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Effective Use of Padlet as a Tool to Enhance Students' Engagement with the Concept Learning: A Case Study

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***Abstract*— Active learning is a key feature of outcome-based education which can be implemented by using various tools made available by technology such as Padlet, Wakelet etc. Padlet is a web 2.0 tool which can be used effectively to share information, audio and video files on virtual walls. The paper discusses the effectiveness of Padlet as an ICT tool to enhance students' engagement with concept learning in the post pandemic era. A Padlet wall was used by the course instructor and the students of the third-year undergraduate Mechanical Engineering program, to generate a digital repository of concept-based questions and answers for the course Applied Thermodynamics. This activity triggered peer discussion outside the classroom in a stress-free environment and encouraged students to contribute to the Padlet wall in a competitive spirit. Active participation of the students in the teaching learning process with the use of Padlet promotes collaborative learning and ensures thorough understanding of the key concepts which has direct impact on the attainment of Course Outcomes. Hence, in the present study students' performance in the Continuous Internal Evaluation (CIE) and Semester End Evaluation (SEE) is discussed in terms of the attainment levels of the Course Outcomes. It was observed that most of the course outcomes are attained with highest level which was remarkable as students were just venturing back into offline mode after COVID 19 pandemic. The study shows that students have a strong and unanimous positive perception of the use of the Padlet as proved by Wilcoxon test.**

***Keywords*— Active Learning, Outcome Based Education, Padlet, concept learning, Course Outcome.**

***JEET Category*—Practice.**

I. INTRODUCTION

In the context of advancement in technology and increasing industry expectations, engineering education system must equip engineering graduates with strong conceptual foundation and greater analytical problem -solving skill. Outcome based education (OBE) has provided an effective framework to address the demand by focusing clearly defined learning outcomes and aligning teaching learning processes with the course specific attainment. OBE encourages a student -centric learning environment, where instructional methodology is designed to ensure measurable achievement of course outcomes (COs'). However, achieving effective OBE implementation requires student engagement, continuous feedback and instructional approach that would go beyond traditional lecture-based methodology, particularly in conceptually intensive and numerically driven courses such as Applied Thermodynamics.
To foster active learning and student engagement, instructors are adopting technology based instructional tools that support collaboration, reflection and knowledge building. Digital platforms such as Kahoot, Padlet, Wakelet, Photostory and Sway have been reported to strengthen learner motivation and active engagement. Amongst these, Padlet stands out as simple yet powerful collaborative tool that help student to share ideas, pose questions and engage in peer assisted learning. Previous studies have shown that Padlet promote collaborative learning tool, encourages learner interaction and enhance conceptual understanding through digital platform (Zhi & Su, 2015; Kay & LeSage, 2009). Such tools align with the need of collaborative learning environment (Chi, 2005). The need for such collective pedagogical mediation became inevitable during and after the COVID -19 Pandemic. In the post pandemic academic environment, there was a crucial need to reinforce conceptual clarity and enhance students' engagement actively in the learning process.

II. LITERATURE REVIEW

(Dewitt et al, 2015) explored the use of Padlet for synchronous online debate for teaching ICT concepts to higher education students. Based on a student survey and interview it was found that students experienced the effectiveness of tools for

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generating new ideas. The findings support the use of Padlet for online mode for higher education. It enhances active participation of students as it gives the platform to work in group and share the ideas, thoughts and exchange knowledge thus providing good learning opportunity. Also, it's a very user-friendly tool (Zainuddin et al.,2020). Padlet can be used to share the questions, related to the content to be delivered in the class, to prepare the students for in class discussions, post class reflections and post class assignments (Fisher, 2017).Anonymity is one of the features of Padlet which encourages students to express themselves freely and allow experimentation in the learning process. Also, teacher gets review on the topic from the complete class of students rather than from only those who are more expressive and confident (Fuchs, 2014).

