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Implementation of Project Based Learning and Think-Group-Share for Enhancing Student's Active Learning in Engineering Chemistry

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***Abstract*—The current trend of utilizing various methods to enhance learning allows teachers to think about the effectiveness of different tools that boost learning. This research focuses on understanding the implementation of Project Based Learning (PjBL) and Think-Group Share (TGS) to enhance student learning in the Engineering Chemistry course. The study revealed increased effectiveness of learning, active participation and better understanding of concepts in Engineering Chemistry. Some examples of the PjBL and TGS activities for Engineering Chemistry are explained in this article. An appropriate assessment of the proposed techniques is made, along with an assessment of their effectiveness from the perspective of acquiring new skills and gaining experience in teamwork.**

***Keywords*- Project Based Learning, Think-Group-Share, Engineering Chemistry, Substantial learning, Active learning tools.**

I. INTRODUCTION

In the 21st century, the world has become borderless, globalized, and technologically advanced. Developing technologies and distributing information rapidly will result in the expansion of knowledge that affects the economy, culture, and politics of a country. As a result, the education system is being implemented differently (Turiman, 2012).

Numerous approaches have been used by many experts to develop a learning attitude in many folds (Waite, 2011). These approachesare a set of considerations which deal with teaching learning activities (Sumarsono, 2014). It serves as the fundamental framework for developing strategies and methods. Approach therefore plays a significant role in instruction.

Cooperative learning is one of the educational strategies that teachers use to boost student's performance. Compared to just lectures, students learn more thoroughly through it, and their retention rates are also higher (Bidabadi. 2016). Cooperative learning, a form of strategy that allows team members with different levels of competence to each enhance their understanding of a subject, can always be done in a group session (Le, 2018).

Students can work in pairs, small groups, or a combination of both during cooperative learning to provide each other with prompt feedback, encouragement, and reinforcement. Every group member has the capacity to comprehend what is being taught and to support partners in learning, which promotes a sense of success. The cooperative learning models developed by Lyman (1985) and his colleagues at the University of Maryland were created to accomplish at least three significant instructional objectives: scholastic accomplishment, tolerance and acknowledgment of decent variety, and social skill improvement.

Albeit helpful learning incorporates an assortment of social objectives, it also goes for improving student execution on significant scholarly tasks (Arends, 2009). Among a number of cooperative learning strategies, TGS and PjBL can be applied in the classroom to improve student's understanding in particular subject (Hetika, 2017; Raba, 2017; Ellzey, 2019).

The TGS is a simple addressing system that keeps all students involved in class conversation and offers each student a chance to reflect by allowing them to think about their response and discuss about it with group members before they are asked to react. This makes it a convincing justification for using TGS to structure students' thinking and learning (Rocca, 2010). Another benefit of TGS is that members from other groups are allowed to add their inputs to the conclusion in order to make it a final and amicable result.

PjBL is a student-centered pedagogy that combines a dynamic practical approach for previously acquired theoretical or experimental concepts with hands-on experience to help students for better understanding of the subject matter (Tsybulsky, 2019). The project-based learning approach aims to inspire students to create, develop their problem-solving skills, enhance their management and communication abilities, motivate them to conduct independent research, raise their awareness of the significance of the integration concept, and enable them to integrate various principles and skills (Blumenfield, 1991).

The current study focuses on the effects of TGS and PjBL, two active learning techniques putting these tools into practice for first-year engineering students studying Engineering Chemistry. The article includes an examination of TGS and PjBL, as well as its approach, methods, and purposes. Further analysis of the activities was done using data such as student involvement, the outcome of that specific activity, and the evaluation of learning objectives utilizing rubrics.

II. PURPOSE OF THE ACTIVITIES

TGS employs intervals during lectures to give students time to reflect on complex topics. It is meant to encourage students to express and discuss ideas regarding a certain topic, issue, or problem. All of this creates a stable environment for students to collaborate and work openly with their peers and teachers, as well as discuss the best ways to comprehend the concept effectively. To phrase it differently, TGS is a cooperative learning strategy that encourages communication among all students. It is important to look at the appropriate learning strategies in order to enhance scientific literacy and communication skills.

PjBL, according to current studies, offers three different types of learning outcomes, including cooperative behavior, tolerance of variety, and academic performances, while cooperative learning allows students to solve any problem in order to strengthen their skills in the science process.

