Implementation of Active Learning Tools in Modern Pedagogy

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Abstract: Now-a-days, it is important to integrate innovative tools in engineering education. It is need of hour that conventional teaching-learning techniques should be replaced by state-of-art tools that enable instructor to deliver the content in effective manner so that learners become proactive in teaching-learning process. Active learning tools play a vital role in modern day pedagogy. Today's pedagogical tools in active learning give that opportunity to learners to exercise their problem-solving skills and allow them to work collaboratively in groups. A detailed analysis of tools such as Kahoot, Eclipse crossword and flipped class is discussed in this paper. Our analysis involved engineering learners from Electrical and Electronics and Communication streams from our college. Participation of learners in activities such as Kahoot and Eclipse crossword was more compared to flipped class which indicates learners are more inclined towards puzzle solving and quizzing technique. We examined how these techniques improved students' approach towards learning. It is a prime duty of instructor to engage students in the activities which serves the purpose of learning by doing. Active learning tools play critical role in making students proactive in their learning phase.

Keywords - Teaching-learning, pedagogical, social, Kahoot, Eclipse crossword, flipped class

JEET Category — **Practice**

I. Introduction

Advancements in technology and the application of the technology in every field have emerged tremendously in past few years. Engineering education and modern pedagogy is also going through a transitional period in terms of innovation and acclimatizing to the changes in teaching-learning process. State-of-art technology gives liberty to instructors working in educational field to come up with innovative tools and techniques that raises the bar of content delivery in classrooms and make the process more interesting and learner-centric rather than conventional instructor-driven. It is indeed a challenge for an instructor to encourage student communication and interaction. Creating a collaborative environment than enable a comprehensive learning is a challenge. There is always a gap between active learning and components of teaching viz. course material, assignments, assessments etc. Hence it is important to bridge the gap to promote a high level of student engagement. Key components in every course is to design the course material for content delivery, formulating rubrics to evaluate assignments and developing methods to assess overall performance of students. Active learning tools are such tools that enable instructors with that extra dimension to deal with literature and empower the whole process of percolating the knowledge to the students. There are various online active learning tools available now-a-days such as Idea Spinner, Q&A Platform, Polling, Cubing, Four Quadrants, Whip around, JIGSAW [23] etc. that develop and elevate students complying outcome based education. These virtual tools also provides a rich and joyful experience to students and help them retain the knowledge. Thus active learning techniques are useful in upgrading the soft-skills as well as technical skills of the students.

II. Literature Survey

Active learning technique in a non-conventional way of approaching a teaching-learning process. It contrasts conventional teaching in terms of greater understanding of the subject literature through collaboration with peers, discussions and individual or group work through small projects [10]. A paper on Collaborative inquiry learning [11] shades light on improving engagement of students in class. It aims at bringing a new and promising culture of teaching and learning into the classroom where students in groups engage themselves into activities and develop a strong thinking on lines of how to tackle a problem and come up with a reasonable solution on their own. Conventional chalk and board technique is less productive than an active learning tool used for the same purpose. A comprehensive study [12] about integrating debate as an active learning technique in a group activity was found more effective than a conventional lecture in a class. With the advancements in technology, it gives as added advantage to the instructor to make use of tools based on the state-of-art technology and present an enriching experience to students in teaching-learning process. Various online gaming techniques give teachers and students a valuable returns [13]. Rapid information processing is a valuable aspect of leaning. In order to understand relevant course concepts in short duration of time in class, one of the ways can be to give a short time span and students are required to investigate the topic given to them, analyse the context or in some cases come up with a solution for a particular problem assigned by the course instructor. This definitely helps the critical thinking ability of students. Impromptu presentations can also be integrated as active learning tool [14].It is required to bridge the gap between the conventional abstract class-based methods to fully immersive active learning activities which

satisfies the cognitive demands of the learner [3].Project based learning [2] is another powerful tool that allows students to think out of the box and come up with the real-time solutions to the issues happening around. This tool allows the students to even use the technical knowledge he or she learns in the class and apply it practically in real world applications.