Putting the time limit to post the responses on the Padlet wall is beneficial for both the students and the teacher as it inculcates timely submission habits in the students. It also solves the problem, of students submitting their assignments as per their convenience which otherwise increases burden on the teacher. Also discussing some of the responses on Padlet wall in the class, can increase students' participation on Padlet when done cautiously without offending any of the learner (Deni and Zainal. 2018). As Padlet is an easy-to-use tool, it can be incorporated from the very beginning without investing time in training (I. Beltrán-Martín, 2019). (Mehta K et al., 2021) examined Dentistry and bioscience students' perception of using Padlet for collaborative learning. Both groups found the tool easy and beneficial. Based on Statistical analysis using Spearman's rank correlation Dentistry students rated the benefits significantly higher ($p<0.01$) with better content understanding ($\rho = 0.5$), whereas the bioscience strongly correlated to fondness of tool ($\rho = 0.75$; $p < 0.01$), indicating how digital tools are received.

(Al Momani et al., 2022) evaluated students' perception using a padlet tool for interaction and collaboration between two Jordanian Universities in a distance learning platform. It was observed that students had a highly positive approach towards the tool with significant difference in appreciation between two universities, but no difference was seen based on gender diversity. The author suggests the use of Padlet in an online learning environment. (DeWitt et al., 2013) conducted study with first year undergraduates at a Malaysian public University to examine the type of technology application used by digital natives, such as social media, microblogging platforms like Facebook, video sharing repositories (YouTube) etc. the result of the study claims that digital natives engage with collaborative, content sharing and discussion oriented platforms, showing strong potential for including tools like Padlet into teaching learning process, as students are willing to use such technologies for academic and professional purposes.

(DeWitt et al, 2015) study investigated the use of Padlet as a communication supporting tool for deaf students in higher education. The author recognized the need for a communication supportive tool for deaf students as they were facing learning difficulties due to deaf students' inclusive facilities in the institutions. The author designed a learning module using Padlet as an interactive web-based platform; the design was validated using fuzzy Delphi technique with inputs from 27 experts and interviews with four deaf students. The findings suggest that Padlet can effectively support communication among deaf students, although further research is recommended to examine its applicability across wide educational contexts.

(Lucy Gill-Simmen, 2021) discussed the integration of Padlet as a digital learning tool to enhance students' engagement in an undergraduate marketing course. Padlet was used as a supportive tool for formative assessment, substituting traditional assignments that students found difficult to engage with. The author implemented the technology based instructional design focused mainly to improve students' motivation, effort and cognitive engagement, results showed that students perceived the Padlet supported task as highly cognitively engaging, author also states that the use of Padlet is a flexible supportive tool for face-to-face and online educational learning.

(Guillermo Díaz-Sainz et al., 2021) highlight the function of E-learning especially mobile learning (M-learning) in enhancing teaching and learning in chemical engineering education. M-learning uses the students' mobile usage flexibility, into an active engagement learning platform. The review discusses different mobile based platforms and applications featuring their cost-effectiveness.(Rashid et al., 2019) examines the use of Padlet as a collaborative writing tool among ESL learners to boost interaction and language learning. The author highlights that the Padlet supports collaborative learning enabling students to share ideas, provide peer feedback and collectively construct written text. Findings show that the use of Padlet enhances students' engagement, motivation and writing skills in an ESL context.

Erstwhile studies in engineering education emphasize the effectiveness of technology-supported active learning in enhancing student active engagement and conceptual understanding. (Abirami et al. 2021) reported that blended learning techniques significantly improve participation and learning outcomes. (Abburi et al. 2021) validated that virtual platforms advance experiential learning and creativity. (Kulkarni and Desai 2021) highlight the importance of real-world environment in enhancing student engagement, while (Bandi and Naik 2021) highlighted that service-learning improves student engagement and learning. (Achappa and Desai 2021) also confirmed that visualization support tools help students to understand complex concept learning. In succession with these findings, the present study examines the effective use of Padlet as a collaborative digital tool to boost students' engagement with concept learning.

