Application of STAD in Engineering Pedagogy

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Abstract: Student Team Achievement Division (STAD) is a cooperative and active learning methodology in which small groups of student learners with various levels of ability work together to accomplish a shared learning goal. STAD type of cooperative learning was originally developed by Slavin and his colleagues at the University of John Hopskin United States. STAD is one of the elementary and widely used methodologies of cooperative learning, especially for students who are new to cooperative learning. This paper presents a case study on STAD applied to an undergraduate course named Finite Element Methods (FEM) in the Mechanical Engineering program at Vidya Jyothi Institute of Technology (VJIT) permanently affiliated to Jawaharlal Nehru Technological University Hyderabad (JNTUH), India. It also includes the quantitative comparison of results and feedback of students with the STAD.

IndexTerms - **STAD, Cooperative learning and Finite Element Methods (FEM)**

I. INTRODUCTION

21st century learning is all about student centric learning which includes social collaborative learning, flipped learning, blended learning and personalised learning. Time has come to think about what employers want and what will we do as educators? In the learning evolution, these are the days of collaborative learning. 21stcentury learning is also about use of technology to harness information around us. In the current work, collaboration (STAD) and use of technology (laptop with internet) is experimented to teach course on FEM [1]. It has been observed that students face lot of difficulty to understand and pass FEM course. Previously lecture method (LM) i.e. chalk and talk was used as methodology of teaching. LM is effective in making a large number of students understand the lesson within the limited time [11]. But unfortunately, it is almost impossible for a teacher handling a large class to check student's ability to solve given problems. Students cannot develop their problem solving skills as they should and tend to become passive learners. STAD is planned as a pilot project for FEM course in undergraduate program of Mechanical Engineering (MECH), at Vidya Jyothi Institute of Technology, Hyderabad. Encouraged by the success of this try-out, the authors want to implement the same for other courses [4]. This paper describes about implementation of FEM course with STAD, delivery of course and the comparison of the feedback and pedagogies given by students in support of STAD [2]. Collaborative activity STAD is selected among many types of activities as the authors felt STAD best suits for courses comprising mathematical problem solving.

II. METHODOLOGY

II.I. Formation of streams

In order to compare the pedagogies, out of two sections (A, B) of mechanical third year second semester students, STAD was implemented for section A (59 students) and conventional approach lecture method (LM) for section B (60 students). LM is defined as the pedagogy where the teacher dominates the class, orally demonstrates the lesson while students listen and take note passively. At the end of lecture, there will be an opportunity for students to ask a question [7]. The teacher gives lecture in lecture classes, gets some problems solved in the class and asks students to solve some problems in FEM as assignments. Time is given to complete these assignments and they are graded. The students in STAD stream were initially asked to form groups including four to five students of their choice. Set-up was provided to facilitate interaction and discussion among groups. Students were asked to use resources (laptop and internet) to solve assignments collaboratively and share ideas with group and comprehending the answers with other groups. Tutorial classes were used to conduct this activity.

II.II. Teaching Pedagogy

(a) The teaching pedagogy for the conventional section continued to be "traditional" using lectures, followed by tutorials and assignments. The teacher prepares hour wise lecture plan and lab plan. Lecture wise and lab wise schedule for delivery of entire syllabus, right from knowledge level to the application level is prepared by the teacher [3]. Course is delivered in agreement to the same. The syllabi delivery in lecture classes is teacher centric. However, students will not be allowed to work in groups, practice new problems and discuss the issues in the class. Assignment given for a particular topic is always after the concept is delivered and understood by students in the lecture classes. From the current experience it was observed that, most of the assignments were

copied from other students. When they copy, no learning takes place giving no scope of self-learning for student. It's a passive way of learning.

(b) For the STAD section, after completing each unit of the course, STAD activity is conducted on the assignment part of the course. Total of eight, 3 hour STAD-sessions were conducted. By this, students developed an understanding and also found the solution to the problems while traversing the concepts. In this cooperative learning method, students in each group of STAD stream had the group goals that they were to attain by assisting other members in their respective teams [5] [6]. This helped to build a team spirit and also instinctively promoted student-student interactions. The achievements of the team depend up on every member in the team [7]. This individual accountability affected the success of the team. Cooperation within the teams and positive competition with other groups in the class was encouraged. High and low score students in groups had the same opportunity to contribute to the team and this helps them gain better skills [3] [8].

