

Games and dramatic interpretations enlivened the lecture process on a subject that is typically theoretical or technical. The outcomes of this strategy's two semesters of experimental use were extremely positive. Laboratory exercises, an online learning environment including lecture slides, lecture recordings, and a discussion board are additional supplements to the course.

With the aforementioned strategies, the lectures were methodically enhanced, which was a substantial improvement over previous year. Comparing the last two semesters to this semester, there was just a very tiny increase in the course's passing rate. However, student engagement and enthusiasm were where the major gains were made. Additionally, the Department's annual assessment of its teaching effectiveness revealed the students' favorable response. The goal of the questionnaire is to give professors insightful feedback on how to improve student learning in a course. It comprises of 15 questions that take into account the available materials, assignments, and evaluations, as well as student engagement and course evaluation. Three semesters of evaluations were conducted on the students' questionnaire responses. The first semester was the one before new methods to the teaching process were implemented (pre-intervention). The new teaching strategy was initially presented during the third semester. Students then completed the surveys in the fourth semester, which were utilized to confirm the change.

I. The course material was organized properly for the semester.
II. The library had readily available, pertinent research materials.
III. The course was challenging given the semester it was delivered.
IV. The course's objectives were met.
V. When there were written or oral assignments, the instructor provided advice.
VI. When there were written or oral assignments, the task aided in your understanding of the particular subject.
VII. The teacher was successful in piquing students' interest in the subject.
VIII. The teacher enhances my learning by using excellent teaching strategies and examples.
IX. The teacher promoted participation in class discussions in a way that helped students contribute and gain knowledge and skills.
X. The instructor was consistent in keeping class and office hours, provided timely feedback on projects.
XI. The instructor was receptive/open to students' questions.
XII. In general, the overall performance of the instructor was very good.
XIII. As student, I attend class regularly.
XIV. Being student, I always participated in class discussions, projects, and written and/or oral assignments.
XV. On average, I have spent _____ hours per week doing work outside of class for this course. (0–1 hour (1), 2–4 hours (2), 5–6 hours (3), 7–8 hours (4), 9+ hours (5)).

With this survey 02 questions were posed to the students to evaluate the impact. Question 1: does teaching reform help classroom learning and mastery of content? Question 2: Are you satisfied with this teaching method? Results for the same are presented in table 2.

Table 2: Teaching evaluation survey

| Students' answers | More helpful | Helpful | No opinion | Satisfied | Dissatisfied |
|---|---|---|---|---|---|
| Student numbers | 44 | 20 | 6 | 55 | 5 |
| Ratio (%) | 62.9 | 28.6 | 8.6 | 78.6 | 7.1 |

## V. CONCLUSION

This paper discusses various strategies for engaging students and fostering a sense of ease while they learn fundamental ideas in computer networking. The outcomes of this strategy's two semesters of experimental use were extremely positive. Experience has shown us that theatre is more difficult to convey than magic and games in a typical lecture. The advantage is greater, nevertheless, as a result of students' active participation. Such strategies could be quite useful when attempting to engage students, and we think they are ideal for introductory computer networks courses in higher education. Students in the experimental group gave positive comments, indicating that they were involved in and enjoyed the flipping of the classroom activity. Therefore, flipped classrooms may be a better option than traditional teaching for encouraging students' active involvement in their education and subsequently enhancing that education.

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