III. STRATEGIC STEPS OF TGS AND PJBL

The algorithmic approaches of Think–Group–Share strategy are as given below;

A. The thinking step

The strategy started with posing a question that encourages students to think on a problem related to the exercise's topic that requires them to look for a solution. Then the specific time period was given to students to deliberate in order to determine the problem on their own. This time interval is decided based on individual reflection, student’s information, the context of the problem and the level of complexity of the problem (Susan, 2001).

B. The grouping step

Students are divided into groups of four in the second step (if uneven numbers allowed 5). They were given 2 to 5 minutes to debate their responses. In general, it has been observed that they share their opinions with each student in the group and persuade them to exchange ideas and viewpoints in order to arrive at a conclusion (Ahmed, 2006).

C. The Sharing step

In the final step, to expand the discussion for the entire class the groups were called to share their proposed solutions and any difficulties they had. We have joined each group to think together in order to save time and effort (Saleh, 2015; Christine, 2001).

The PjBL activity was discussed with two differentexamples from Engineering Chemistry. The algorithmic steps involved in complying of PjBL strategy are given below;

A. Group formation

Heterogeneous groups containing four students (girls and boys) are created on the basis of slow and advanced learners. This is the primary step where all the instructions related to PjBL are shared with each group.

B. The practical step

In the second step they will collect samples randomly from their native places. On the basis of theoretical concepts studied and practicals students will choose methods for experimentation. Further various parameters related to samples were estimated followed by performing various calculations to find out final results.

C. Report and presentation

On the basis of data obtained after laboratory analysis, the detailed project report with conclusion was prepared and presented by the group.

IV. METHODOLOGY

These activities were conducted for F.Y. B. Tech students of Civil and Mechanical Engineering program studying Engineering Chemistry course. The activities were a part of the teaching and learning process for the units; Water and Corrosion and its Prevention.

TGS activity conducted as shown in Fig. 1, after notifying all the instructions to the whole class, the following questions were raised in the class during discussion of the respective unit.

Water:

1. What are the disadvantages of using hard water in a boiler?
2. What are the methods used to prevent scale formation?
3. List the methods used to soften hard water?
4. What is Zeolite? How is water softened by zeolite? Giveequations.

5. Explain prevention of scale formation.

6. Describe the demineralization process of softening of hard water.
7. What are the salts responsible for the temporary and permanent hardness of water?
8. Why do we express hardness in terms of $CaCO_3$ equivalents?
9. What are the requisites for potable water?
10. What is sedimentation with coagulation?
11. What is the principle behind EDTA titration?
12. What is alkalinity? What are the possible reasons for alkalinity?

Corrosion and its Prevention:

1. How can you define rusting?
2. Comment on oxidation corrosion in detail.
3. How oxidation corrosion is destructive in the case of alkali metals?
4. Which oxide layer is most destructive? Justify your answer with a suitable example.
5. Which oxide layer is most protective? Justify your answer with a proper example.
6. Would corrosion take place if Aluminum and dil. HCl are put in contact with each other in a dry container? Justify your answer.
7. Comment on hydrogen evolution mechanism with suitable examples.
8. Comment on oxygen absorption mechanism with suitable example.
9. Explain how following factors would affect the rate of corrosion of iron plate; a) Moisture b) Temperature c) pH d) Concentration.
10. Explain how following factors would affect the rate of corrosion of copper plate; a) Conductivity of medium b) position in the EMF series c) Solubility of corrosion product d) Nature of oxide layer.
11. How metallic goods which are generally utilized for storage of foods are protected from corrosion?
12. Give a reason why Zn is added in the galvanizingprocess.
13. Explain how proper design can be helpful inprevention of corrosion?
14. Explain how 25% ship structure is protected from corrosion using cathodic protection?
15. Why lowering pH increases the rates of corrosion?
16. Explain how to measure the rate of corrosion of Aluminum metal by weight loss method?
17. Explain how metal spraying is the most appropriate method for fabricated metallic structures in protection against corrosion?
18. "If a corrosion product is soluble, it increases the rate of corrosion." Prove this statement with appropriate examples.

