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A Case Study on the Impact of Peer Tutoring in the Education of Freshmen Engineering

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***Abstract*— In an online or offline classroom, it might be difficult to ensure student engagement and learning during and after the COVID-19 epidemic. The learning of global engineers, need to engage effective teaching and learning practices in higher education is required. The best way to learn is to teach. Learning by teaching others is extremely effective method. To enhance the learning of engineering students, a pilot study is aims to exam in the effectiveness of the freshmen engineering students' engagement in learning using peer tutoring. In addition, considered the performance of tutees (slow learners) guided by the identified tutors (fast learners) of the same group for peer tutoring. For that the students are engaged in the practice of learning by teaching, understanding and retaining the knowledge while comparing the students who are in existing learning. A peer teaching method is effective learning method by involving the student in group presentations combined with cooperative learning. In this paper a review of related literature focusing on active learning methods –like learning by teaching, peer tutoring, team presentations in engineering education are done. The results strongly endorse learning through teaching by the student and for the student throughout the practice of peer tutoring in a pilot course study of Applied Physics.**

***Keywords*-Cooperative learning, peer tutoring, learning by teaching, engineering education, freshmen engineering students.**

I. INTRODUCTION

In order to satisfy the growing demand from the industries, academic organizations and institutions must produce millennial engineers with strong domain expertise who can handle difficult multidisciplinary challenges. All engineering institutions in India held their classes virtually during the COVID-19 outbreak. The pandemic offers instructors the chance to use online materials and lead classroom activities, but it also creates challenges they were unaware of. Teachers are worried about the pupils' learning because they aren't responding to questions about whether the subject has been understood or not in online classrooms. Additionally, students offer a range of explanations, such as network issues, device issues, personal issues, etc., which poses barriers to their learning. Despite sharing the same result, the student and the teacher divided and transformed into two parallel lines. In this aspect, engineering educators must substitute student-centered learning methodologies for more traditional methods. To avoid passive learning, educators should implement cutting-edge online/offline pedagogies.

Encourage and support the pupils as they teach their peers to learn. Studies have shown that teaching is the most effective way to learn. Students that have used learning-by-teaching techniques have a greater knowledge of the subject matter and remember their concepts for longer (Learning by teaching-Carpenter, 2021).

Peer tutoring is the best technique of learning, according to the literature study, because it encourages undergraduate students to actively participate in their academic work. According to Topping, for undergraduate level students this method enables them to learn teaching skills. (Topping, 1996).Ten Cate reported the impact of peer tutoring in medical education to increase learning capacities and confidence, to offer coaching and leadership training, to allow students the chance to teach, and to use multi-source or peer feedback and evaluation in order to lessen the burden of teaching on faculty (Ten Cate O, 2007). It addresses the lack of resources for communication skills training by substituting a peer tutor from the same group for teachers (Rees et al., 2016).

According to Nestell and Kidd report in some institutions the peer teaching is encouraged by giving incentives to the peer tutors (Nestell D, 2005). The institution in which this study was conducted encourages student self-governance once in a month by the peer or near peer members. In other school's peer teaching method is used to deliver the extracurricular activities. And this peer teaching shows not much difference in the quality of learning in comparison to the teacher teaching. In recent years, to enhance the quality of peer teaching skills, academic organizations are encouraging the peer teaching development programs, workshops, and community outreaching programs.

To enhance the learning and competence of 21st century millennial engineers, the industry demands on their presentation skills & attitude (Abid, January 2008). Also, in the workplace, an engineer's ability to communicate is crucial, and 58% of their time is spent doing so (Tenopir & King, n.d.). According to ninth Malaysia plan "If graduate communicative competency is left unchecked, nation building plans will probably not materialize due to insufficient human capital" (Ena Bhattacharyya, 2009).

Teamwork has a significant role in academia and industry. Korkmaz concluded that "collaborative learning and teamwork methods have improved students' attention and knowledge (Korkmaz, 2013); similarly, it enhances the critical thinking

skills and in order to work in an integrated way". There is a huge section in the literature that focuses on examining the importance of teamwork and how teamwork enhances students learning (Kittur & Salunke, 2020). Students have been inspired and driven to learn more by participating as teams in student – team achievement – division (STAD) activity and flipping the classroom activity (Kittur, 2016).

According to Shri Ramasawmy a peer teaching method is effective learning method by involving the student in group presentations combined with cooperative learning (Ramaswamy et al., 2001).

Here the main focus is the student learning by creating an environment where students in this group cooperate, prepare the presentation, and teach/present it to their peers. This method ensures the learning of the various levels (quick, moderate, and slow learners) of team members to excel understanding and engage in academics with teamwork. The present case study discusses the impact of collaborative peer learning.