III. Methodology of Active Learning Tools

A. Kahoot Quiz

Kahoot quiz platform delivers engaging learning experience to the students. The peculiarity of using this tool is this activity instils a competitive spirit among students and keep them engaged throughout the session.

The platform allows the creator to include multiple choice questions, a true or false questions, and a single word response from each participant which makes a word cloud. Platform also gives students to express their opinions through poll activity.

Procedure to conduct Kahoot Quiz:
1. Log in at https://create.kahoot.it/auth/login with your credentials.
2. Create the quiz with a "CREATE" tab.
3. At the time of conduction of quiz, a game pin is created. Share the pin with the participants.
4. Ask participants to join the quiz at https://kahoot.it/
5. After completion of the quiz, the report gets generated automatically which helps us in analysing the quiz thoroughly.

Salient Features of Kahoot quiz:

- Emphasis on engagement of each and every students of the class
- Encourages students to do well in every question
- Leader board after every question builds competitive spirit among students
- Learning through fun quiz
- Checks the quick-mindedness of students

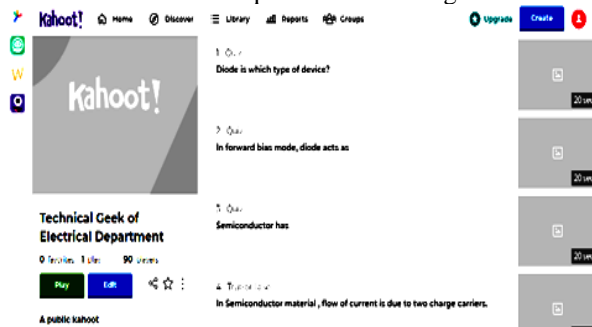Snapshots of the conduction of quiz is shown in figure 1.

Fig.1 Questions of Kahoot Quiz

Figure 2 shows detail report indicating students' reflection on quiz.
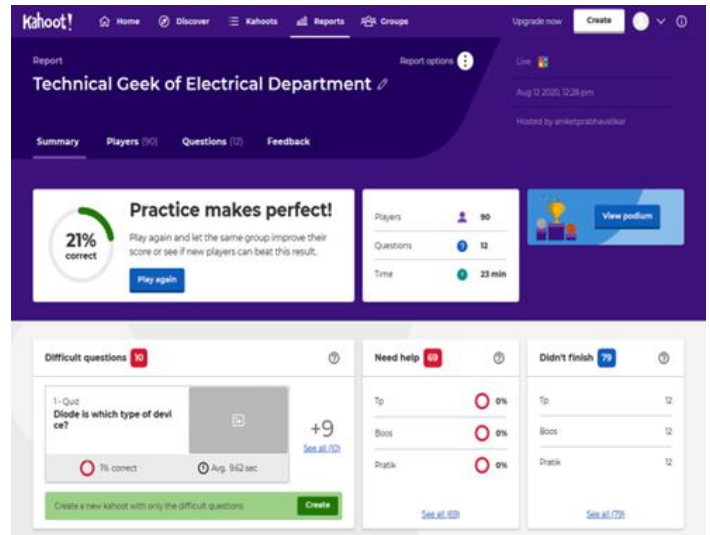

Fig. 2 Report of Kahoot quiz

This activity was carried for the students of Second Year engineering from Electrical department for the course of Analog Electronics on a topic "Semiconductor Physics". This particular topic involved concepts that were already learnt by the students in their previous semester. Hence the objective of conducting the activity was to make them recall the same.

