Library Progress International
Vol.44, No.2s, Jul-Dec 2024: P. 2181-2186

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

Improving teaching-learning in engineering students using correlating standard theory exams with practicals, software game and research papers.

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How to cite this article: Abhijit Ravindra Kulkarni,S.P. Agnihotri (2024).Improving teaching-learning in engineering students using correlating standard theory exams with practicals, software game and research papers.. *Library Progress International,* 44(2s), 2181-2186

Abstract: Four innovative teaching-learning methods are implemented. First: learning by demonstration, second - solving GATE problem in laboratory, third - use of Game, fourth- use of case study. First experiment uses LM339 in place of MAX 998. In GATE problem solving, assumptions are essential with verification of numerical answer. In Fourier series game, learners come on stage, click possible answer in front of remaining learners in class and this raises confidence amongst all and team spirit is created. In case study, application of Fourier series is explored in robotics-where learner identifies properties of Fourier Transforms and sensors used with need of filters.

Keywords*: teaching-learning, problem solving, demonstration, simulation game.*

INTRODUCTION

Teaching learning process is important in context to outcomes. Outcomes are expressed in terms of knowledge, skills and outcomes. Conventional teaching process in some cases is still strong that use board and chalk. Other methods however are evolved because newer and newer techniques and pedagogies were implemented by researchers. Creativity, skills and knowledge are not available at lower price [1]. In [1] innovation in teaching learning included parameters like participants. Qualitative study, lesson observation, interviews, data analysis along with design thinking. The task of innovative teaching-learning is to provide excellent, demanding and involving students. This includes use of Virtual Reality (VR), games and simulations that brings philosophical and technical shift [2]. Teaching including activities enhancing learning for others; however it is a difficult, demanding and creative activity, still it is an alternative that satisfies all [3]. Innovation includes opportunity for creative approaches to research, curricular development, and all aspects of institutional life that supports excellence and growth, along with customized experiential learning to serve nontraditional student body-these services change communities [4]. Example of teaching-learning further includes technology enabled active learning that involved use of laptops in groups, interactive web based lectures, mix of lectures and case studies, use of mathematics with Java simulators, solving complex problems- preparing Tsunami preparedness plans, concept questions and team based design projects, field trips, building multimedia essays linked with videos [5]. Teaching engineering methods are always open for evolution in order to include the huge possibilities as technological advances arise. Remote and virtual laboratories, robotic applications, 3D virtual worlds, augmented reality developments, complex data visualizations and mobile applications are few examples of emerging technological supports for teaching methods based on problem-based learning, cases-based learning, and inquiry-based learning. All these approaches are related to a more active student-centric education in engineering subjects.

Alternatively, other trending topic that is interesting to be discussed is open education issue in engineering education, especially with regard to the MOOC (Massive Open Online Course) phenomenon. The main question is how to achieve the personalized interaction that Engineering processes require with the massive audience of MOOC approaches. Therefore, it is important to analyze the real impact of these innovative teaching approaches in engineering education just in order to be ready to spread and share these successful case studies and lessons learned from previous experiences. Specifically, this paper explores some of the above-mentioned topics in the twenty selected papers from the eighty-seven received contributions. We have grouped the main themes of the papers in the following ones. In India Graduate Aptitude Test in Engineering (GATE) exam is a crucial examination for engineering students through which students develops and tests his knowledge, problem solving skills, general aptitude. The problems in GATE exams develop analytical skills among students and teachers. The paper of this exam however is an online paper to be solved on computers and is available with answer keys [10].

As a part of first innovative teaching-learning method, we exploited GATE old exam question papers as an excellent resource. One of the problems is solved in lab by teacher and students are explored to check, verify their results in laboratory. This is an innovative learning method that is called as demonstration or learning by demonstration. Secondly, we also used an excellent resource as a game to explore Fourier series to increase interest in complex mathematical subject like Signals and Systems. This game is developed by University of Colorado. Thanks to them as it created interest among students and faculties. Third- we added an innovative method-we call it as use of alternative electronics – again it is learning by demonstration.

OBJECTIVES OF THE STUDY

1) To explore the innovative teaching-learning methods and to check impact of the method.
2) Use of demonstration with alternative methods to implement existing circuit.
3) To demonstrate how GATE exam problem is solved in laboratory and to inculcate problem solving skills in students.