(Desai 2022) studied the impact of various active and cooperative learning techniques on student engagement and academic performance. The study incorporated multiple strategies such as the Jigsaw technique, Muddiest Point Technique, Concept Mapping, and collaborative learning to cater and adopt student learning styles. The study confirms that active learning techniques help enhance student involvement and overall learning outcomes in engineering education.

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More recently, a case study by (Agavekar et. al 2023) demonstrated the effective use of the Muddiest Point Technique integrated with Padlet in the course Computer Oriented Numerical Methods. A Padlet wall was created to help mechanical engineering students to anonymously post the most difficult concepts from lecture content delivered in class. Students were informed on how to identify and submit their "muddiest points". This approach improved student participation, encouraged reflection, and helped clarify difficult concepts.

Existing literature highlights, Padlet is used as an effective active learning tool in various areas. However, the gap identified for this study is to provide a structured model to create Q&A repository using Padlet, not merely as an engagement tool, but also to enhance outcome-based education for engineering studies, addressing core Mechanical Engineering Course-Applied Thermodynamics. The Study aims to develop digital repository by the students' collaborative efforts. The focus of the model is to inculcate the habit of collaborative study amongst the Engineering students for lifelong learning. In addition, the present study addresses the need to facilitate the learning transition in the post pandemic educational scenario, to re-establish an offline educational environment.

III. METHODOLOGY

Implementation plan for the use of Padlet is as shown in the figure 1. Padlet wall was used to generate the digital repository of the conceptual questions and answers. Students were explained about the use of the Padlet regarding posting questions as well as responding to the questions posted by their peers and the course instructor. During the initial phase of this activity, the course instructor posted the questions so that students get idea as regards to framing of concept-based questions. In the theory class, the concepts regarding the course content were explained and reinforced by problem solving. Students were motivated by maintaining a conducive and participatory environment to post on the wall. As the semester progressed, students explored various features of the Padlet in collaborative manner. This exercise led to healthy peer discussions. The content posted by the students was monitored and reviewed by the course instructor. The Padlet wall created for the course is as shown in figure 2.

Conceptual clarity of the fundamentals is core to the engineering students as it enables the students to cater to real life complex engineering problems. Real life problems are executed in teams with a wide range of expertise and experiences where potential of each team member can be used to advance the project efficiently. From the figure 3 it is evident that questions posted by students are conceptual and very much related to the fundamentals of the course and multiple students have responded to the question as per their understanding of the concept. Each response has tried to fill the gaps in the previous responses and thus the entire thread provides complete discussion covering all aspects related to the concept.

