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Effectiveness of Jigsaw Strategy on Students Achievement in Engineering Education

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Abstract— **Outcome-Based Education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). OBE is playing a great role in engineering education, the world over and in traditional educational settings as well as in continuing education. It is a student-centric teaching and learning process in which it deals with the planning, course delivery, and students' assessment to achieve stated outcomes. A number of classroom assessment techniques (CAT) or active learning tools like think-pair-share, flipped classroom, problem based learning (PBL), and cooperative learning techniques such as jigsaw are used for achieving effective learning of the students. The jigsaw technique is one of the active learning techniques which has proved to be an effective method for classroom teaching and hence it is widely used for teaching engineering courses. The present paper focuses on the use of 'jigsaw technique' for teaching the course 'Biology for Engineers', a core course of B. Tech. program, to study students' performance in the End Semester Examination. The course content is difficult to get understood by the engineering students. Therefore, some difficult concept from this course is taught by using jigsaw technique. The students were divided into 8 groups with 8 students in each group. All the groups were assigned a topic with eight different subtopics for study and the jigsaw technique was implemented. The results of study indicated that the use of jigsaw technique improves students' performance by 15% and helps them in developing their lifelong learning skills.**

***Keywords*—** Cooperative Learning; Experiential Learning; Graduate Attribute; Jigsaw; Outcome Base Education; Student Performance.

***JEET Category*—Research**

I. INTRODUCTION

The Outcome-based education (OBE) is education in which an importance is placed on a clearly articulated idea of what students are expected to know and be able to do, that is, what skills and knowledge they need to have, when they leave the college system. The OBE empowers students to choose what they would like to study and how they would like to study it. Not only does it adapt to a learner's strengths and weaknesses, but it also provides sufficient time to attain proficiency and fluency in the subject matter in Civil Engineering program. OBE aims to assess the capabilities of learners in their totality. It takes a holistic approach in describing the capability of a learner in terms of knowledge, skills and values, and assessing capability by using a variety of assessment approaches. OBE is a pedagogical model that involves the restructuring of curriculum, pedagogy and assessment practices to reflect the achievement of high-order learning, as opposed to a mere accumulation of course credits. OBE means clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experience.

Nowadays, OBE and Graduate Attributes (GA) as prescribed by National Board of Accreditation (NBA) plays important role in engineering education in India. Collaborative learning is the educational approach of using groups to enhance learning through working together. Groups of two or more learners work together to solve problems, complete tasks, or learn new concepts. For attainment of GA engineering faculty must use collaborative and cooperative learning tools like jigsaw, flipped classroom, gallery walk technique, problem based learning and project based learning.

In present research paper jigsaw technique was used for Biology for Engineers course which is offered in 6^{th} semester of Under Graduate (B. Tech.) program. The course outcome for Biology for Engineers is as given below:

CO 1: Apply biological engineer's principles, procedure needed to solve real world problem.
CO 2: Demonstrate the functions of biological systems
CO 3: Analyze biological phenomena with math and physics to gain important insight.
CO 4: Explain working of different biological instruments
CO 5: Select the sensors for given biological applications
CO 6: Explain relevant aspects of movement control process

This course deals with Circulatory system; Respiratory and Cardiovascular system, Gastrointestinal system; Kidney and excretory system which plays very important role in human body. The content of human body system was taught by using jigsaw technique. After implementation of jigsaw technique

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benefits as well as few challenges were discussed in current research paper.

II. METHODOLOGY

For effective implementation of jigsaw activity following methodology is adopted. The details of methodology are discussed in following section:

A. Training of students:

Before implementation of the activity, the training of students was conducted. In students training, theoretical concepts about Jigsaw technique was discussed with students. At the time of training, the concept of home group and expert group, rules for making group and benefits of jigsaw technique were also discussed in detail. The details of jigsaw technique are as given below:

The Jigsaw technique asks a group of students to become "experts" on a specific text or body of knowledge and then share that material with another group of students. This strategy offers a way to help students understand and retain information while they develop their collaboration skills. It is a cooperative learning strategy that enables each student to become an expert on a certain topic, through communication and discussion with others reading the same text, researching the same topic or unit, and then share their findings to their original "home" group. According to Johnson and Johnson (2000), there are also some disadvantages of using the jigsaw method and are given below:

1) The technique requires some time to prepare students to learn how to work in groups,
2) Additional time is also required while implementing the technique as heterogeneous groups are required to be formed.
3) The teacher has to take special efforts for successful implementation of this technique.

The implementation of the jigsaw technique was done by following the concept of the technique as illustrated in Fig. 1.