II. METHODOLOGY

The survey/feedback on the established peer tutoring activity was gathered from the freshmen engineering students taking the Applied Physics course. In a recognizable freshmen engineering class of sixty students, divided into fifteen diverse teams. The team size consists of four students. Teams were given the topic in virtual mode as part of a revision of the topics covered in the Applied Physics course. The team members are working together to prepare the presentation on the allocated subject. Members of each team are carefully selected for the four responsibilities of Lead, Moderator, Team Member-1, and Team Member-2, in that order.

1. Lead: Academically excellent performer who led the team and act as bridge to fill the gap between the students and facilitator. These 15 students were identified as the lead based on their performance scores of previous examinations.

2. Moderator: Academically good performer and cooperates with team members in learning. Also supports in learning too along with the other members. There are 15 students identified as moderators, one in each team which was again assessed based on students' prior performance in examinations.

3. Team member-1 and Team member-2: These members are the target audience who improve their performance and presentations too along with other members. They are totally 30 participants identified out of 60.

Each team is required to show up on the weekends to present collaborative peer tutoring to the entire unit. Teams are instructed to finish the three course modules (covering the II mid portion) in three weeks. They must present the material in accordance with the rubrics that have already been given

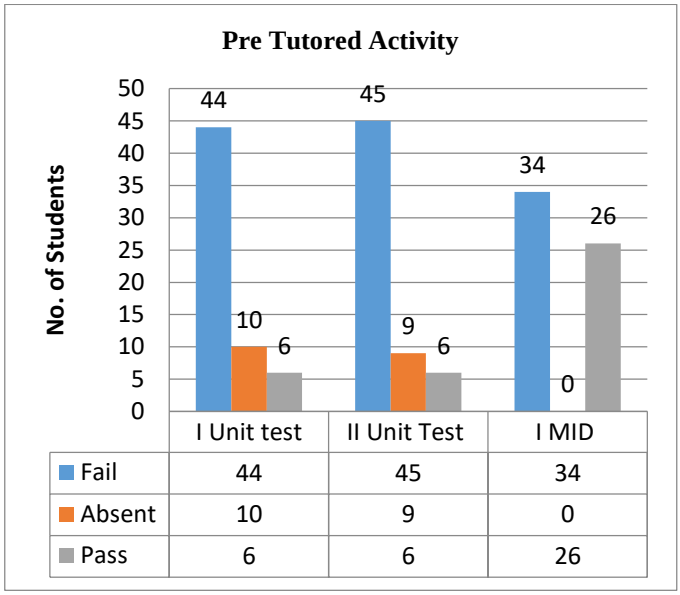

Figure: 1 Pre-tutored activity

III. RESULTS

Results and participant feedback gathered during the current semester are pertinent to the literature. The graphical representation given below is the comparison of academic performance in the first and second mid exams. Before and after implementation of peer teaching, the I Mid-term result is not appreciated and seen that as the peer teaching was not adopted (the examination was conducted in off-line mode) as shown in "Figure: 1".

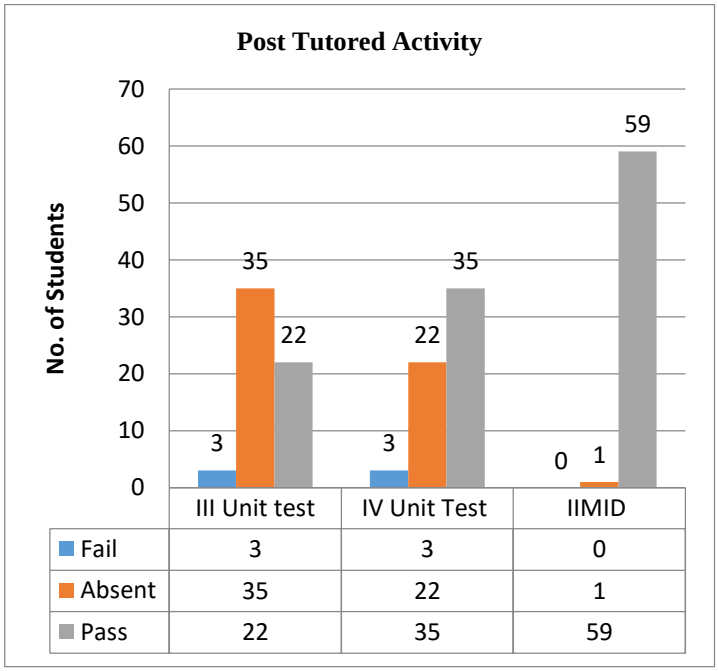

Figure: 2 Post Tutored Activity

Post- presentations of peers tutoring the II Mid-term results are appreciated and the examination is taken in online mode as in shown the "Figure: 2".