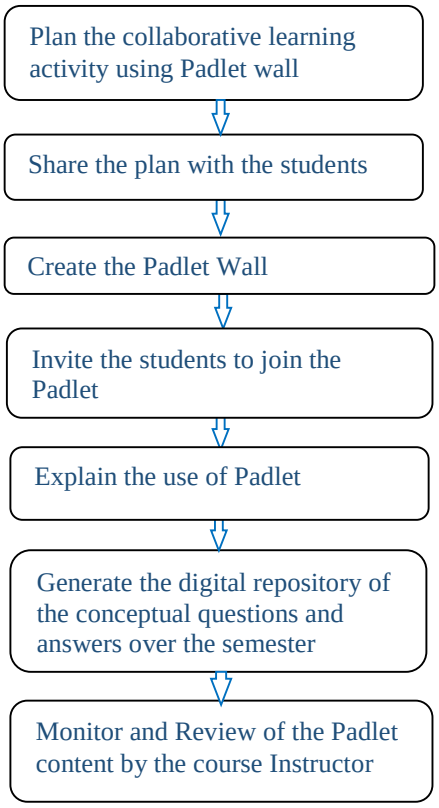

Fig 1. Implementation of the Padlet to generate Repository

Fig 2. Padlet – Digital Repository

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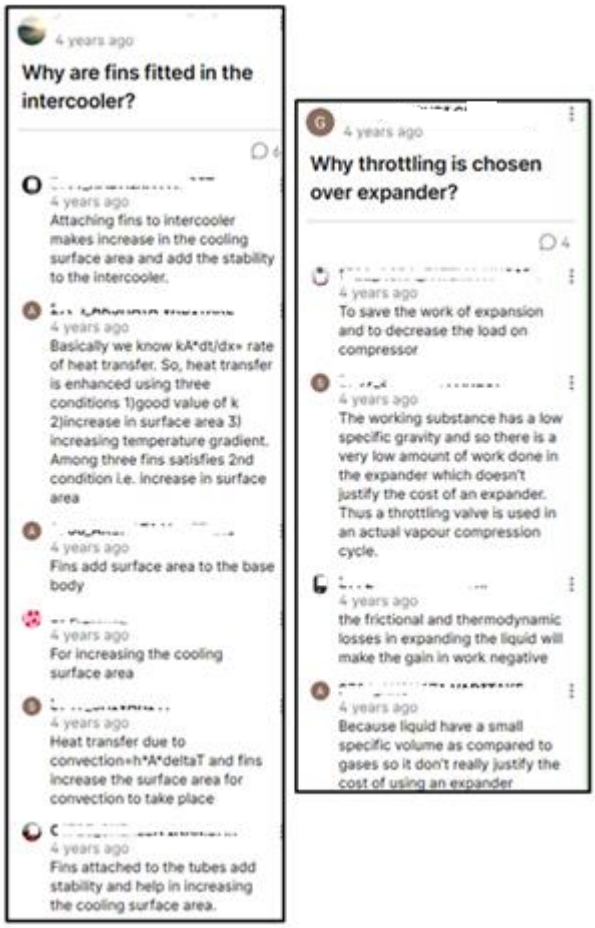

Fig. 3. Collaborative Conceptual Understanding Demonstrated by students via. Padlet Wall

IV. RESULTS AND DISCUSSION

The effect of using Padlet for the course Applied Thermodynamics was studied in the following two ways.

A) Student Performance

Table I shows course outcomes for theory course. In OBE, the focus is on achieving Program outcomes for which attainment of the course outcomes is the major contributor. Accordingly, the teaching learning evaluation process is to be planned. Hence, it is important to assess the effect of any digital tool used, pedagogy implemented on students' academic performance. The effect of use Padlet on the student performance was analyzed in terms of the following:

1) Attainment of the Course Outcomes

Table II shows the mapping of theory and laboratory course outcomes. The laboratory course outcomes are in strong alignment with the theory course outcomes, particularly for topics such as IC engine, compressor, refrigeration systems and psychrometric processes. To strengthen the lab-theory integration, Padlet helped students to generate conceptual question-answer repository mainly aimed at strengthening students' understanding of fundamental thermodynamic concepts, it indirectly contributed to improved performance in numerical problem solving. Through the continuous peer interaction and instructor facilitation on Padlet, students gained clarity on assumptions, governing principles, and process interpretation derived from laboratory experiments. This enhanced conceptual understanding helping student's solve numerical based questions, resulting in improved attainment in numerical intensive theory course outcomes. It is demonstrated that the Padlet based conceptual repository effectively bridged experimental learning and analytical application, thereby strengthening outcome-based education (OBE) implementation and course attainment.

TABLE I
COURSE OUTCOMES – THEORY COURSE

After completion of the Theory course, students will be able to	
COs	Statement
CO1	Comprehend combustion processes and cycles in IC engines
CO2	Ascertain the performance parameters of IC engines from given data
CO3	Evaluate isothermal and volumetric efficiency of reciprocating compressor
CO4	Analyze refrigeration cycles and calculate COP
CO5	Plot psychrometric processes and perform air conditioning load calculations
CO6	Construct velocity triangles of turbo machines