Fig. 1. Implementation of TGS activity

Two PjBL activities viz; Analysis of water samples for its quality and estimation of rate of corrosion of two different metal samples under different conditions was performed by different groups. The detailed methodology utilized for the analysis of water quality of two water samples from different geological areas as shown in Fig. 2 that were tested for five different water quality parameters is mentioned as below;

Fig. 2. Sampling of water for estimation of water quality parameters

1. A group of four students has collected two water samples other than municipality drinking water.
2. On the basis of theoretical concepts studied and practicals performed students chose any five water quality parameters for which collected water samples were analyzed.
3. Collected water samples were analyzed for five different parameters viz. acidity, alkalinity, chloride content, hardness and pH in the Engineering Chemistry laboratory.
4. Next results are drawn from the experimental data obtained. This helped them to reach a particular conclusion.
5. A detailed project report was prepared that includes introduction, experimentation, calculations, result and conclusions.
6. Finally a group presented the report in front of the whole class.

The steps involved in estimating the corrosion rate of two different metals are as follows;

In the first step, the group has collected two used metal pieces having different areas.

1. The rate of corrosion is then measured in the Engineering Chemistry laboratory by considering various corrosion conditions like tap water, salt water, oil with water, rice andair as shown in Fig. 3.
2. On the basis of observations, the rate of corrosion was determined by using calculations and the conclusion was made by comparing the process of corrosion under differentconditions.
3. A complete project report was prepared and the final presentation of the same was given in class.

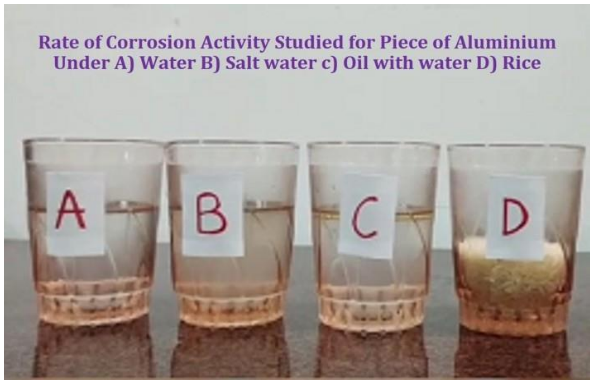


Fig. 3. Experimental set-up for measurement of rate of corrosion activity

V. ANALYSIS OF DATA

In general, during laboratory sessions of Engineering Chemistry, students deal with the same water sample for determination of water of quality parameters. Whereas the PjBL activity allows students to perform experimentation using various water samples. In this regard, students of the Civil Engineering program have collected 30 different water samples from nearby places. Fig. 4 shows a categorization of water samples collected by all 15 groups. The objective of this exercise was to expose the students to the process of estimating water quality parameters and comparing their analysis results with those of other students. This enables students to understand the concepts related to water quality parameters through hands-on experience that may lead to life-long learning.

The active participation in water analysis activity was evaluated using five point scale rubrics, also with presentation and report writing skills of all groups (Brookhart, 2019; Zemel, 2021). The Fig. 5 specifies that more than 60% students have achieved 3 and above point rating in stage daring, presentation skill, communication skill and concept understanding. Out of 15 groups, the project reports of four groups were the best because they included properly organized accurate information and had a deep sense of conclusion.

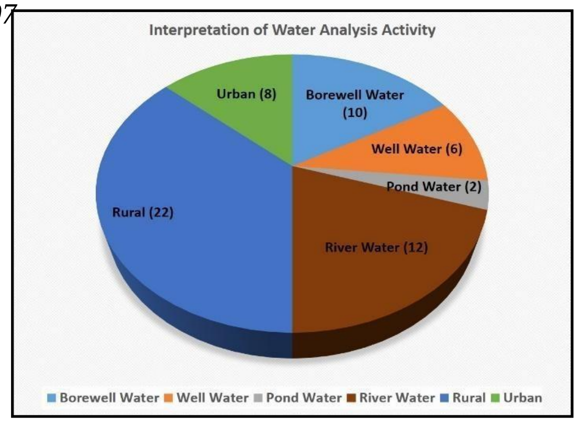


Fig. 4. A categorization of water samples collected at various locations

Fig. 5. Active participation analysis for water analysis activity

The next PjBL activity was to assess the rate of corrosion ofdifferent metal pieces which are given to 15 groups of F. Y. B. tech. Mechanical Engineering students. The main objective of this activity is to assess the rate of corrosion for 30 different metal structures under five environmental conditions. The Fig. 6 shows an interpretation of the rate of corrosion activitywhich allows students to verify the different factors that affect the rate of corrosion. This exercise enables students to improve their abilities to retain and recall information, reinforces understanding of subject matter, ability to help students who don't excel during solo work etc.

