in architecture, music, films, picture book illustrations etc.

Digital collage, also called as e-collage is an extended version of traditional collage which has gained immense acceptance in the recent days. It is a form of graphic art that uses virtual images from various online sources and juxtaposed together to from one assemblage to convey a specific theme.

Active learning approach has been proved to be more effective mode of learning which helps in internalizing the concepts and effortless retaining of memory recall of the concepts (DeNeve and Heppner, 1997). Several active learning techniques practiced involved, Group role-play (McCarthy and Anderson, 2000; Desai et al, 2016), debates (Elliot, 1993), use of games (Somers and Holt, 1993), problem based learning (Wood, 2003) and project-based learning (Bell, 2010).

Collage when used as a pedagogical tool can be instrumental in discovering the fundamental principles of design, storytelling and meaning-making of the concepts. An approach of active learning mode is more effective especially when the participants are to spend time and toy with the art of making something symbolic or metamorphic and then representing it (Gauntlett D, 2007). Narrative collage has been employed as a tool for narrating the explorations of the domain of imagination (Kostera, 2010). It is extensively used in architecture studies to understand the space-making concepts (Shields, 2014). Multipronged approach of blending free association, story-telling and collage are being practiced as research tools in marketing and management (Koll et al, 2010). Simmons and Daley (2013) advocates the use of collage as an art of thinking to stimulate scholarly work and conceptualizing research questions. While several attempts to teach Immunology with different pedagogical approaches like, virtual teaching using simulation tools, demonstration through kits have been made, the present study focuses on art-based activity through collage and story-telling as pedagogical tools. (Bercot et al, 2010).

Immunology as a course requires, microbiology, cell biology and molecular biology as pre-requisites for good understanding. The research problem that has been attempted to address in the present study using collage as a solution is to understand and remember the concepts for long-term memory . This is attained by employing story-building activity and pictorial representation.

The objective of the present pedagogical exercise was to attain a comprehensive understanding of the scientific concepts by engaging the students in active-learning through story-building and collage-making. Immunology course was selected for the activity, since it is intricately associated with and holds immense scope for explanation of scientific rationale for several aspects of daily life. The course provides for context-building and story-telling exercises for teaching-learning process. The activity was implemented for IV Semester undergraduate students of engineering in Biotechnology.

2. Methods

A. Participants and Design of the Activity:

The activity was group-based comprising four members in each group with a total of 12 groups. Each group was assigned with a topic.

The topics chosen for the activity were central to the understanding of the course and their applications. They spanned across the chapters of the course so as to cover the course contents. Accordingly following is the table showing the various topics chosen for the study.

Table 1. Topics for Digital Collage Activity

Sl. No.	Title	Significance/rationale for selection
1	Phagocytosis	Non-specific defense
2	Primary and Secondary Immune Response	Types of Immune response
3	Humoral Immunity	Specific immune response
4	Monoclonal Antibodies	Applications & technology of production
5	MHC Restriction	Basis for organ transplantation
6	Complement System	Facilitation of primary immune response
7	Immunological Tolerance	Homeostasis and self- restraint
8	Hypersensitivity	Adversities of immune reactions
9	Autoimmunity	Types and causes
10	Immunodeficiency Diseases	Causes & consequences
11	ELISA	Antigen-antibody reaction
12	Vaccines	Types and Mechanism

B. Process of the activity:

The activity comprised three phases: 1). Drafting of technical sketch related to the topic; 2). Story-building to explain the topic & developing a digital-

collage to elucidate the same and 3). Oral presentation of the activity by the group members.

As part of the first phase, the students had to learn the theory and underlying principle of the topic and draft a detailed technical sketch of the same, so as to have an idea of the collage they were to make.

This was followed by the second phase, which involved a context-building exercise to explain the topic . The story developed were reviewed for the logical flow, feasibility for collage-making and non-deviation from the topic in focus. Due care was exercised so as not to oversimplify and dilute the immunological concept in the process.

Subsequently a digital collage was developed following a common pattern across all the groups to have uniformity. Each collage was designed with a central image having technical flow-chart, surrounded by images supporting the story/context built. Every effort was made to make the images self-explanatory by supplementing with in- built text.

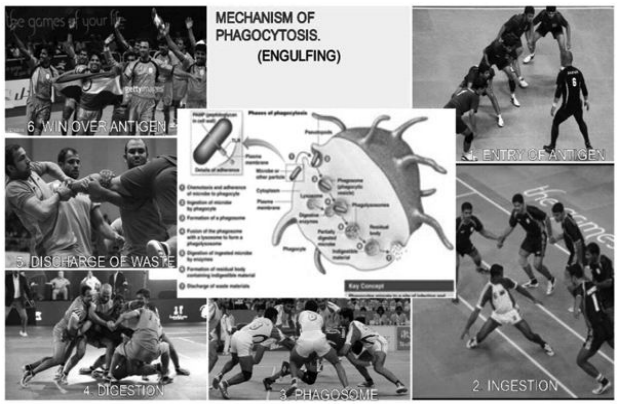


Fig. 1. Collage Illustrating Phagocytosis

The third phase of the activity concluded with oral presentations by each group with other groups and course instructor as audience. The presentation was followed by discussion highlighting the significance of the topic and relevance of the story being built.