Tables III, IV and V present attainment calculations for CIE, SEE (theory course) for CO1 to CO5 and CIE (laboratory course) respectively, for which Padlet was used to develop the repository. The attainment of the course outcomes was assessed by using CIE as well as SEE. CIE has two components viz. T1 and T2 and each one was evaluated for 25 marks. SEE was conducted for 50 marks. Attainment of the Course Outcomes was calculated in line with the guidelines given in National Board of Accreditation Self-Assessment Report NBA SAR (www.nbaind.org). For CO attainment, benchmark score was decided as 60% of the maximum marks. Target levels were set as follows.

level 1: Up to 40% students scoring marks above Benchmark.
level 2: 41% to 60% students scoring marks above Benchmark.
level 3: More than 60% students scoring marks above Benchmark.

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TABLE II
MAPPING OF APPLIED THERMODYNAMICS LAB COS WITH THEORY COS

Lab CO	Lab CO Statement	Mapped Theory CO(s)	Contribution of Padlet-Based Conceptual Q&A Repository
Lab CO1	Conduct trial on IC engines and calculate performance parameters.	Theory CO1, CO2	Padlet facilitated conceptual discussion on IC engine cycles and interpretation of experimental observation enhanced students understanding of performance parameters, thereby improving problem solving.
Lab CO2	Conduct trial on reciprocating air compressor to ascertain volumetric and isothermal efficiency.	Theory CO3	Padlet discussion on clearance volume and various efficiencies strengthen conceptual clarity. It helped students to face numerical problems with confidence.
Lab CO3	Compute performance parameters of refrigeration systems.	Theory CO4	Padlet base conceptual discussion of refrigeration cycle processes, COP significance and deviations between ideal gas and actual cycles reduced errors and helped students to solve COP based numerical problems.
Lab CO4	Perform a trial on air conditioning tutor to understand different psychrometric processes	Theory CO5	Conceptual Q&A discussion on psychrometric properties and process identification improved students' confidence in solving numerical questions on psychrometric processes.

TABLE III
CO ATTAINMENT- THEORY CIE

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Number of students scoring marks above bench marks (60%)	38	65	58	35	72
Total number of students appeared	77	77	77	77	77
Percentage of students scoring marks above bench marks (60%)	49.3	84.4	75.3	45.4	93.5
Attainment Level	2	3	3	2	3

TABLE IV
CO ATTAINMENT- THEORY SEE

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Number of students scoring marks above bench marks (60%)	6	47	46	52	32
Total number of students appeared	77	77	77	77	77
Percentage of students scoring marks above bench marks (60%)	7.7	61.0	59.7	67.5	41.5
Attainment Level	1	3	2	3	2

From table III, it is observed that, for theory CIE, the attainment level is 3 for course outcomes CO2, CO3, and CO5. Out of five COs under consideration, three course outcomes have the highest attainment level. From table IV it was observed that, for SEE, the attainment level is 3 for course outcomes CO2 and CO4. In case of SEE, two COs out of five considered for analysis have the highest attainment level. Higher CO attainment levels lead to higher attainment levels of Program Outcomes. Thus, the active learning strategy of using Padlet indirectly helps in meeting the target of OBE.

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TABLE V
CO ATTAINMENT- LABORATORY CIE

	CO1	CO2	CO3	CO4
Number of students scoring marks above bench marks (60%)	77	73	77	72
Total number of students appeared	77	77	77	77
Percentage of students scoring marks above bench marks (60%)	100	95	100	94
Attainment Level	3	3	3	3

Table V shows that attainment calculation for Lab course. The fixed benchmark of 60% was used to calculate the attainment levels. CO1 to CO4 were attained with highest level of 3.

2) Marks distribution using Box and Whisker Plots

The box and Whisker plots are used to view the marks distribution at a glance in a clear and readable way. Figure 4, 5 and 6 box and whisker plots for the mark's distribution of theory course CIE, theory course SEE and lab course respectively.