"TABLE: 1" contains the student feedback was collected by posting relevant questions on the activity of peer tutoring and presentation. There are 27 students participated out of 60 students in the survey.

TABLE 1
STUDENT SURVEY FEEDBACK

1. Did the event help you in new learning or knowledge?
The event was well-received by all attendees, who concurred that it improved their learning.
2. Do you recommend peer learning presentations? Is it helping the student in learning?
All of the participants endorsed the benefits of peer learning and suggested that other batches do the same.
3. How would you rate the session?
Ten participants rated the entire session as Excellent, twelve as Very Good, and five as Good.
4. What are the things need to improve for effective implementation of peer learning?
All members, with the exception of two, are happy with the implementation. And have made the following suggestions. 1. It was a little challenging at first, but with repeated practice, we can achieve the required level. 2. Only a few students struggled to understand the concepts being addressed, which prevented them from being able to explain a specific issue when it was given to them. Students who don't participate in the process only ruin it. 3. Due to network issues and disturbances, peer learning caused challenges since it was done online.
5. How was your learning impacted by peer?
With the exception of four students, everyone responded favorably. And the following comments are made. 1. The best aspect is that even someone with no prior knowledge may easily obtain a general understanding of the topic, and as a result of this activity, they retain the material covered for longer. 2. This peer learning activity is a bigger impact than ordinary classes. 3. I had no issue understanding the concepts because they were so expertly put into practice.
6. Do you have any other comments/suggestions that would help us make future events better?
Many of them responded "no suggestions." A handful of the responses are shared here. 1.Only let students who are interested to engage, and choose competent leaders 2. At the time, the majority of our work was completed offline. I'm glad about that, but given how intensely online classes seem to be proceeding from my vantage point, I would suggest interacting with students in the classroom more and more by posing questions at the beginning or end of the session, making presentations, holding quizzes, and engaging them in numerous other activities to pique their interest in the subject.

As per the students feedback survey most of the participants have recommended and appreciated the peer tutoring activity by rating as Excellent. They told that they were well understood the concept and enhanced their learning. And also suggested the valid points for the future develop the activity by focusing more on interactive and learning sessions. There is a need to care few things which were raised by the participants in the "Table: 1" for effective implementation of peer tutoring activity.

The active participation of the members can be improved by giving the clarity on benefits of participation and provided incentives to the leads. And also financial support for the gadgets like smart tabs, phones with uninterrupted network facility.

Counseling the slow learners of team members 1 & 2 to follow the instruction given by the team leads.

And also facilitator is regularly monitoring the team member's activities.

Reflection of student survey on pedagogy implementation

1. Active participation of the team members in the meetings
2. Establish a collaborative relationship among the tutors and tutees.
3. Online network flexibility to avoid technical snags.
4. Effective leadership/administration to monitor the team
5. Initially time consuming and hectic process
6. Tutors are only retaining the innate knowledge of academics but no new learning of communication skills or team work
7. Facilitator needs to monitor each and individual team clashes among the team members.
8. Team members are expected to maintain the discipline in meeting, time management and cooperate with each other with healthy competition.
9. Team members are getting motivated and encourage among each other without any biases.
10. All the team members are making available as per the scheduled meetings. Otherwise communicate to the team members about their unavailability.
11. Avoid the background disturbances and cross talks while presentations/ meetings are going on.
12. All the schedule meetings are must be interactive with complete focus on learning.

