Games as a Pedagogy for Teaching & Reinforcing Engineering Concepts to Learners

B. Hema Kumar, R. Sundaramurthy

Abstract*: Engineering learners often find traditional classrooms lectures more difficult to assimilate contents. Studies suggest that it will be difficult for learners to concentrate in class more than 15 minutes. Hence different pedagogy approaches may be required to make learners' active participation inside class. Usage of games to actively engage learners is one of the excellent pedagogical approach. Incorporating games can help learners with an active environment in order to promoting learning by doing. Our proposed work is mainly focused on the modified implementation of casual & tailor-made games to teach and make undergraduate engineering learners' participation active & stimulating in classrooms. Games were exclusively designed to suit the needs of the subject topic. Our work on the implementation of modified games in undergraduate engineering classrooms has proved that, learners actively participate in classroom sessions. This was validated by using T test and P test results and the repeatability was ensured by conducting the pedagogy for three consecutive years 2016 to 2019

Keywords: games, pedagogy, active learning, engineering.

I. INTRODUCTION

The industry readiness and employability of Indian engineers remains still a big question mark for various government and industry agencies. A News report in December 2018 by the Times of India, mentioned that only 40% of engineers are employed. The main reason for this situation has been identified as poor quality of engineering education. Hence there is an immediate need to transform the education methodology, is the need of the hour [6].

The most common methods of teaching in most of the colleges is done by delivering Lectures. Today, the core objective of the engineering education has to be in developing learners by making them having skills in problem solving, analysis, design skills and also to enhance creativity [6], [7]. The development of these traits requires a transformation from conventional lecture based to active engaging of learners.

Using games as a pedagogical method in the classroom provides an exciting proposition for facilitators who are interested in developing student centric education. This approach specifically removes the role of teachers acting as mere knowledge transferring agents into facilitators [2]. Game play provides a fun and engaging pedagogy approach for educators to incorporate into teaching core engineering subjects [3]. Hence, we propose usage of games for active engaging of Learners. We have designed games, exclusively suiting the needs of the subject.

II. METHODS

The work was conducted through a study with Fourth year Undergraduate Engineering learners. The subject taken for study was Analytical Instrumentation. This subject has abstract topics and quite challenging for the teachers to make learners listen. Total number of students taken for the study was 66. The class room was divided into two sets CL & CLG with 33 students in each

A. Design of Spectroscopic Statue Game

a. Statue Game

Generally, Kids love to dance like crazy for music. To play the statue game it is required to have the children spread out in a room. A music will be played and the children are allowed to dance. Once the music stops the children needs to freeze in whatever position they are in. The first person to move will be taken as loser. Then music is again restarted and repeated until one person is left as the winner.

b. Design of Spectroscopic Statue game

A very popular topic in the subject Analytical Instrumentation is Spectroscopy. The fundamental block diagram of a spectrum measuring instrument (commonly called as spectrometer) is shown in Fig. 1.

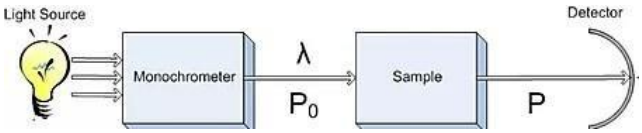

Fig. 1. Block Diagram of a spectrometer

Learners have to play the role of Light source, Monochromator and Detector by using different actions in any informal manner. This will be done continuously until the facilitator issues a stop signal. Once the stop signal is issued the students need to freeze in whatever position they are. We found that Learners actively participated in these games. Fig. 2 shows a snapshot of Spectroscopic Statue during class activity.

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B. Design of Pocket Spectrometer

a. Pocket Kaleidoscope

Kaleidoscope is a toy for toddlers. It contains a tube with mirrors and pieces of colored glass or paper. The reflections in the mirrors produce changing patterns when the tube is rotated

Fig. 2. Spectroscopic Statue

b. Pocket Spectrometer

Similar to a pocket Kaleidoscope, learners are instructed to construct their personal pocket Spectrometer. This can be used by them to view the spectrum of common light sources like incandescent lamp, mercury lamp, Candle light, Neon Lights etc. The spectrum of a light is the whole variety of colors which are emitted from that light source.

For this activity learners will be using cardboards to make the body of spectrometer; CD's with top surface removed acting as Lenses and small closed spaced blades acting as eye piece.

The music on compact disks are recorded by digital means. Circular tracks of binary digits are recorded on the mirror surface of the compact disk. Since the circular tracks are close together, they act as a grating for diffraction of the light. Since each color bends at a particular angle, it gives a beautiful spectrum which can be recorded using a Mobile camera placed at the eyepiece. Fig. 3 shows the snapshot of pocket spectrometer constructed by the learners in the Batch of 2017.