C. Illustration of Representative Collage:

A total of 12 collages pertaining to various key concepts of Immunology and spanning across the chapters of the course content were prepared. An indicative collage of the topic 'Phagocytosis' is illustrated in Figure 1.

Phagocytosis is a process through which a cell absorbs a particle, molecule, bacterium, or other type of matter by engulfing it. Phagocytosis refers to the engulfing of larger, solid particles. Often the engulfed particle is another cell, like when a white blood cell, which is a part of the immune system, engulfs a bacterium to destroy it. It involves 5 sequential steps namely 1). Activation 2). Chemotaxis 3). Attachment. 4). Ingestion and 5). Destruction.

As depicted in the collage, a raider (antigen) in Kabaddi game initially enters the zone of opponent team (host cell). The members of the opponent team (host cell defense, macrophage) gradually surround the raider and encircle him from all sides. Once the raider is subdued (antigen neutralized) he is relegated to outside the court zone (released from the cell in the form of puss).

D. Assessment of the activity:

Rubrics-based assessment was practiced for all the three phases of the activity as shown below (Table 2).

Table 2. Rubrics Parameters for Digital Collage Activity

Phase	Rubrics Parameters
1. Drafting of technical sketch	Focus on topic, technical vocabulary, depth
2. Story -building and digital - collage	Story building-Clarity, logical flow, non-deviation from the topic Digital Collage - Quality images, self-explanatory, use of appropriate texts
3. Oral presentations	Fluency, flow of presentation,, slide quality and team coherence

E. Resources:

Open source tools for designing the collage were used. The images were obtained from online repositories and compiled to suit the topic and supplemented with appropriate texts to make them self-explanatory.

3. Results and Feedback

Attainment from the activity:

The activity was instrumental in attaining the various Graduate attributes, Competencies and Performance indicators as shown in Table 3 below.

Table 3. Attainment of Graduate Attributes, Competence and Performance Indicators

Sl. No.	Graduate Attribute	Competence	Performance Indicator
1	Engineering knowledge	Domain knowledge	Molecular biotechnology to solve problems
2	Communication	Listening, speaking & presentation	Oral presentation
3	Communication	Integrate different modes of communication	Use variety of media to convey a message in document or presentation

The activity was able to address all the seven Course Outcomes (CO) (Table No. 4) defined to achieve clear and measurable learning and facilitate proper assessment for the course chosen .

Table 4. Course Outcomes (COs) for Immunology Course

Sl. No.	Course Outcomes
1	Illustrate the concepts of scope. significance and basic concepts of immune system and immune response.
2	Discuss the fundamentals of Humoral immunity, structure and functions of Immunoglobulins, antibody production and hybridoma technology.
3	Interpret the mechanism of Cell -mediated Immunity, Major Histocompatibility Complex and Phagocytosis
4	Explain the functions of Complement system, role of cytokines, concepts of immunotolerance and Hypersensitivity reactions.
5	Apply the concepts of autoimmunity & immunodeficiency and their associated disorders
6	Describe the immunological basis of transplantation and graft rejection, Human Leukocyte Antigen, tissue typing and tumor-specific antigens.
7	Describe the basic concepts and applications of molecular immunology and immunodiagnosis in regard to vaccines and Antigen-Antibody reactions respectively.

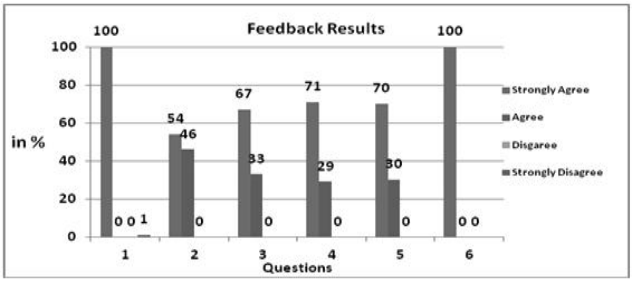
A formal anonymous feedback was taken from students through Typeform tool. The questionnaire of Closed-ended structured format with four elements, Strongly agree, Agree, Disagree and Strongly disagree for each question was framed. Twenty four respondents participated in the survey.

The following table (Table 5) represents the questions asked as part feedback survey.

The results of the feedback survey are shown in Fig 2. All the respondents strongly agreed that the approach was a new method of learning and the tools for making collage were easy to use. No respondents either disagreed or strongly disagreed to the questions in the questionnaire.