The details of the activity were conveyed to the students on the previous day of the activity. During the activity all the students were present and participated in the activity. As we have already discussed the mode of the activity, students were active and enjoyed the same. The strength of the class is 79 and the number of participants was the entire class. Following are the statistics of the activity. Let's concentrate on leading 10 candidates throughout the session so that we get an idea that how proactive the students were.
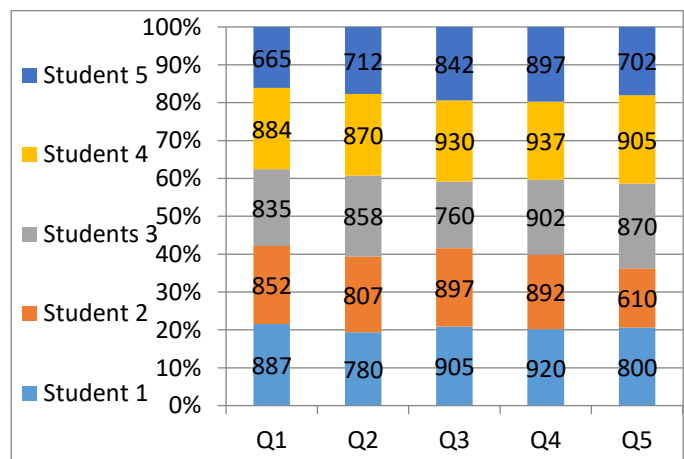

Fig. 3 Student engagement activity

From the graph in figure 3, we could easily identify how the students were engaged in the activity. The chart shows the percentage of top 5 student's participation for every question. For every question it was required that the students should

answer quickly and accordingly the points will be allotted to them. The one who is sharpest will be awarded maximum points out of 1000. Thus every student was focusing on right answer in minimum time. For Q.1, student 1 was quick to respond and hence got highest points as 887 while for Q.2 student 3 was awarded highest points 858 as student 3 was quick to give the answer.

Thus this activity helped in improving the skills of the students in terms of quick thinking capability. It also inculcated competitive spirit in students. Proactiveness and involvement of students in the activity indicates the success of implementing it in the class.

Table I: Performance and feedback of Kahoot Quiz

Overall Performance			
Total correct answers (%)	21.30%		
Total incorrect answers (%)	78.70%		
Average score (points)	1923.00 points		
Feedback			
Number of responses	79		
How fun was it? (out of 5)	4.95 out of 5		
Did you learn something?	100.00% Yes	0.00% No	
Do you recommend it?	100.00% Yes	0.00% No	
How do you feel?	85.00% Positive	10.00% Neutral	5.00% Negative

Feedback was taken from the students on the quiz conducted. Some students really enjoyed the mode of learning. Some were a bit sceptical about it and were facing network issues because of which they could not give fast answers. Feedback of students and the overall performance of students in Kahoot Quiz is given in Table I.

B. Eclipse Crossword

We do solve crossword puzzles in the newspapers which requires thorough knowledge of the words. Similarly in courses where you need to focus on specific important concepts and the keywords in the course are to remembered by students, then you can use this tool which helps students to recall those keyword easily based on the hints given.

Eclipse crossword runs on Windows operating system and one can download it from https://www.eclipsecrossword.com/ . Once the software is downloaded, you can run the executable file and platform is now available to explore.

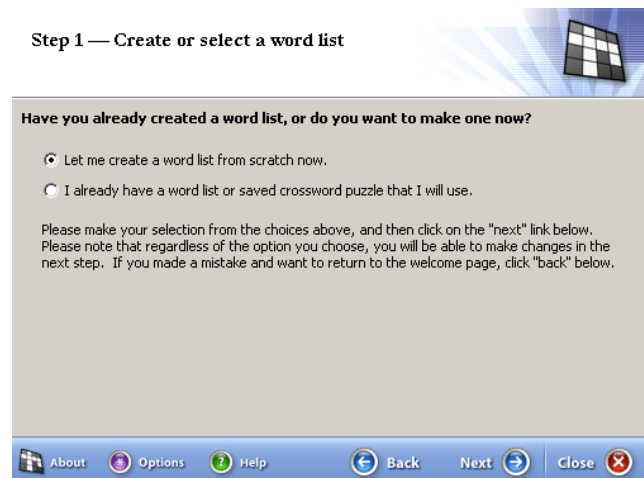Following are the steps that need to be followed to create our own crossword.