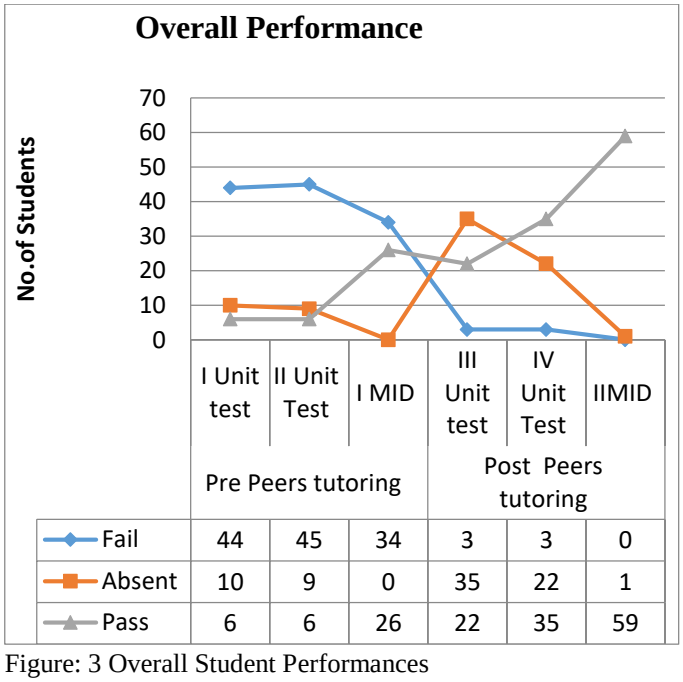

Figure: 3 Overall Student Performances

The overall performance of the students has improved significantly in II Mid (post peer tutoring) compared to the I Mid (pre peer tutoring) which as shown in the "Figure: 3".

In graph (Figure: 3) the blue line is showing that the failed student number drastically decreases from I unit test to II Mid test. At the same time the rising line of gray color in the graph showing the number of students pass from I unit to II Mid is increases continuously.

T-test: A paired-samples t-test was conducted to determine the effect of exercise on a peer tutoring.

H_0: There is a no significant difference between Mid I & Mid II student secured marks (null hypothesis)

H_1: There is a significant difference between Mid I & Mid II student secured marks (alternative hypothesis)

TABLE 2
t- TEST PAIRED TWO SAMPLE

t-Test: Paired Two Sample	MID I	MID II
Mean	13.83	22.71
Variance	19.73	6.78
Observations	60	60

To determine the effect size, the mean posttest score was subtracted from the mean pretest score and the result was divided by the pretest score standard deviation. The paired t test was used to evaluate the hypothesis.

From the "TABLE: 2" t-test shows that there is a significant difference between the group that exercised before Mid II (M=22.71; SD=2.60) and the group with no exercise after Mid I (M=13.83; SD=4.44); t (59) = 2.00 p< 0.001.

The mean and standard deviation values in the t-test differ significantly, and the computed value of t is higher than the critical value of t (p value of 5%).

The alternative hypothesis H1 was therefore substantially supported whereas the null hypothesis H0 was strongly rejected. It shows that the adoption of a peer tutoring pedagogy resulted in a noticeable improvement in students' performance in Mid II as compared to Mid I.

IV. CONCLUSION

This study is enforcing the significant benefits of peer tutoring for enhancement of learning and knowledge retention in Applied Physics course for the freshmen engineering students. These results are good agreement with the previous implemented work of peer tutoring in higher education. In this research study students are equipped with the practice of instructing their peers to develop the communication skills too. Peer tutoring provides a unique opportunity to promote the teaching skills and a key practice in the development of professional skills at the undergraduate level.

The peer teaching/tutoring is an academic pedagogy in higher education is essential as it enhances the student skills related to (a) critical thinking, (b) learning autonomy, (c) motivation, (d) collaborative and (e) communicative skills (Stigmar, 2016). These abilities improved in the teams where peer tutoring was used. In summary, peer tutoring practice can play a significant role to improve the student learning through well intended plan and with an organized content in designing the course. It's known that the pedagogy can be implemented in both online and off-line teaching/learning strategies.

Limitations and Future Work

This study has some limitations. The participants chosen in this study were from only one specific course and institution. Hence, the findings cannot be generalized to the full extent. In future, the participants could be recruited from different courses, different class standing (freshmen, sophomore, junior and senior levels), and other institutions. This is a pilot study and hence the data collected to validate the importance of peer tutoring needs more attention and in future the author would like to collect more data to thoroughly examine the arguments and present more concrete findings. Specifically, a survey instrument will be designed to measure students' perceptions of their learning using the peer tutoring approach; (Costello & Osborne, n.d.) This will be a quantitative study (McNabb, 2020). Interviewing participants and collecting qualitative data to gain more insights on how the lead, moderator, and the team members-1 and -2 experience their learning using peer tutoring is another direction for future work (McNabb, 2020) (Borrego et al., 2009). Examining the influence/impact of the demographic characteristics of the students on their learning could be another next step moving forward.

APPENDIX

Presentation Rubrics					
Category	**Excellent (5points)**	**Good (4points)**	**Average (3points)**	**Poor (2 points)**	**Score**
# Presentation	Content, text, and relevant images presented well in the presentation	Most of the Content, text and relevant images presented well in the presentation	Some of the Content, text and relevant images presented well in the presentation	Content, text, and relevant images not presented well in the presentation slides	5
# Communication-Language	Language is appropriate and professional and is compelling to the audience	Language is appropriate and is compelling to the audience	Language is clear but awkwardness words used.	Language is not clear inappropriate vocabulary used.	5
# Command on subject projection	If the team members are very strong on subject	If the team members are strong on subject	If the team members are weak in subject	If the team members are poor on subject	5
# Teamwork or collaboration	Excellent teamwork	Good teamwork	Average teamwork	Poor teamwork	5

REFERENCES

Abid, R. F. (January 2008). Developing Speaking Skills Module for Engineering Students. *The International Journal of Learning Annual Review* , 61-70.