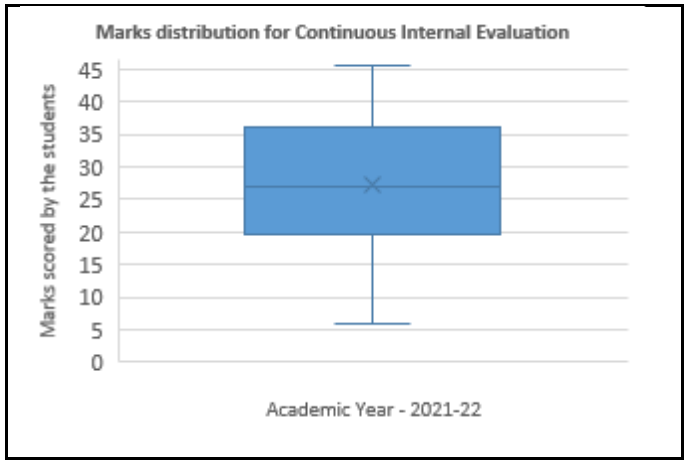

Fig 4. Box Plot for CIE marks distribution of theory course

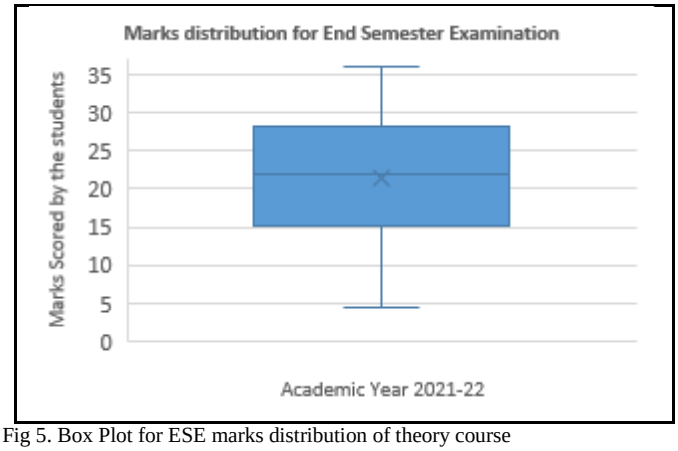

Fig 5. Box Plot for ESE marks distribution of theory course

For CIE, the total marks considered for analysis were 46.6. From figure 4, it was observed that, range of marks is 39.5 with median marks 27. The minimum and maximum marks scored are 6 and 45.5 respectively. Top 25% of the class has scored marks above 77% while top 50% of the class has scored marks above 57%.

For SEE total marks considered for analysis were 37. From figure 5, it was observed that, range of marks for ESE is 31.5 with median marks 22. The minimum and maximum marks scored are 4 and 36 respectively. Top 25% of the class has scored marks above 75% while top 50% of the class has scored marks above 59%, which is an indicator of the good academic performance.

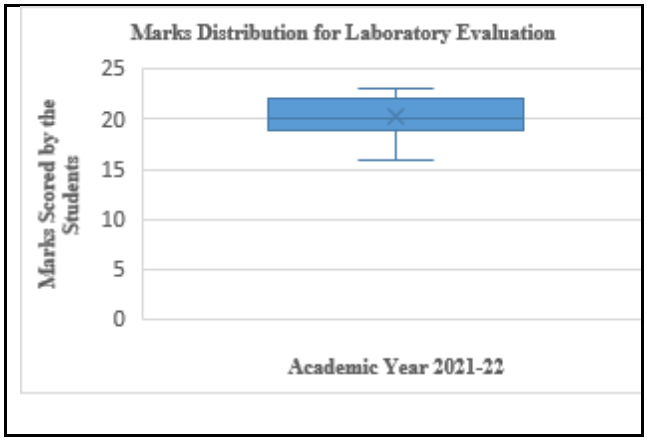

Fig 6. Box Plot for marks distribution of laboratory course

For laboratory course, the total marks considered for analysis were 25. From figure 6, it was observed that, range of marks is 7 with median marks 20. The minimum and maximum marks scored are 16 and 23 respectively. Top 25% of the class has scored marks above 22.