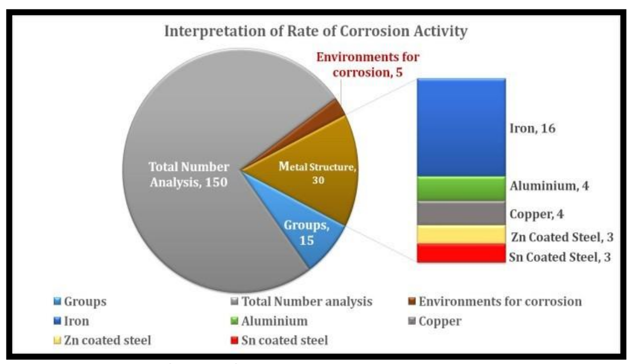


Fig. 6. Interpretation of Rate of Corrosion Activity

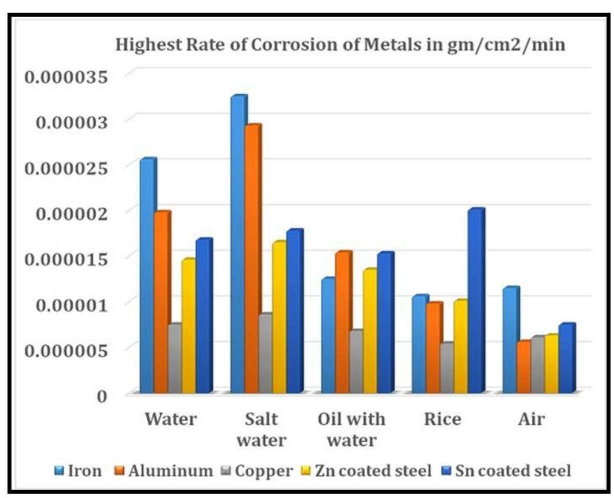
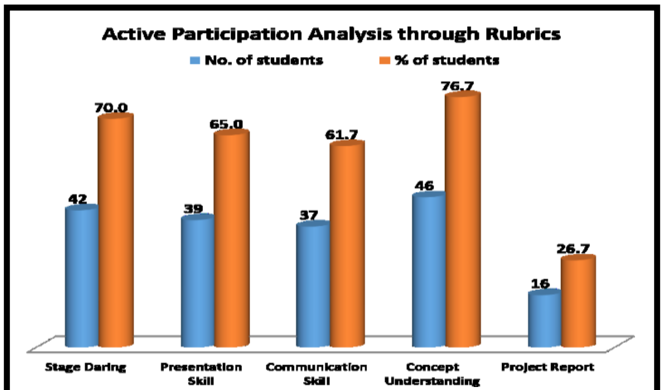


Fig. 7. Analysis of Highest Rate of Corrosion

Additionally, the analysis shown in Fig. 7 as the highestrate of corrosion under various environments enables students to handle real-life problems that demand for real-life solutions. Likewise, it is also observed that engaging in such PjBL activities is beneficial for students who find it difficult to understand abstract ideas during traditional academic sessions. TGS activity enabled us to comprehend how the students felt about their competence in Engineering Chemistry and their involvement in subject discussions on the units; Water as well as Corrosion and its Prevention. It becomes easier to evaluate whether TGS has an impact on their confidence and ability to engage in conversation. Further the observations made prior to the use of TGS provided a baseline for the level of student engagement in that particular class. Additionally it permitted us to observe who dominates the discussion during answering to the above questions, who stays away from involvement, and what kinds of remarks and queries were made during the exercise. Comparing class discussions before and after the use of TGS was really helpful.

Students' participation in class and level of confidence were quantified at the beginning and end of both TGS and PjBL activities in order to examine the effects of these learning strategies. The Fig. 8a, 8b and 8c compare the responses of students provided for the pre survey and feedback (Fry, 2003)..