Fig.4 "Step 1" Create a new crossword puzzle

As we know crossword is an inter-link between words. Hence the wordlist is important.

Step 1 is to create puzzle is to select "*Let me create a word list from scratch now*". Refer Fig 4.

Step 2 is where most of the work is done. The clues or the hints with the associated word can be given in the tab "*clue for the word*" and the actual word for that hint could be written in the tab "*word*". The saved word will appear in the "*Word List*". One can save the word list for reference and even can modify the list as well as remove the word from the list with the options shown in the fig.5.
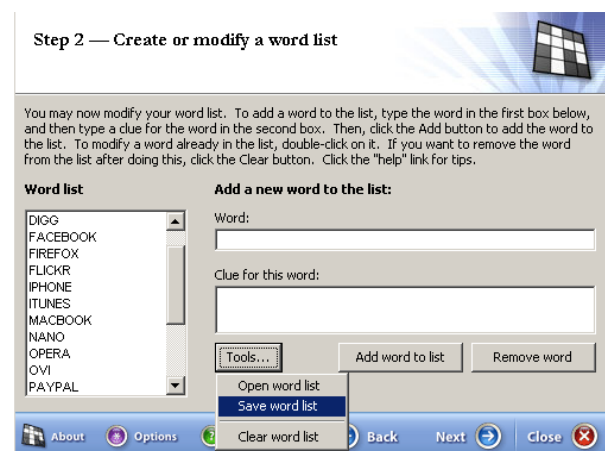

Fig.5 "Step 2" Create a word list

Step 3 is most often an optional thing where if one wants the puzzle to be constructed around that particular word then one can add that word as a "*Primary Word*" in this step.

Step 4 names the puzzle. One can save it with a particular theme or date or any name that is relevant to the topic on which the entire crossword is built.
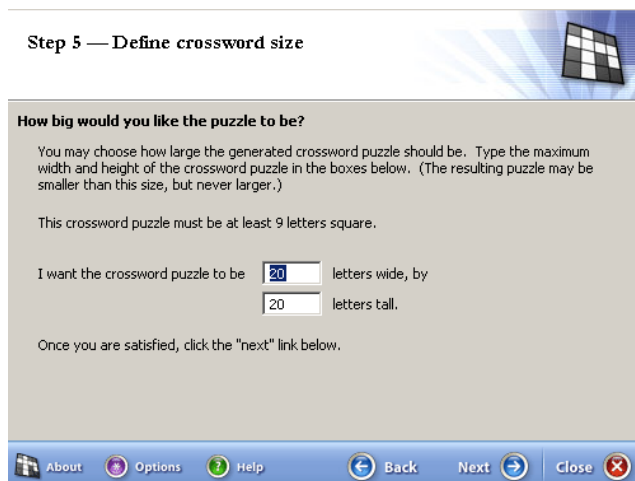
Fig.6 "Step 5" of crossword creation procedure

Step 5 deals with aesthetics of the puzzle. This step sets up the grid dimensions. In a way in this step one can decide the look of the puzzle. Sample of the same is shown in figure 6.

Step 6 basically gives a visual layout of the crossword. If you are not satisfied with the layout or you want any changes to it, you can always click on the "*Make another puzzle like this one link*" to redraw it. Refer figure 7.