Table 5. Questions for Feedback Survey of the Activity

Sl. No.	Questionnaire
1	Was collage-making a new method of learning?.
2	Collage-making activity was instrumental in terms of sensitizing the creative thinking.
3	The activity helped in better understanding of the concept.
4	The oral presentation helped in improving the communication skills.
5	The topics chosen for the activity were clear and spanned across the course content.
6	Usage of software tool for collage-making was easy/difficult



PS:The numbers on the horizontal X-axis correspond to the questions indicated in Table No 5.

4. Conclusions:

It was inferred from the feedback results that, the activity was useful to students in terms of sensitizing their creativity, provided an opportunity for context-building and able to correlate the immunological concepts and its applications to practical aspects of daily life. Nevertheless, some the activity confronted some challenges like having a logical flow of sequences in the story building, correlation of the story and technical concept and coherence of the images used for presentation.

It was concluded that the approach of Digital collage-making, as a pedagogical tool could enhance the teaching-learning process by engaging the students through active-learning.

Post activity, there exists a future scope for the assessment to be performed by the peer groups. This would make it more objective, competitive and student-centric.

Acknowledgment

The author thank Dr. Ashok Shettar, Honorable Vice-Chancellor, KLE Technological University, Prof. B.L. Desai, Registrar, KLE Technological University and Dr. P.G. Tewari, Principal, B.V. Bhoomaraddi College of Engineering and Technology, Hubballi for their constant encouragement and support. The active participation of the students and support of the Dr. Uday Muddapur, Head, Dept. of Biotechnology KLE Tech, Hubballi and all the faculty members is acknowledged.

References

[1] Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. Journal. The Clearing House: A Journal of Educational Strategies, Issues and Ideas. 83 (2) 39-43.

[2] Bercot, F.F., Fidalgo-Neto, A.A., Lopes, R.M., Faggioni, T., Alves, L.A. (2013). Virtual immunology: Software for teaching basic immunology. Biochemistry and Molecular Biology Education, 41 (6), 377-383.

[3] DeNeve, K. M., & Heppner, M. J. (1997). Role play simulations: The assessment of an active learning technique and comparisons with traditional lectures. Innovative Higher Education 21 (3) 231–246.

[4] Desai, S.V., Joshi, G.H., Tennalli, G.B., Patil, R.R. (2016). Molecular Skit- Role-play as a pedagogical tool for teaching molecular biology as an under-graduate engineering course. Journal of Engineering Education Transformations, 29 (3) 138-142.

[5] Elliot, L. B. (1993). Using debates to teach the psychology of women. Teaching of Psychology 20, 35–38.

[6] Gauntlett D. (2007). Creative Explorations: New approaches to identities and audiences. Routledge, London

[7] Koll O., von Wallpach, S., Kreuzer, M. (2010). [8]Multi-method research on consumer–brand associations: Comparing free associations, storytelling, and collages. Psychology & Marketing, 27 (6), 584-602.

[9] Kostera, M. (2010). The Narrative Collage as Research Method, Storytelling, Self, Society, 2(2), 5-27.

[10] McCarthy, J.P. and Anderson, L. (2000). Active learning techniques versus traditional teaching styles: Two experiments from history and political science. Innovative Higher Education, 24 (4), 279-294.

[11] Shields, J.A.E. (2014). Collage and Architecture, Routledge Publishers, New York.

[12] Simmons, N. and Daley, S. (2013). The Art of thinking; Using collage to stimulate scholarly work. Canadian Journal for the Scholarship of Teaching and Learning, 4(1).

[13] Somers, J. A., & Holt, M. E. (1993). What's in a game? A Study of games as an instructional method in an adult education class. Innovative Higher Education 17, 243–257.

[14] Wood, D.F. (2003). Problem based learning. British Medical Journal, 326 (7384) 328–330.

Journal of Engineering Education Transformations ,
Volume 32 , No. 1, July 2018, ISSN 2349-2473, eISSN 2394-1707

A case study of implementing active learning techniques in electrical machine course

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Abstract: Based on recent case studies, the faculties in engineering college are facing more struggle because how to make students to understand the concept clearly. So many faculties are failed to reach the students as facilitator. In some studies, students understand the concept which was taught by faculties, but fail to reproduce or remember the fundamentals during assessment period. In this paper, the improved teaching method for students to understand the concepts and remember the fundamentals through Active learning techniques (ALT).

Here the techniques which explain the student's entertainments like games, puzzles, quiz, peer-to-peer learning and demonstration that are converted into education methods. Also few innovative ideas are implemented and examined on students. The active learning questionnaires, activities of students and experience over the activities are explained with the help of case studies, by taking two batch (2014 & 2016 – electrical machine course) of students and their performance are compared with and without the activities using active learning techniques. The comparison will be based on Blooms taxonomy assessment pattern results. However, the improvement of student's communications, self-confidence level, interest towards the course, perspective thinking, team work, knowledge over the concept and course fundamentals are explained through these results.

Keywords: ALT, peer-to-peer learning, Blooms taxonomy, Electrical Machines.