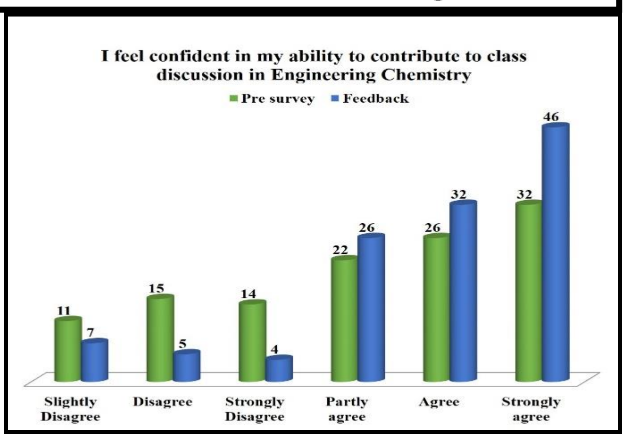


Fig. 8a. Pre survey and feedback for question 1

The pre- survey and feedback indicate that PjBL and TGS had a good effect on students' opinions about taking part in discussions and activities in Engineering Chemistry class. Every question had more positive comments than it did in the pre-survey. The study's findings advise students to consider using the PjBL and TGS methodologies to boost their learning.

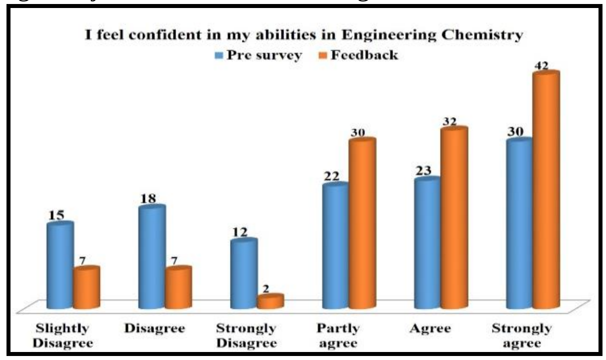


Fig. 8b. Pre survey and feedback for question 2

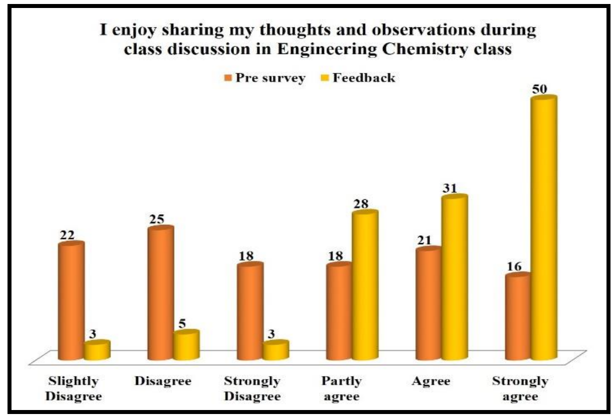


Fig. 8c. Pre survey and feedback for question 3

VI. CONCLUSIONS

Employing TGS and PjBL in a targeted class is found to be effective in enhancing the number of students participating in classroom discussion, allow students to give long-lasting clarifications, and improve students' capacity to express their thoughts and ideas. The following important outcome points were discovered to be significant in the protocol used for carrying out both tasks.

1. TGS builds up a learning culture of elevated requirements where all students are tested, engaged and bolstered to accomplish their maximum capacity.
2. Students have the opportunity to learn from one another, work on using and expanding their Chemistry vocabulary, exercise on using their scientific thinking skills, and receive some sort of developmental evaluations through TGS.
3. The project-based educational approach is based on a thorough integration of project-based learning strategies into the traditional educational framework from the very beginning of engineering Chemistry studies.
4. Beginning with their first year of engineering studies, students learn how to operate in teams effectively where each individual has a specific function to play and is held

personally accountable for finishing the tasks that have been assigned to them.

These results reinforced the use of TGS and PjBL in teaching of Engineering Chemistry. Many students expressed their excitement at adopting the TGS method and even mentioned in their comments that they found studying via TGS to be simple to comprehend and apply. It was well entrenched that this technique substantially contributed to the students' learning process. It is noteworthy that the most fruitful outcome of the project-based activities has been the development of initiatives like idea generation, hackathons, startups, and tackling societal concerns.

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