Thus, three are the most important elements regarding innovation:

1. It means the creation of something new using already existing study material.
2. It is a process through which student and teacher must go.
3. It should provide some kind of quantitative and / or qualitative improvement in the outcomes.

METHODS

Sample Size & Data Collection: The present study has been undertaken to carry out to “Study on understanding impact of Effective Teaching Method with Reference to the Engineering Students”. Necessary data for the study was collected from Primary Sources. In order to collect primary data a structured questionnaire was prepared covering various aspects included in the objective of the study mentioned. The data thus collected through fully filled questionnaires have been analyzed and interpreted to arrive at the findings and giving suggestions.

In method 1 (learning by demonstration): demonstration of use of alternative methods to implement existing circuit, IC LM339 is used which is a very low cost IC in place of MAX998. Learner has to refer datasheet to implement this circuit. In [9], a circuit to generate Pulse Width Modulated (PWM) signal is elaborated. When this experiment is implemented, students also have to adjust control voltage and analyze effect of control voltage on output pulse. Figure 1 shows both the circuit diagrams and figure 2 shows actual demonstration in lab. In method 2: Solving a GATE problem in Laboratory, learner explores problem solving, evaluation skills, through experiential learning. In method 3: use of simulation games (credit to [16]), students gets interested to come on the stage in the class and choose specific keys of computer so that correct answer appears on the screen; they get a motivation of small prize like chocolates in front of all students; they feel very happy. In method 4: Uses of case study, sample learning

goals are mentioned in [12]-[16], where students explore self-confidence and evaluation skills. In method 4: a research publication [7] is explored in which student explores variety of parameters and comes to know how fundamental knowledge is applied in research. Table I shows methods, its relationship with outcomes explored and justification of outcome explored. Table II shows results of four methods explored. It involves number of students present in the experiment during that method, number of students responded to Google online and offline feedback (many of the students did not submit online feedback; so an offline feedback is take for one of the method here- that also shows an important aspect of learning outcomes-attitude of learners). Table III shows all details of two feedbacks those support results.

Table 1: Method-Outcomes-Justification table

Learning method used	Outcomes explored by learner	Justification of outcome explored
Method 1	Analyzing and problem solving	Identification of datasheet, deciding effect of control voltage on PWM signal, single supply IC
Method 2	Analyzing, evaluating skills	Selecting IC, testing, problem solving
Method 3	Problem solving, analyzing, visual skills	Stage daring and excellent visualization skills explored
Method 4	Analyzing skills	Learner identifies application area, properties used, constraints, software used by researchers, number of samples used in FFT (Fast Fourier Transform) block

Table 2: Results of applying four different methods

Method used for teaching-learning	No. of students involved	No. of students feedback	Average Impact on scale-3*	No. of questions asked
Method 1	19	19	2.98	07
Method 2	28	09	2.80	05
Method 3	30	28	3.0	04
Method 4	12	12	2.18	04
Total	89	70	NA	26

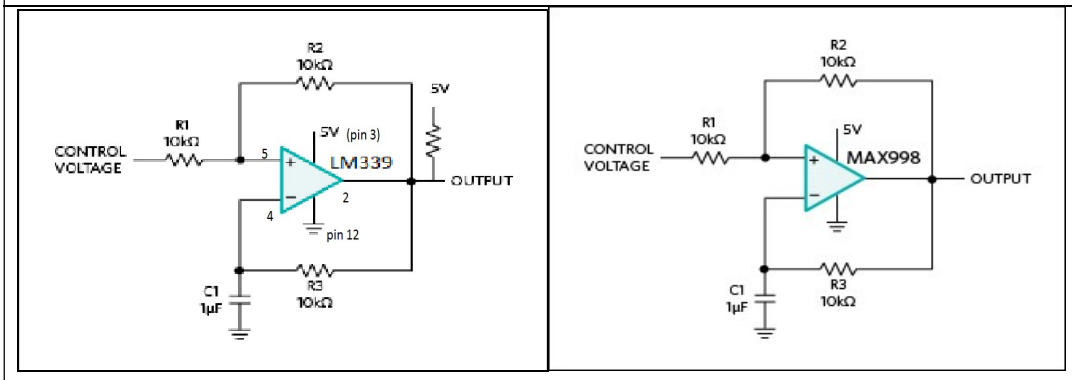
Scale-1: Poor
Scale-2: Good
***Scale-3: Excellent**