Step 7 is publishing it via the first option creates a simple html file that needs only be uploaded to one's website. If you would prefer the interface of the Java applet, you will also need to upload the .class file alongside the html file created via the second method. Refer figure 8.
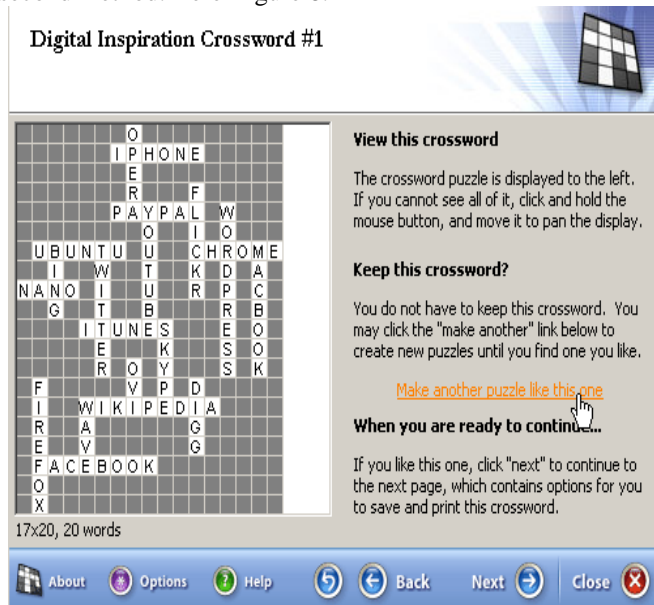

Fig .7 "Step 6" Visual Layout of Puzzle

Fig.8 'step 7" Saving and Publishing the puzzle

Implementation of Eclipse Crossword in class:

The implementation of this active technique enables students to think and react based on the hints provided. It also helps students in terms of cultivating a habit to interlink words. The activity helps in developing the habit to search for the word and in turn increases the vocabulary of students and improves puzzle solving skill of students. Advantages of Eclipse Crossword are that it is an open source software, freely available and its interface is user friendly.

Conduction the Eclipse Crossword activity is explained in Figure 9, Figure 10 and Figure 11.

Figure 9 shows how the crossword looks in HTML format and the user can now start to solve the puzzle.

Figure 10 gives a fair idea about how to solve the puzzle. You can see a word is guessed and new second word need to be identified based on the clue given.
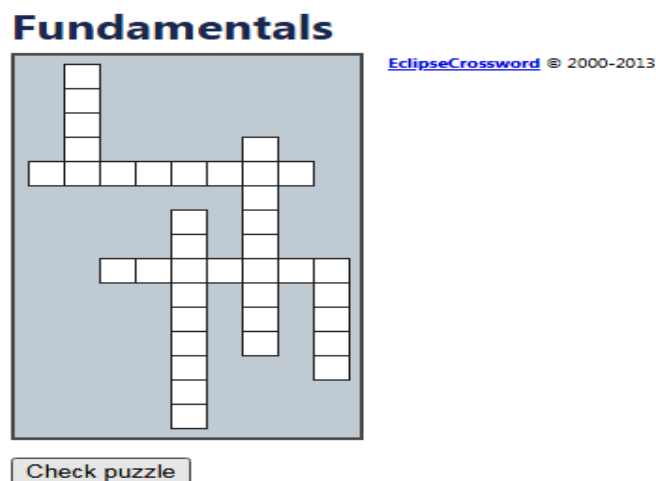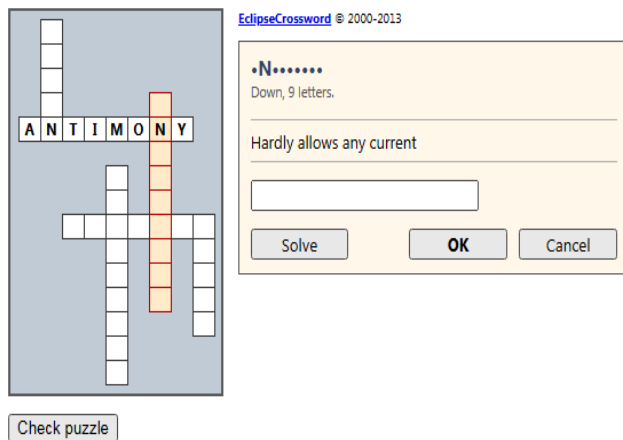