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1. Introduction

Conventional teaching methods are based on classical components like textbook-blackboard-lecture homework and evaluation test for student learning has received much criticism in recent years. Many studies have shown that the use of lecturing paradigm produces a passive learning atmosphere. Today there is a clear picture that engineering students learnt much better by participating and interacting, instead of by watching and listening. Traditional classroom learning is very passive with the professor lecturing and the students listening. Current teaching technique emphasized active, co-operative, problem based learning to get fundamentals in certain courses like mobile robotics, where students engaged in the course by practicing concepts learned in lecture immediately on robots; cooperative learning, where students worked on projects in teams; and problem-based learning, where all lectures and assignments brought students back to the fundamental computational problems. Active learning is said to be different type of teaching method, where the student is doing something and gain knowledge besides

listening. By using software tools like interactive web sites or interactive computer-based learning, to study theoretical concepts abstracted by means of interactive elements. Hands-on laboratory like virtual labs are also one of active learning to improve the student improvement in chemistry course. Virtual lab is an environment with predefined experiments about Chemical Transformations. Also, the gamification elements were used to increase students' motivation. The flipped class room technique is another active learning method where digital textbook to ensure student accountability for the pre-class reading assignments and teaching in a classroom that affords greater use of active learning can be adopted by other instructors. Micro flip teaching (MFT) is advanced from flipped method where the students are engaged to take part in other activities and improve the creation of learning methods. In the past years, digitalization has become a worldwide trend that transformed the way societies and economies function. We are standing at the beginning of the 4th industrial revolution powered by the internet. The social networking technology awareness to be given to students. That establish the technology's effectiveness at improving student learning; investigate implementation strategies; monitor social impact; and report on common uses to shape the direction of the field. The problem of motivating students in doing the assigned tasks is one broadly discussed, but so far no final "fit-for all" solution was found. It is doubtful whether there will ever be one single solution, but the playful approach offers some techniques to reach, engage, and motivate a wider audience of students than traditional methods. One of the case studies involving edutainment indicates that students find a game more motivating than paper exercises. In all studies as listed above, there are various learning methods to make students actively participated in class sessions regularly. In this paper, the Chapter I gives the introduction part and literature survey. Chapter II demonstrate the various gamification techniques used to engage the students activities towards certain course knowledge. Chapter III gives the case study scenario in which the comparison between 2014 & 2016 batch electrical machines course activities. Chapter IV compares the assessment pattern results outcome towards CO's mapping. Chapter V discuss the results of two batch students and graph explanation of results. Chapter VI gives the conclusion and future work to engage the students in different case studies. The chapters are denoted in roman letters.

2. Different Gaming Techniques

The gaming techniques used here to motivate the students are as follows,

- Gaming like Hangman, Monoact.
- Circuit designing/Debugging.
- Quiz
- Demonstration

Hangman

Hangman is a guessing game where one player thinks of word, sentence or phrase and the other or team tries to guess it by suggesting letters within a certain number of guesses. The word to guess is represented by a row of dashes, representing each letter of the word. If the guessing player suggests a letter which occurs in the word, the other player writes it in all its correct positions. If the suggested letter

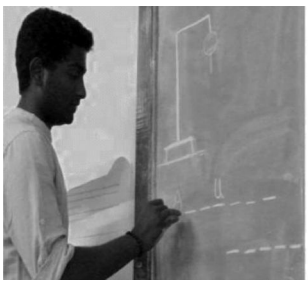

Fig.1 Hangman ALT activity
Fig.2 Monoact ALT activity

does not occur in the word, the other player draws one element of a hanged man as shown in figure 1.

The player guessing the word is correct, the game is over and the guessed student wins. Otherwise, the other player may choose to penalize the guesser by adding an element to the diagram. On the other hand, if the other player makes enough incorrect guesses to allow his opponent to complete the diagram, the game is over, this time with the guesser losing. However, the guesser can also win by guessing all the letters or numbers that appears in the word, thereby completing the word, before the diagram is completed. Similarly the students will guess the technical word and give definition for the same.

Monoact

Monoact is an acting performance where the character is given and acting person can take one character and give performance only through gestures by not opening the mouth for dialogues. The student will perform through gestures and other teammates will find the technical word and explain that word as shown in the figure 2.Through this activity the student gestures are improved and stage fear are reduced.

Circuit Design/Debugging

The circuit design/debugging is a drawing performance where the student has to draw the circuit diagram and characteristics waveform for the given statement or problems. Through this activity the student's team work made them to learn better about the circuits and cognitive skills are improved.

Quiz

A set of objective type or fill in the blank questions are asked to student related to the course. If the student answers the volunteers will ask student to justify the answer. Normally the questions are displayed in the plickers open source software. When the questions are displayed in projector, the students must discuss with, their teammates and answer in the QR code sheet given. These answers are scanned and the resultant answer is dictated to the students and give proper justification for the answer.

Demonstration (Demo)

The set of students who create a group and do the prototype related to the topic given by the faculty. During presentation students have to prepare flow diagram, chart explanation and prototype of the model have to be showcase to the faculty.