Table 3: Details of two feedbacks are generated here to support results

Name of Method:	Learning By Demonstration

Learning Objective:

1. To demonstrate the use of alternative methods to implement existing circuit.



(Figure 1: On left is altered low cost circuit, on right is original circuit)

Impact of Method: Students see how existing circuit can be alternatively implemented; and how to use resources in optimum way.

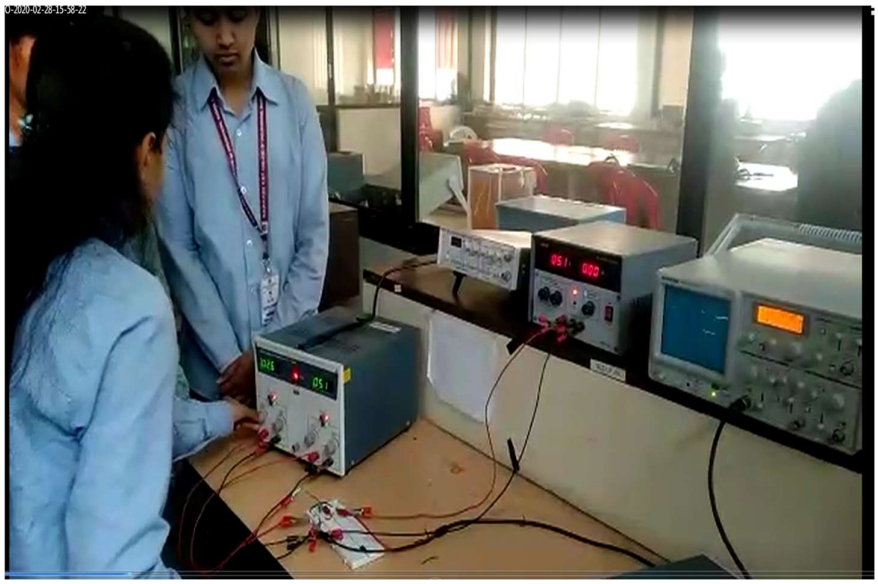


Figure 1: Pulse Generator experiment in laboratory

Figure 2: Outcomes: On completion students were able to Understand how theory problem is implemented in practice and how to check the output the problem.

IMPACT OF INNOVATIVE METHOD: Students' problem solving skills are increased and learning by demonstration help them to identify how components are selected in actual circuit from theoretical values; and how to use resources in optimum way.

DISCUSSIONS

1) Difficult to test parameters like ethics is also explored in the feedback from students. In the feedback forms a question reminds students to mention their physical presence during the experiment.
2) Number of students in a group is kept low: three students per group.
3) Still ethical practice is a challenge to check in case of use of simulation game.
4) To move from specific to generalization, students face difficulty- example: to find phenomenon those follow a similar structure like a specific solved in lab. Here is research perspective coming to existence.
5) Topic like Fourier series at Second Year Engineering level is difficult for students as exam pattern asks them to remember and solve. Also there are seldom examples of research literature on Fourier series applications in engineering area. See [6] and [7] for further references.
6) For use of animations readers are encouraged to visit [8].
7) Learners are recommended to visit [11] to download latest and old GATE question papers.
8) It is a cumbersome process to get filled feedback forms from learners.

CONCULSIONS

- Use of alternate methods to develop and test electronic circuits can be easily implemented in laboratory at low costs and using simple components; this increases problem solving skills and analytical skills of learners-which are essential part of experiential learning.
- Implementation of all India level GATE examination problems-solving in laboratory can not only develop analytical and problem solving skills in laboratory but also may open new area of research- as a specific answer of a problem can motivate learner to find such generalization.
- Learners can make use of published literature even at second year of engineering and can thus make themselves better.
- Learners can make use of existing resources available on web and utilize those. Further a similar applications can be developed; however learners must be encouraged to do so along with skilled resources.

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