Fig. 9 "First view of Crossword"
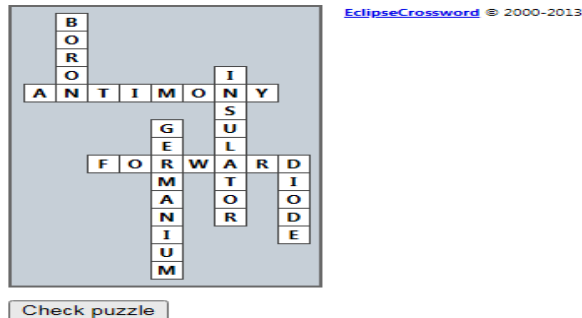
Fig.10 "Clue to guess the word"

Fig.11 "Solved Puzzle"

The above puzzle was taken as an exercise for a class of Second Year Engineering students from Electrical Engineering to identify different words related to "Diode Fundamentals". There were lots of keywords associated with the concepts regarding basics of diode. This activity helped students in understanding the words through this small puzzle solving game which is indicated in figure 11.

The .html file was shared with the students and asked them to try on their own. Time limit of 5 minutes was given to them. After the time out, the entire puzzle was discussed on instructor's screen and students were active in helping to complete the puzzle.

Feedback was taken after the activity and learners were very much excited to solve the puzzle as they found it fascinating to be involved in such a unique technical riddle game. Some of the students suggested to incorporate the activity on a regular basis.

The feedback was taken on the basis of following 5 questions on a scale from 1 to 5 with "1" being the lowest or "Strongly Disagree" and "5" being the highest or "Strongly Agree".

A. Was the activity interesting?
B. Scale the activity in terms of learning quotient
C. Learning concepts through puzzle solving was fun.

D. The concepts could be better understood through clues given.
E. The activity helped in creating interest in the subject.

Feedback Analysis of Eclipse Crossword activity is plotted in the graph showed in figure 12.
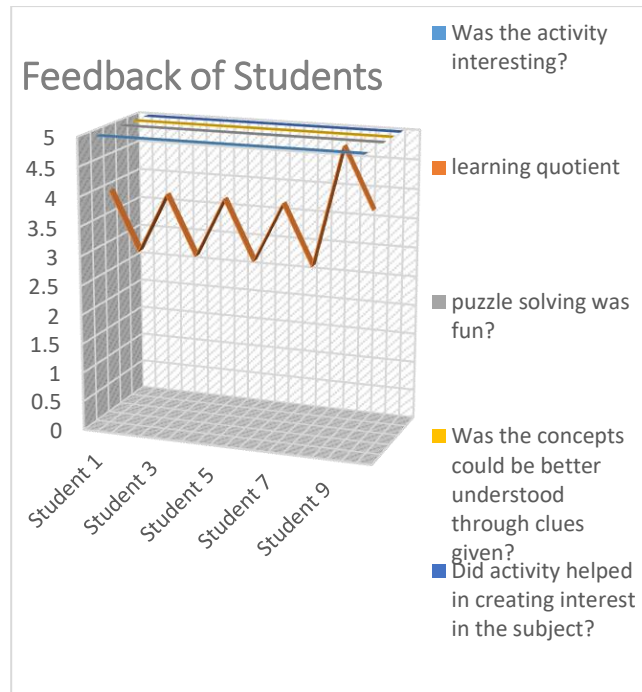

Fig. 12 Feedback Analysis for Eclipse Crossword

C. Flipped Classroom

One of the most efficient techniques of active learning tools is Flipped classroom. This practice of modern pedagogy is non-conventional tool which allows learners to collaborate with the peers and learn the concepts through online resources available. This technique revolves around learner-centric model where it creates a more deep understanding of the topics and gives learners an opportunity to have creative learning experience.

Class activities may vary from using discussion on in-depth laboratory experiments, a technical paper analysis, and debate over a research proposal, presentation on a topic such as current advancements in technology, peer reviewing, project-based learning and skill development. These types of active learning allow practicing different levels of instruction. This also gives liberty to an instructor to spend more time in class on higher-order thinking skills such as problem-finding, collaboration, design and problem solving as students deal with difficult problems, work in groups, research, and construct knowledge with the help of their instructors and peers.