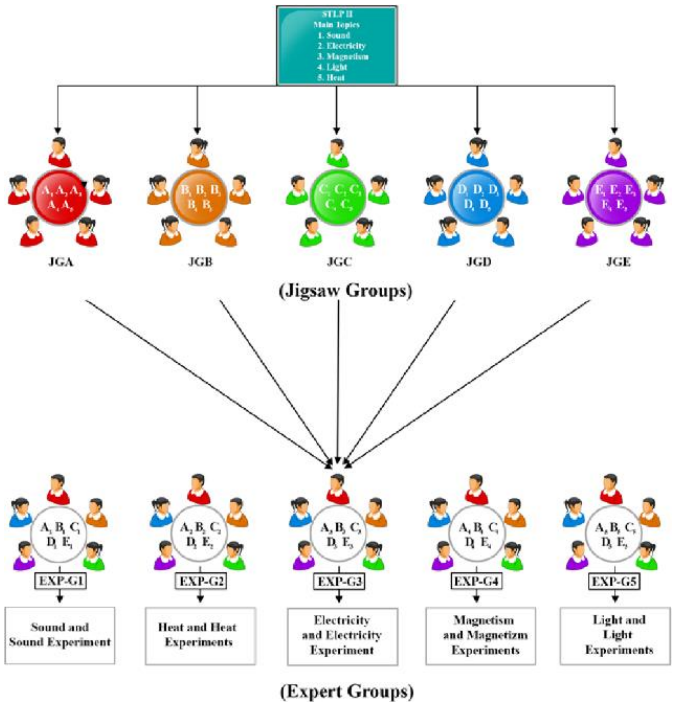

Fig. 1 Concept of jigsaw technique

B. Preparation of course teacher:

As a course teacher of biology for engineer course. We have circulated contents of every system with students from TY Civil Engineering class. We have divided whole class in nine different groups. Every group allotted one leader and 06 student members with different learning style. All students are instructed to prepare poster for every human body system. For preparation of poster following points needs to be addressed during poster presentation activity.

1. Importance of respiratory/cardiovascular/ Gastrointestinal system; Kidney and excretory system
2. Prepare Sketch showing all components of body system
3. Working of each system
4. Tips for maintaining system in good condition.
5. Relevance of each system

For preparation of poster one-week time is given to student. All students from TY class instructed to present their concept in next week in from of all class.

C. Actual implementation of jigsaw technique:

One week before class we have requested all students to read information of circulatory system Respiratory and Cardiovascular system, Gastrointestinal system; Kidney and excretory system from Biology for Engineer book or refer e-content from internet. We also request all students to bring A4 size sheet and sketch pen box for preparation of poster related to assigned topic. As a course teacher we have divided all class in nine groups which consist excellent student, medium level student and weak student (heterogeneous group).

For first we instructed each group member to collect information of their points from Book of Biology for Engineer course and internet. For this activity we were allotted 25 minutes' time slot. After 25 minutes we made group of expert team. We requested all members to share their information of their point with each other. At the same time, they can take notes of their point. After this activity we requested all group member to join their home group and prepare report of this activity and upload on RIT Moodle. During jig-saw to support student, we called one senior student from other class. We also requested senior student to evaluate all reports and poster prepared according to rubrics prepared by me.

The rubrics used for assessment is as given below

1. Content of presentation
2. Presentation skill and coordination during Presentation
3. All presentation is evaluated by senior student and me.

The sample poster prepared by TY Civil Engineering student is presented in **Fig. 2.**