III. Case study scenario

The Electrical Machine course for Mechatronics students is selected as case study for this assessment. In this electrical machines the chapter selected for analysis is DC Machines. For comparing we selected two batch of students ie. 2014 Mechatronics batch students (58 students) and 2016 batch students (58 students). 2014 batch students are referred as Batch A and 2016 batch students are referred as Batch B. The electrical machines course outcomes (CO's) are listed below. The CO's are normally at the end of the course the students are able to,

Table 1. Course Outcome for DC Machine

CO's	Course outcome	Category
CO 1.	Write the principle and different laws for DC machines	Remember
CO 2.	Explain the Construction principle and control of different types of DC Machines.	Understand
CO 3.	Select suitable DC Machines for given situation or application.	Apply

The teaching methods are classified as traditional theory method and another is teaching along with active learning. The active learning comprises of Gaming, Circuit designing and debugging and Machines demo. At first the above mentioned chapter is taught to both batch A and batch B students. At the end, to assess this chapter as per CO's the Continuous assessment test-1 is conducted. Here as per the assessment pattern for this course is shown in table 2 where the CO1 i.e. remember category consist of 10 mark and CO2 i.e. understanding category consist of 20mark and last CO3 which is apply category has 20 mark.

Table 2. Continuous assessment marks for DC machines

Bloom's Levels	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	20	20	20	40
Apply	20	20	20	40

So out of 50 mark how students are performing to compete their Co's will be assessed as per Blooms taxonomy assessment pattern and compare the two batch students as shown in flow diagram figure 3. In this the maximum mark for satisfying the Cos are 60% of marks.

For Batch A and Batch B students, faculty taught basic principle of electrical motor and generator through black board and power point slides. Also with the help of some video's the construction and working principle of different types of DC motors (separately exited, shunt, and series) are explained for both the batches. With the help of black board the simple circuit diagrams with different starters are explained to students. At the end of covering this DC machine chapter for Batch A we give certain problems related to this chapter and certain questions like explain about different types of starter and different characteristics

of DC motors etc. as assignment and asked them to submit in particular dead line. After that we conduct Continuous assessment test -1 (CAT-1) for Batch A students.

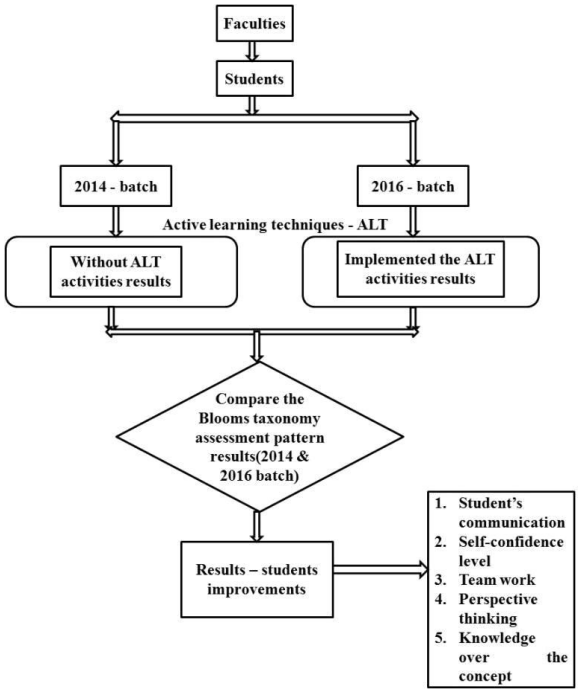

Fig.3 Flow diagram for student assessment and activities

Whereas for Batch B instead of asking the students to write the same assignment, the introduction of active learning techniques like Quiz, Circuit design, Hang man, Monoact and Demo was performed after completing the theoretical part. The schedule for the activities are given to class students as before CAT-1, two hours for Active learning session and another two hours for Demo session. For active learning session the students are separated in to three groups randomly and asked them to prepare basics in DC machine chapter.

4. Assessment Results

After completing the Active learning techniques to batch B students, here come the results of both the batches as per Blooms assessment pattern as shown in table 2. The assessment marks for two batches are listed below,

Table3. Batch A students scored marks in CO1- Remember category (Out of 10 marks)

Reg. No	Marks	Reg. No	Marks	Reg. No	Marks	Reg. No	Marks	Reg. No	Marks
14F01	10	14F13	4	14F25	8	14F37	6	14F51	4
14F02	4	14F14	6	14F26	7	14F38	7	14F52	5
14F03	4	14F15	5	14F27	5	14F40	4	14F53	4
14F04	5	14F16	4	14F28	8	14F41	10	14F54	7
14F05	4	14F17	3	14F29	3	14F42	4	14F55	6
14F06	5	14F18	6	14F30	4	14F43	7	14F56	8
14F07	6	14F19	7	14F31	4	14F44	5	14F57	5
14F08	4	14F20	6	14F32	5	14F45	3	14F58	0
14F09	2	14F21	5	14F33	2	14F46	4	14F59	4
14F10	4	14F22	0	14F34	4	14F48	6	14F60	6
14F11	6	14F23	2	14F35	6	14F49	4		
14F12	8	14F24	6	14F36	2	14F50	7		