Implementation of Flipped Classroom:

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This activity was carried out for students of Second year Electronics and communication engineering for a topic on Basics of Operational Amplifiers. The basic structure of operational amplifier and the fundamentals were discussed in the class so that students get a fair idea about the amplifier as a whole. The videos regarding the intricate knowledge is shared on the MOODLE platform. This activity was carried out in the view that it will improve the presentation and communication skills of students. The activity also involved evaluation of the students by their peers. Thus the participation of instructor was minimal and students were involved in knowledge acquisition through their colleagues.

In-class Activity:

- The students are grouped with 4 members in a team. Thus 17 such teams were formed and each with having their own team name

- Students are asked to select the one application from each group. It involved the Think-pair-share activity within the group to finalize the application.

- A presentation was asked to create for which the instructor had already shared a template.

- Each group was given around 2 to 3 minutes to present the concept in front of the class.

- The students are instructed to provide open peer assessment feedback on the discussion forum created on MOODLE.

In peer assessment strategy, each group is assessed by the four peers groups and one time by the instructor.

Table II Peer Assessment strategy

Team work within the group is observed in the class-room activity by the instructor. Thus in-class assessment is achieved through peer assessment and facilitator assessment.

The feedback questions were formed to have a check on whether the students are comfortable with this active learning tools and what they have gained through the in-class activity.

Table III Rubrics for assessment

Group ID	Group Name	Groups to assess
1	OPAMP1	2 , 3 , 4, 5
2	OPAMP2	3 , 4 , 5 , 6
3	OPAMP3	4 , 5 , 6 , 7
4	…………	5 , 6 , 7, 8
..	…………	---------
17	…………	17, 1 , 2, 3

Sr. No.	Parameter	Good (5)	Average (3)	Below average (1)
1	Selection of application	Practical and real time	No practical feasibility	random
2	Selection of parameters	Justified parameter ranges and use	Parameter ranges specified without justification	Parameters ranges are not feasible
3	Selection of methods to explain the concept	Simple and elaborative	Complicated and too much data	Not properly discussed
4	Conclusion	Perfect summary	No proper summarization	Vague Summary

The students were given the following five options to choose from for the feedback.

Strongly Agree (SA)	Agree (A)	Neutral (N)	Disagree (D)	Strongly Disagree (SD)

The questions were:

Q1.I can explain the concepts of Operational amplifier to the entire class.
Q2.In-class activity contributed to my own learning.
Q3.I can make use of the concepts of operational amplifier in future.
Q4.I am confident to design any application with the help of concept of operational amplifier.
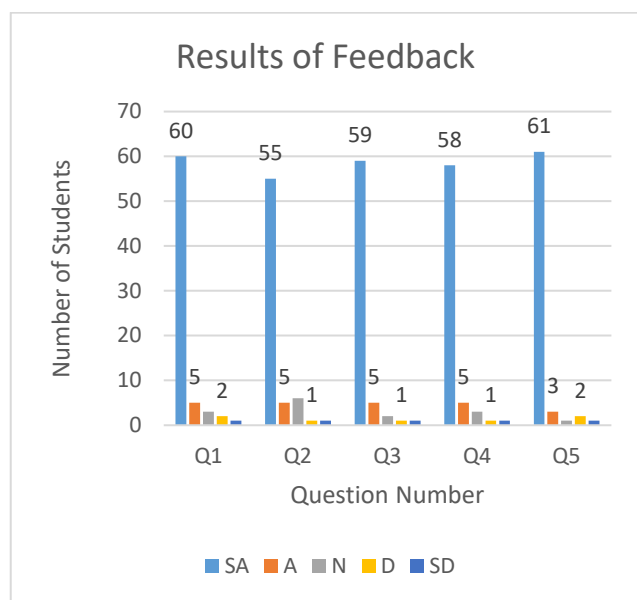Q5.I can analyze any given complex system of operational amplifier.