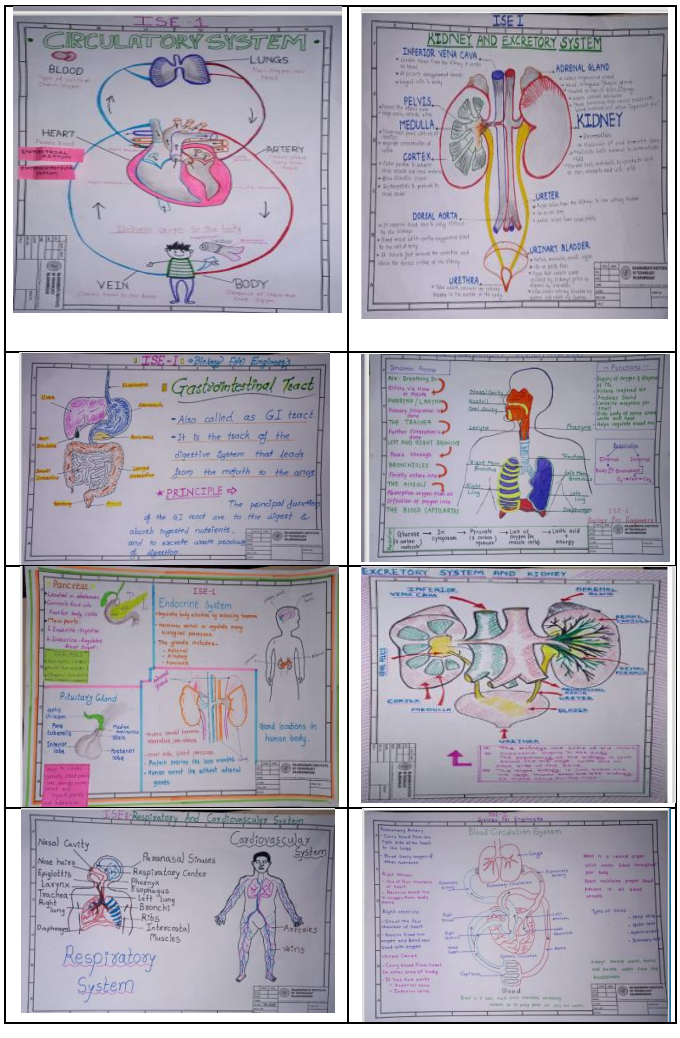

Fig. 2 Student presentation for Jigsaw activity

For jigsaw activity we have conducted presentation of student groups also. The details of student presentation are given in **Fig.3**

Fig.3 Student group presentation for jigsaw activity

D.Declaration of winners of competition:

By using designed rubric, the rubric for assessment of presentation is as given in Table 1

Table 1: Rubrics for Assessment

Sr.	Criteria of assessment	Marks
1	Content of presentation	10 marks
2	Presentation of group members	10 marks
3	Question Answer session	10 marks

We evaluated all presentation and declared three winner's groups from TY Civil class which score higher marks. The details of winner are given in Table 2

Table 2: Details of winners in activity

Rank	Topic	Group members
First	Kidney and excretory system	Shreya and team (28)
Second	Endocrine System	Chetak and team (27)
Third	Circulatory system	Neha and team(26)

At last we congratulate all student for their performance. We also proposed vote of thanks to all who directly or indirectly involved during presentation. In this way we have implemented jig-saw activity for biology for engineer course.

E.Question/Answer session:

After successful completion of this activity we also conducted quiz using an ICT tool viz. 'Slido'. In Slido, we have designed 15 questions based on the topics considered for the jigsaw technique. In this way we implemented Jigsaw technique for the delivery of the course 'Biology for Engineers'.

F. Challenges during Jigsaw Activity:

As a course teacher we have few challenges as given below:

1. Slow learner student was not participated during presentation/quiz effectively.
2. During presentation some student from group were not comfortable.
3. During poster preparation some student who were weak in drawing was not participated.

As a course teacher we have implemented following activity for 100 % participation of student.

1. We were conducted counselling session for slow learner student. This will develop confidence in slow learner student
2. We have also conducted happy hours (extra office hours) after college hours by using MS team online app for motivation and participation of all student in jigsaw activity.

III. RESULTS AND DISCUSSIONS:

The effective implementation of Jigsaw activity for Biology for engineer course in 6th semester of B. Tech. Civil Engineering program. The CO attainment and % CO attainment is as shown in Fig.4.

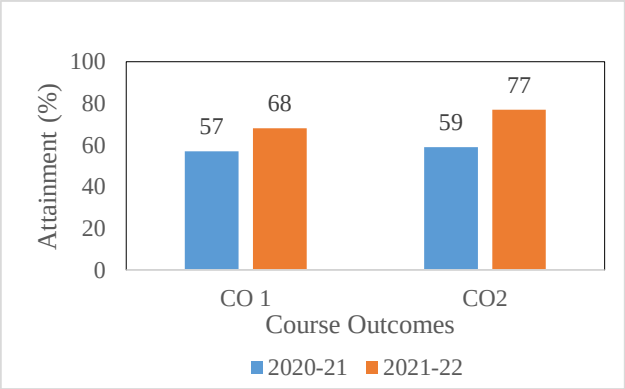

Fig. 4 CO attainment (%)

The CO 1 attainment for AY 2021-22 is improved by 11% and CO 2 attainment for AY 2021-22 also improved by 18%. The overall CO 1 and CO 2 attainment is improved due to jigsaw as a collaborative and cooperative activity. This activity is also improved presentation skill and lifelong learning skills in engineering students. The ICT tool like slido develop student ability for GATE like competitive examination. The effective implementation of jigsaw activity is also need coaching and mentoring of slow learning student.

Conclusions:

1. The use of Jigsaw technique helped in improving the students' performance by 15% in the End Semester Examination when compared with the students' performance in the last year for the same course that was taught without the use of jigsaw technique.
2. The use of Jigsaw technique could boost the students' confidence as it is a cooperative and collaborative learning.
3. The implementation of Jigsaw technique helped low performing students to score good grades in the course.

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