Table 4. Batch B students scored marks in CO1- Remember category (Out of 10 marks)

Reg.No	Marks	Reg.No	Marks	Reg.No	Marks	Reg.No	Marks	Reg.No	Marks
16F001	10	16F014	10	16F026	9	16F038	10	16F050	8
16F003	10	16F015	10	16F027	8	16F039	7	16F051	8
16F004	0	16F016	7	16F028	10	16F040	6	16F052	9
16F005	8	16F017	10	16F029	9	16F041	8	16F053	6
16F006	10	16F018	7	16F030	10	16F042	9	16F054	8
16F007	6	16F019	9	16F031	5	16F043	10	16F055	9
16F008	5	16F020	8	16F032	10	16F044	9	16F056	4
16F009	8	16F021	6	16F033	10	16F045	9	16F057	5
16F010	9	16F022	10	16F034	10	16F046	7	16F058	10
16F011	10	16F023	8	16F035	10	16F047	10	15F001	2
16F012	10	16F024	7	16F036	8	16F048	7		
16F013	9	16F025	9	16F037	0	16F049	10		

Table 5. Batch A students scored marks in CO2- Understand category (out of 20 marks)

Reg.No	Marks	Reg.No	Marks	Reg.No	Marks	Reg.No	Marks
14F01	**18**	14F16	8	14F31	6	14F48	9
14F02	12	14F17	9	14F32	8	14F49	10
14F03	8	14F18	8	14F33	6	14F50	18
14F04	12	14F19	10	14F34	10	14F51	10
14F05	14	14F20	15	14F35	8	14F52	16
14F06	12	14F21	12	14F36	6	14F53	6
14F07	8	14F22	8	14F37	10	14F54	17
14F08	9	14F23	6	14F38	12	14F55	10
14F09	6	14F24	8	14F40	9	14F56	15
14F10	3	14F25	10	14F41	20	14F57	11
14F11	12	14F26	14	14F42	10	14F58	5
14F12	6	14F27	11	14F43	16	14F59	12
14F13	8	14F28	18	14F44	14	14F60	8
14F14	6	14F29	6	14F45	10		
14F15	10	14F30	10	14F46	12		

Table 6. Batch B students scored marks in CO2- Understand category (Out of 20 marks)

Reg.No	Marks	Reg.No	Marks	Reg.No	Marks	Reg.No	Marks
16F001	..	16F017	12	16F032	10	16F047	16
16F003	14	16F018	18	16F033	12	16F048	20
16F004	14	16F019	16	16F034	20	16F049	18
16F005	12	16F020	16	16F035	12	16F050	18
16F006	10	16F021	10	16F036	16	16F051	16
16F007	13	16F022	12	16F037	10	16F052	8
16F008	14	16F023	6	16F038	12	16F053	12
16F009	12	16F024	10	16F039	13	16F054	14
16F010	15	16F025	20	16F040	14	16F055	15
16F011	16	16F026	12	16F041	15	16F056	10
16F012	18	16F027	12	16F042	20	16F057	12
16F013	18	16F028	14	16F043	12	16F058	13
16F014	14	16F029	12	16F044	14	15F001	17
16F015	12	16F030	20	16F045	10		
16F016	16	16F031	14	16F046	10		

Table7. Batch A students scored marks in CO3- Apply category (Out of 20 marks)

Reg.No	Marks	Reg.No	Marks	Reg.No	Marks	Reg.No	Marks
14F01	16	14F16	10	14F31	6	14F48	12
14F02	6	14F17	12	14F32	0	14F49	0
14F03	12	14F18	14	14F33	10	14F50	6
14F04	9	14F19	18	14F34	10	14F51	10
14F05	7	14F20	11	14F35	8	14F52	10
14F06	10	14F21	15	14F36	13	14F53	17
14F07	13	14F22	8	14F37	9	14F54	12
14F08	9	14F23	4	14F38	12	14F55	16
14F09	14	14F24	14	14F40	16	14F56	13
14F10	14	14F25	9	14F41	14	14F57	14
14F11	16	14F26	4	14F42	6	14F58	0
14F12	14	14F27	12	14F43	14	14F59	10
14F13	13	14F28	14	14F44	10	14F60	13
14F14	12	14F29	0	14F45	5		
14F15	14	14F30	12	14F46	8		

Table 8: Batch B students scored marks in CO3- Apply category (Out of 20 marks)