Fig.13 Results of Feedback

Figure 13 clearly indicates that the students were really satisfied with the way they were able to learn fruitfully through this in-class activity of flipped classroom. Almost for all the questions, majority of students have given a STRONGLY AGREE opinion in terms of understanding the concepts though the active learning tool.

IV. Discussion

Tool	Focus	Pre-requisite Knowledge Level	Cognitive Implications
Kahoot Quiz	Student's Level of comprehension regarding course material	Enough to attempt the quiz	Comprehend the question, Choose from the options and answer correctly
Eclipse Crossword	Student's ability to recall and memorize facts related to course	Enough to identify the response	React from the clues and generate answer
Flipped Classroom	Student's ability to understand concepts on their own	Interaction and communication skills	Analyse the course material and communicate to the audience

From the literature survey and analysis of the results of the active learning tools explained here clearly indicated that the conventional methods are the form of disseminating information to students. Active learning methods truly imbibe and focuses on student's ability to comprehend the course material, enhances the ability to recall concepts clearly and understand the course in a better way so as to apply it to the real-world scenario. The cognitive implications of using active learning methods is tremendous in the sense that the students

explore the course in a whole new dimension of comprehending the material and communicating it to the audience with the help of a flipped classroom. A blende of active-learning tools and conventional class-room teaching methods could guide us to retain the glory of engineering education and also careers in various national and international levels. More in-depth analysis of studies in this regard could definitely pave a way towards finalizing the proportions of conventional teaching and active-learning techniques.

Engineers have always played a vital role in the development of society as a whole with initiatives that enhance the quality of life and bring transformation in the society.

In Industry 4.0, the world is going through the development of a few parallel trends including the rapid emergence of ecological limitations, the beginning of an increasingly multi-faceted international standards introducing a new era of globalization. In this context, the business environment is increasingly shaped by continuous change and growing complexity. The challenges for companies arise not only from the need for flexible technical solutions, but also from managing complex socio-technical systems, and contribute tangibly to the sustainable development of the economy and the environment. This implies engineering researchers and graduates with the ability to understand complex technological processes in the context of social, environmental, economic, and global concerns will play a critical role and will be increasingly sought after in the emerging industrial and business worlds. In this context, it gets essential to understand the future direction of global engineering education and identify the defining trends to support positive educational change and build the next-gen engineering talent in the country.

Active Learning Tools explained in this paper are the part of basic building blocks of various anticipated shifts that will shape the engineering programs in a promising way ahead.

V. Conclusion

Facilitator-centric and conventional chalk and board teaching-learning is now obsolete. The most relevant part of modern pedagogy is the need to effectively cater to needs of millennials with low attention spans and always expecting flexibility in learning. The active learning tools possess the flavour of student-centered learning which gives experiential, flexible and personalized learning through the combination of on and off-campus learning. The above all active learning techniques definitely give facilitator that edge of inculcating those habits in students where he or she can learn the subject on their own with the help of guidance from the instructor and become profoundly confident in dealing with the real time problems in future. The feedback analysis of all the tools mentioned in the paper clearly suggests that the students are more inclined towards activity based learning than the conventional chalk and board technique. Students welcome these modern ways to acquire knowledge in a productive manner. The satisfactory outcomes of all the techniques used for the teaching-learning emphasises the fact that these active strategies with effective use of ICT tools enhances cognitive skills and proactive ability

of students in terms of soft-skill development and technical knowledge. In the Kahoot quiz 85% students feel positive about the conduction of activity while the fun element is 4.95 out of 5 which is 99%. In Eclipse Crossword activity, the students strongly agree with the idea of understanding the concepts through puzzle solving. Feedback for flipped classroom technique indicates students enjoy learning through discussions with peers and find it more comfortable to deal with the concepts deeply through self-learning where the instructor only be a facilitator. Thus use of active learning tools is a need-of-hour. This new approach will certainly breed a new generation of students with required inter-personal as well as professional skills to survive in this world full of opportunities and cutting edge technology.

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