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B) Student Perception

The success of implementation of any active learning strategy depends upon the dedicated involvement of the students. While assessing the effectiveness of any active learning strategy, the students' perception about the same is of vital importance. Hence a survey questionnaire was prepared to study and analyze the students' perception about the use of Padlet wall. To prepare the survey form, questionnaire as regards to students' satisfaction with the use of Padlet by (Inma-Beltran Martin 2019) was referred. The third-year students of the undergraduate Mechanical Engineering program participated in the survey, to provide qualitative feedback with respect to the use of Padlet wall for enhancement of the conceptual understanding, as a tool for collaborative learning and user friendliness. The total nine survey questions were divided in to the following three groups.

Group 1) Use of Padlet for conceptual understanding
(Q. No 2, Q. No 5 and Q. No. 6)
Group 2) Use of Padlet for collaborative learning
(Q. No 3, Q. No 4 and Q. No. 8)
Group 3) User friendliness of the Padlet
(Q. No 1, Q. No 7 and Q. No. 9)

TABLE VI
PADLET - SURVEY QUESTIONNAIRE

Sr. No.	Statement	Median	Mode
1	It was easy to use Padlet.	5	5
2	Use of Padlet motivated me to study and revise the course material.	5	5
3	Padlet motivated peer discussion regarding the course concepts.	5	5
4	I was comfortable sharing responses with my fellow classmates on Padlet.	5	5
5	Padlet Wall serves as repository of important concepts in terms of questions and answers.	5	5
6	Use of Padlet helped to enhance conceptual understanding.	5	5
7	I enjoyed Padlet as a learning tool.	5	5
8	Padlet is good for collaborative learning with my classmates.	5	5
9	I would like to use Padlet Wall for other courses as well.	5	5

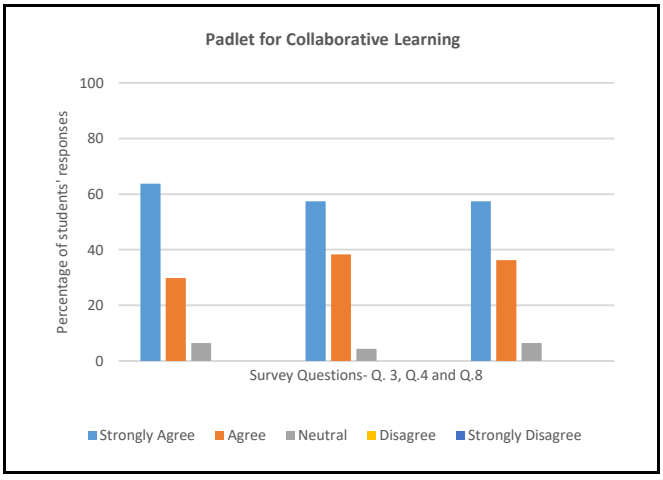

Fig. 7. Use of Padlet for Collaborative Learning

The students' responses were recorded on a 5-point Likert scale. Table VI shows the survey questions about the students' perception about the use of Padlet wall, along with median and the mode. Median and Mode indicate strong and unanimous positive perception for the Padlet. Figure 6,7 and 8 how the responses of the students towards the use of Padlet as a collaborative learning tool, concept learning tool and its user friendliness respectively

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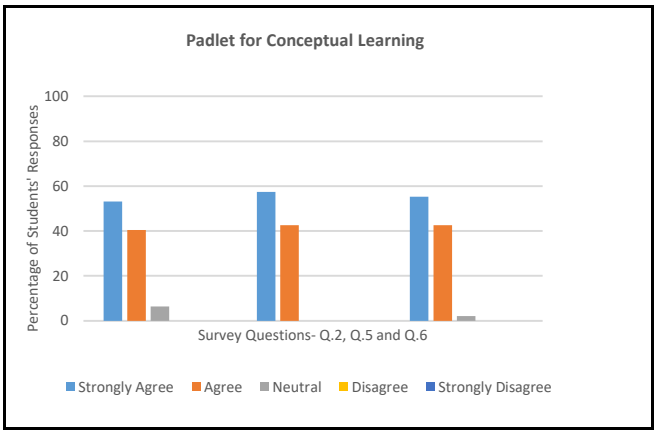