Reg.No	Marks	Reg.No	Marks	Reg.No	Marks	Reg.No	Marks
16F001	20	16F017	10	16F032	9	16F047	6
16F003	11	16F018	13	16F033	15	16F048	20
16F004	0	16F019	16	16F034	18	16F049	10
16F005	13	16F020	12	16F035	13	16F050	16
16F006	19	16F021	8	16F036	10	16F051	19
16F007	18	16F022	14	16F037	6	16F052	2
16F008	13	16F023	14	16F038	0	16F053	19
16F009	13	16F024	12	16F039	14	16F054	12
16F010	13	16F025	0	16F040	16	16F055	15
16F011	18	16F026	10	16F041	18	16F056	17
16F012	17	16F027	20	16F042	12	16F057	15
16F013	13	16F028	16	16F043	8	16F058	10
16F014	19	16F029	18	16F044	9	15F001	10
16F015	10	16F030	14	16F045	13		
16F016	7	16F031	10	16F046	17		

The results are categorized in to different category as shown in the table 2 assessment pattern. So that it is easy to compare the results of both the batches. The comparison of results are displayed in graph for easy understanding.

5. Results and Evaluation

The results are compared between Batch A and Batch B. In that as per the mark obtained by the students in both the batches the cumulative marks are compared as per the Table

2. Through the assessment comparison the students are assessed with respect to mark scored in each CO's. From the activities like Monoact the student's self-confidents getimproved and without any stage fear they can face the crowd and do the activity through their gestures. It also improve student's cognitive thinking skills. Each activity will make the students to do the task in team which improve their team building and problem solving capability. For example in the Circuit design the students are asked to draw the speed control of DC shunt motor circuit diagram. For that in Batch B each team will represent a volunteer to draw the circuit and graph. In table 9 the linear correlation coefficient method is used to correlate the resultant mark obtained by both year students. From that study the resultant correlation coefficient for the 2014 batch

Table 9: Correlation coefficient for Mean Attendance to mean mark obtained by 2014 and 2016 batch

Year	Mean Attendance in %	Mean Total Mark in %			Correlation Coefficient
		CO1	CO2	CO3	
2014	83.23	5	10.3	10.5	-0.07
2016	90.74	8.04	13.8	12.75	0.1465

is in negative form whereas for 2016 batch is positive form. This shows the resultant correlation is linear for 2016 batch in which the attendance also impacted in the activity learning than the conventional learning class.

In this approach the linear correlation coefficient is calculated for mean attendance for bath the batch with the mean marks obtained by the students in both batch. Before the activity start the volunteer can mingle with their team mates and discuss the circuits and graphs. This make the students to understand the concept from other team member's point of view. So that the perspective thinking and team work will develop among the students to complete this activity. From the above table it is clear that the activity encourage the students to attend the classes and the attendance will directly impacted on the resultant marks.

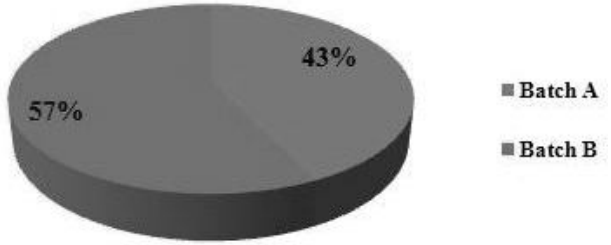

Fig. 5 CO2 comparison- Scored average marks for Batch A & B students.

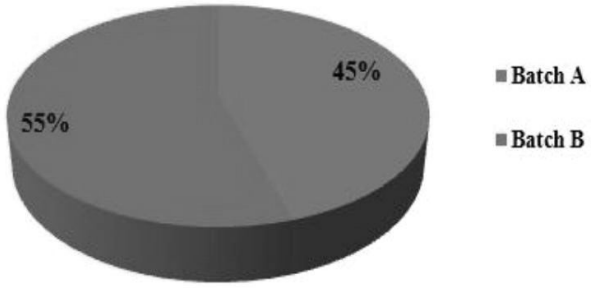

Fig. 6 CO3 comparison- Scored average marks for Batch A & B students.

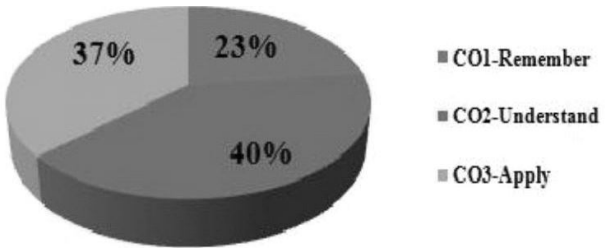

Fig. 7 Batch A students comparison for CO1, CO2, CO3.