Fig 3. Pocket Spectrometer

Similar games were designed for subject topics. These games were exclusively designed based on subject topics. Few children games and Icebreakers were modified to suit the purpose

III. VALIDATION

To test the efficacy of the proposed solution the classroom of 66 Learners were separated into two groups. The first grouped was named as CL. For the CL group of Learners, the concept was explained by conventional class room methodology. The second group was named as CLG. For the CLG group of Learners, in addition to conventional lecturing, they were part of a game activity. The same concept was explained to both the groups CL & CLG. Finally, a test for 20 marks was conducted for both groups. The test scores of two groups CL & CLG are shown in Fig. 4 & Fig. 5 respectively.

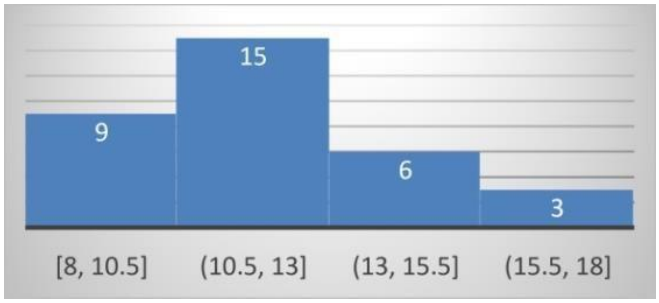

Fig. 4. Test Scores by group CL

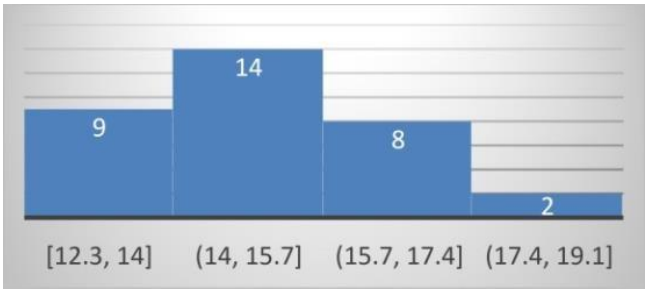

Fig. 5. Test Scores by group CLG

Further statistical parameters were obtained to validate the effectiveness of the proposed study. Table 1 shows the different Mean, standard deviation for the two groups based on the test scores

Table- I. Comparison of test scores

	CL TEST SCORES	CLG TEST SCORES
POPULATION	33	33
MEAN	11.86666667	14.97576
STANDARD DEVIATION	2.299003407	1.532365
VARIANCE	5.285416667	2.348144

From Table 1, it is evident that average mean of the marks is increased in CLG as 14.9 compared to the group CL which has 11.86. This positive shift in average mean was a clear indication of the usefulness of the proposed study. Furthermore, a T test and P test was conducted for the sample data with the Null Hypothesis as "No significant statistical difference between the two groups CL & CLG".

The results are tabulated in Table 2.

Table- II P & T test results

Parameters	Group CL	Group CLG
Mean	11.86666667	14.97575758
Variance	5.285416667	2.348143939
t Stat	6.464379016	
P(T<=t) two-tail	2.69058E-08	
t Critical two-tail	2.003240719	

Table 2 clearly indicates the p-value lesser than 0.5. Hence the method adopted for the group CLG was more effective compared to group CL. To ensure the repeatability of the proposed method the teaching pedagogy was repeated three consecutive years from 2016 to 2019. The results of the same are graphically displayed in Fig. 6

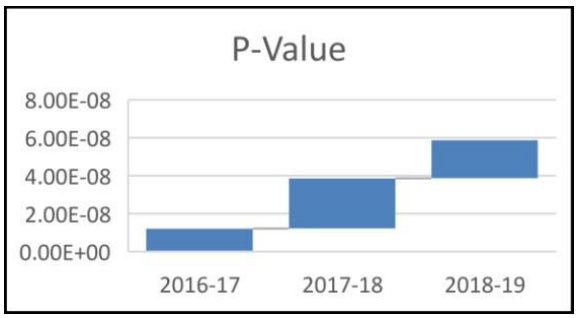

Fig. 6. P values from 2016 to 2019

Fig. 6 provides a clear indication of the efficacy of the proposed pedagogy of using games along with conventional learning for teaching engineering subjects

IV. CONCLUSION

Our proposal on the implementation of games in undergraduate engineering classrooms has shown that, the average performance based on test scores were improved by 27%. Furthermore, learners actively participate in classroom sessions.

We also prepared a special questionnaire to orally interview the Learners about their experiences about usage of games. The most common response from the learners was they felt extremely excited and classroom was totally fun.

These types of games not only increase the interest of learners but also makes them orient back to subject after 15-minute duration. This was validated by using T test and P test results and the repeatability was ensured by conducting the pedagogy for three consecutive years.

Even though Game-based integration strategies changes depending on the facilitator's philosophy of teaching, the unique skills of the learners involved, the needs of the instructional program, and available resources, in spite of these factors the learners enjoyed a lot.

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