Fig. 8. Use of Padlet for Conceptual Learning

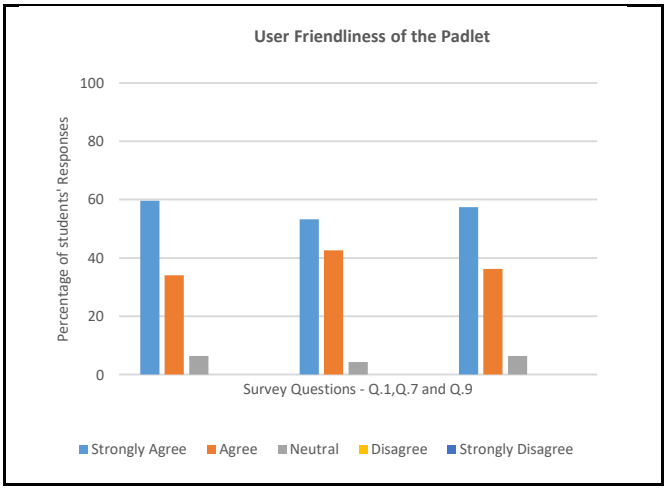

Fig. 9. Padlet as user friendly tool

3) Wilcoxon Rank Test:

The responses of the survey questions were analyzed using a Wilcoxon signed-rank test against the neutral reference value of 3. Wilcoxon statistic (W) is equal to Zero 0) which indicates that all non-neutral responses are deviated in the same direction. p Value is very less than 0.05, which shows statistical evidence that students strongly and unanimously perceived Padlet as an effective tool for supporting both conceptual clarity and collaboration in engineering education

(Mehta et al., 2021) employed Padlet for two different disciplines as a collaborative learning tool. It was observed that students were in complete agreement about the benefits of the Padlet for collaborative learning and its user-friendliness. Authors findings as regards to the course Applied Thermodynamics are in line with these observations.

V. Conclusion and Future Scope

The Padlet wall was used to generate a repository of the conceptual questions and answers for the course Applied Thermodynamics for the third-year students of the undergraduate Mechanical Engineering program. Overall students have expressed satisfaction with the use of Padlet. This exercise helped students to stay focused in the classroom as they were to frame the questions and respond as well on the wall, based on the conceptual understanding of the course content taught. As the students were not supposed to post duplicate questions, they had to go through the existing content on the wall. It helped them stay connected with the course content and thus enhanced the engagement with the concept learning. The digital repository generated on the Padlet boosted students' conceptual clarity and thus resulted in the good academic performance both in the theory and laboratory course. It nurtured collaborative learning environment amongst students. Padlet as an ICT tool brought encouraging environment to the teaching learning process.

It was observed that the attainment level of the first course outcome (CO1) was not satisfactory in the end semester examination. CO1 was evaluated using theoretical questions where students were supposed to elaborate the concepts related to the combustion process and cycles of the IC engine. Hence Padlet wall can be explored in future as a platform where students can practice and perfect their technical writing skills. The use of this tool had some inherent limitations at the time of implementation. The systematic organization of the questions and answers, based on course outcomes and difficulty level was challenging. As the content on the Padlet was voluminous, there was a possibility of missing the important questions while browsing. Latest Padlet has updated features to tackle these issues. Owing to constraints imposed by the teaching-learning context, comparison with the control group could not be incorporated. In the future, the Padlet can also be explored to compile teaching material in terms of multimedia resources, to provide students with a platform to post and brainstorm innovative project ideas in higher education.

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