Bhattacharyya, E., Patil, A., & Sargunan, R. A. (n.d.). *Methodology in Seeking Stakeholder Perceptions of Effective Technical Oral Presentations: An Exploratory Pilot Study*. 22.

Borrego, M., Douglas, E. P., & Amelink, C. T. (2009). Quantitative, Qualitative, and Mixed Research Methods in Engineering Education. *Journal of Engineering Education*, *98*(1), 53–66. https://doi.org/10.1002/j.2168-9830.2009.tb01005.x

Carberry, A., Ohland, M., & Lee, H.-S. (2009). Developing An Instrument To Measure Engineering Design Self Efficacy. *2009 Annual Conference & Exposition Proceedings*, 14.450.1-14.450.14. https://doi.org/10.18260/1-2--4608

Costello, A. B., & Osborne, J. (n.d.). *Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis*. https://doi.org/10.7275/JYJ1-4868

Ena Bhattacharyya, R. A. (2009). The Technical Oral Presentation Skills and Attributes in. *Australasian Association for Engineering Education Conference*, 1029-103.

Kittur, J. (2016). Implementation of Student—Team—Achievement—Divisions Activity and Flipped Classroom to Enhance Student Learning. *Journal of Engineering Education Transformations*, *0*(0). https://doi.org/10.16920/jeet/2016/v0i0/85637

Kittur, J., & Salunke, M. (2020). Mixed Learning Styles: A Strategy for Team Formation. *Journal of Engineering Education Transformations*, *33*(0), 434. https://doi.org/10.16920/jeet/2020/v33i0/150194

Korkmaz, S. (2013). "Case-based and collaborative-learning techniques to teach delivery of sustainable buildings". *Journal of Professional Issues in Engineering Education and Practice*, *138*(No. 2), 139-144.

Learning by teaching-Carpenter, J. (2021, Feb 24). *Learning by teaching others is extremely effective – a new study tested a key reason why*. Retrieved from mpact Image Marketing: https://www.impactimagemarketing.com/post/learning-by-teaching-others-is-extremely-effective-a-new-study-tested-a-key-reason-why

McNabb, D. E. (2020). *Research Methods for Political Science: Quantitative, Qualitative and Mixed Method Approaches, Edition 3.* Washington: Taylor & Francis.

Muntasher, K. H. (2016). *Improving Students' Learning Outcomes by Solving Open – Ended Problem in Highway Laboratory: Work in Progress*. 3.

Muntasher, K., & Kittur, J. (2018). Outcomes of Integrating Total Station and Surfer8 Software in Survey Practice Laboratory. *Journal of Engineering Education Transformations*, 8.

Nestell D, K. J. (2005). Peer assisted learning in patientcentred interviewing: The impact on student tutors. *Med Tech*, 439-444.

Ramaswamy, S., Harris, I., & Tschirner, U. (2001). *Student Peer Teaching: An Innovative Approach to Instruction in Science and Engineering Education*. 7.

Rees, E. L., Quinn, P. J., Davies, B., & Fotheringham, V. (2016). How does peer teaching compare to faculty teaching? A systematic review and meta-analysis. *Medical Teacher*, *38*(8), 829–837. https://doi.org/10.3109/0142159X.2015.1112888

Salunke, M., & Kittur, J. (2017). An Experiential Learning in Electrical Machines Laboratory Course. *2017 5th IEEE International Conference on MOOCs, Innovation and Technology in Education (MITE)*, 15–20. https://doi.org/10.1109/MITE.2017.00008

Stigmar, M. (2016). Peer-to-peer Teaching in Higher Education: A Critical Literature Review. *Mentoring & Tutoring: Partnership in Learning*, *24*(2), 124–136. https://doi.org/10.1080/13611267.2016.1178963

Ten Cate O, D. S. (2007). Peer teaching in medical education:Twelve reasons to move from theory to practice. *Med Teach*, 591-599.

Tenopir, C., & King, D. W. (n.d.). *COMMUNICATION PATTERNS OF ENGINEERS*. 28.

Topping, K. J. (n.d.). *The effectiveness of peer tutoring in further and higher education: A typology and review of the literature*. 25.

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