Feedback was taken from both the streams students on 6 parameters:
- Satisfaction level with the tutor.
- Average time of the tutorial used effectively.
- Confidence to perform external exam.
- Did you copy the assignment from your classmates?
- Did you enjoy attending the classes?
- Do you recommend methodology to your juniors?

III. RESULTS AND DISCUSSIONS

Table 1: Performance analysis in assignments

S.no	Course Units	Average of assignment marks (5)	
		STAD stream	Conventional stream
1	I	3.8	4.0
2	II	4.0	3.9
3	III	4.1	4.0
4	IV	4.1	4.0
5	V	4.2	3.9
6	VI	4.3	4.1
7	VII	4.2	4.0
8	VIII	4.6	4.2

Unit wise assignments for eight units were given and graded for conventional stream and they were compared with the performance of STAD stream activity on assignments. As indicated in Table 1, there is no considerable difference in average assignment marks. STAD stream students got less average assignment marks than conventional stream students in first assignment for the reason that STAD was implemented for the first time to them. Once they got used to this activity, average assignments marks considerably increased. Importantly there is no evidence that assignment given to conventional stream students were done with their own ability. As performance of assignment is compared with previous assignments, students are motivated to do better in STAD stream.

Table 2: Performance analysis in midterm exams

S.no	Midterm exams	Average of midterm exam marks (20)	
		STAD stream	Conventional stream
1	I	16.5	13.2
2	II	16.8	14.5

Table 2, indicates that there is considerable difference in the average midterm examination marks. This clearly portrays that students of STAD stream students overpowered conventional stream students. The findings of this study are consistent with the findings of previous research [4, 5, 6] which indicate that STAD learning results in higher academic achievements.

Table 3: Questionnaire and student response

S.no	On scale of 1 to 10 (1 for most negative and 10 for most positive Response)	Response: STAD (MEAN)	Response: Conventional (MEAN)
1	Satisfaction level with the tutor	7.9	7.1
2	Average time of the tutorial used effectively	8.2	7.2
3	Confident of performing in external exam	6.8	7.0
4	Did you copy the assignment from your classmates?	4.8	7.4
5	Did you enjoy attending the classes?	9.1	6.5
6	Do you recommend methodology to your juniors?	9.3	6.9

Table 3 indicates a remarkable difference in response to the feedback questionnaire. It indicates copying of assignments was controlled by STAD activity. Students enjoyed the activity and recommended STAD activity to their juniors [9].

Table 4: The sample statistics

Mean	STAD group	Conventional group
Standard deviation	$\sigma_1 = 1.528$	$\sigma_2 = 0.162$

The mean and standard deviation for these two groups are computed and mentioned in Table 4. The difference between these two means is taken up with a null hypothesis that both the populations are having the same mean [10]. It is undertaken under large sample category as the size of each section is 60. The standard normal variate for the test is computed by [11];

$$z = \frac{\overline{x_1} - \overline{x_2}}{standard\ error\ of\ (\overline{x_1} - \overline{x_2})}$$

The value of z is 3.33 and hence it can be concluded that at 5% significance level, the null hypothesis is rejected. It means the STAD has helped a lot in improving the activity undertaken.

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IV. CONCLUSIONS

- STAD with Technology for the above said course in under graduate Mechanical Engineering program was successfully implemented.
- Analysis of the results conducted on the students by way of midterm exam showed that the STAD students scored much better.
- The learning skills acquired by the students of STAD group were more than those acquired by the students in conventional stream, as it is clear from the result of the assignments conducted at the end of the unit.
- Students enjoyed the active learning method and this seems to be a good opportunity for the teacher to encourage students to become independent learners. Students then develop themselves to be life-long learners; the scale definitely tilts towards STAD.
- It can be concluded that STAD can be used on larger basis.
- Of course limitation of time is observed and the teacher needs to take time management into considerations for engaging students in learning activities. However, prior to deciding to change over from the conventional methodology to STAD, more issues like faculty training in handling STAD classes, and strategy to form groups within STAD needs to be looked in.

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