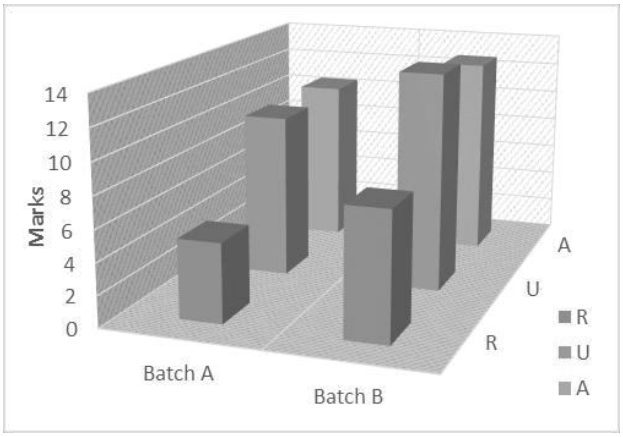

Fig. 9 Comparison of both Batches as per Bloom's Level

6. Conclusion and future work

This paper shared the experience of handling electrical machine course to students through Active learning technique. These techniques would encourage the students to gain knowledge and actively participated in class sessions. The students attendance towards the course would increase by these activities. Also the students would reduce the stage fear and improved self-confidence through the activities like monoact. Through Demo activity most of the students participated in team and developed critical thinking skills. Also by comparing Fig 7 and Fig 8, the apply category percentage improved in Batch B, it states that students in Batch B were practiced the knowledge of concept in different applications. Also the Fig 9 shows the actual comparison of both batch results as per Bloom's

Level. Overall, this paper made the students interest towards the courses through Active learning techniques. In future the implementation of new techniques, online activities and peer learning techniques will improve the students learning towards the course. Also the identification of slow learners in the class room is more important and how to make slow learners to develop their interest towards the courses by introducing advanced learning techniques.

Acknowledgement

The author would like to thank Prof. D. B. Phatak, IIT Bombay, India for conducting the workshop for the author in ICT

References

[1] R. F. Felder, and R. Brent. "Cooperative Learning, Active Learning: Models from the Analytical Sciences", in ACS Symposium Series 970, P.A. Mabrouk, ed., chapter 4, 34–53, (2007).

[2] Laurel D. Riek, "Embodied Computation: An Active-Learning Approach to Mobile Robotics Education"

[3] IEEE TRANSACTIONS ON EDUCATION, VOL. 56, NO. 1, FEBRUARY (2013).

[4] Jeffrey L. Duffany et.al "Application of Active Learning Approach to Mobile Robotics Education" IEEE TRANSACTIONS ON EDUCATION, VOL. 56, NO. 1, FEBRUARY (2013)

[5] R.M. Felder and R. Brent, "Learning by Doing." Chem. Engr. Education, 37(4), 282-283, (2003)

[6] José M. Díaz et al.,"An Interactive and Comprehensive Software Tool to Promote Active Learning in the Loop Shaping Control System Design" IEEE Access, vol.5,pp.10533 – 10546, (2017)

[7] Saulo Ramos et al.,"Hands-on and Virtual Laboratories to Undergraduate Chemistry Education: Toward a Pedagogical Integration", 2016 IEEE Frontiers in Education Conference (FIE), pp.1 – 8, (2016)

[8] Cynthia J et.al., "Work in Progress: Flipping the circuits classroom The impact of pre-class reading and in-class active learning on student and instructor",IEEE Global engineering education conference (EDUCON),(2017).

[9] Angel Fidalgo-Blanco et.al.,"Micro flip teaching – An innovative model to promote the active involvement of students"

[10] Christine Greenhow & Emilia Askari "Learning and teaching with social network sites: A decade of research in K-12 related education" Education and Information Technologies, 22, vol.2, pp.623–645 (2017).

[12] C. Ohm and M. Bürger, "Ausblicke auf Industrie 4.0 und ihr Kybertariat," Das Argument 311, vol. 1 / 2015, pp. 16-31, (2015).

[13] Shell Deutschland, Jugend 2015: 17. Shell Jugendstudie: S. Fischer Verlag, (2015).

[14] G. Sindre, L. Natvig, and M. Jahre, "Experimental validation of the learning effect for a pedagogical game on computer fundamentals," Education, IEEE Transactions on, vol. 52, pp. 10-18, (2009).

Annexure-1

The following are the questions used for assessment of both batches,

Remember category:

Understand Category:

A1	Define electromagnetic induction
A2	List the difference between DC motor and DC generator.
A3	State Faradays law and Fleming's rules.
A4	Draw the circuit diagram of DC shunt motor and denote all parameters properly.
A5	Mention the role of commutator in DC machine.

Apply category:

B1	Explain the construction and working principle of single phase transformer with neat sketch.
B2	Discuss the Magnetization & Load characteristics of DC separately exited generator with neat sketch.
B3	Derive the emf and torque equation of transformer with neat circuit diagram.
B4	Draw &explain the construction, working principle & significance of 3Point Starter.

C1	10KVA single phase transformer has 350 primary
a)	a)and 1050 secondary turns. The primary is connected to 400V, 50Hz ac supply. If the net cross sectional area of the core is 50cm2. Calculate (i)Transformation ratio (ii)Secondary voltage on no load (iii)Full load primary and secondary currents (iv)Maximum value of flux density in the core.
b)	A 250V, dc shunt motor takes a line current of 20A. Resistance of shunt field winding is 200 Ω and resistance of the armature is 0.3 Ω. Draw the circuit diagram and find the armature current and back emf.