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Design Thinking with ICT Tools: An Approach to Enhance Engagement in Design Problem and Practical Exposure

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***Abstract*—These instructions give you guidelines for preparing *Abstract*— Students were unable to gain exposure to think practically, solve real-world problems, and think critically in recent years following pandemic situations, so design thinking is a rapid change in engineering education strategies to increase students' engagement in imparting knowledge and skills remotely to the students. The traditional approach to teaching-learning strategies has given way to some advanced methods utilizing various modern approaches such as design thinking. The engagement of students actively and learning collaboratively with thinking ability is the major challenge in the learning of courses like metrology. The paper is a report on the author's use of the design thinking approach for the learning and active participation of third-year mechanical engineering students at Rajarambapu Institute of Technology in Rajaramnagar. This paper describes the use of the design thinking approach for the metrology course and summaries of students' active participation and improvement in terms of students' "Learning Coefficient (LC)" based on the responses collected. The learning coefficient is represented by a number ranging from 0 to 1, with 0 indicating fewer interactive sessions and 1 indicating extremely interactive sessions. These coefficients reveal how much learning is taking place. Furthermore, the impact assessment shows that course results and course outcome attainment were significantly improved. The students' feedback indicates that they had a great time and appreciated the opportunity to learn.**

***Keywords*— Collaborative learning; Course outcomes; Design thinking; Learning coefficient; Students' feedback.**

I. INTRODUCTION

Teaching-learning of courses is not only limited to, delivery in the classrooms, physical performance, and recording observations. It combines new active learning strategies for interactive learning, critical design thinking, and practical experience. Students' presence is not limited to physical attendance; it also allows instructors to consider how students will be engaged, involved, learn, and think in a planned manner. Interaction among students as well as faculty and students during metrology course learning has become an important aspect of successful teaching-learning of courses. The culture must be such that students can actively participate, debate among themselves, and gain shop floor experience while learning. To create an active learning environment and increase students' skills during sessions, the regular class culture must be such that all can think, engage actively, share their views, and evaluate. The lecture delivery techniques create a link between students for easier learning and understanding, as well as ensuring that positive solutions are provided by the students.

Many instructors now use design thinking as their approach. Given the needs of engineering education, instructors have begun to use these modern approaches to teaching and learning in engineering education.

A. Inspiration for the Study

Because of a lack of active participation, attention to learning, and revision during the teaching-learning process, students are unable to comprehend everything that the teacher teaches. If these actions are taken and these corners are modified, it is hoped that the teaching-learning process will produce significant results. The author was inspired by the interactive learning of the students and the thing in this way to use modern approaches with ICT tools to improve the effectiveness of the teaching-learning process.

II. LITERATURE REVIEW

This section explains the overview of the research articles and recognizes the gap in the use of modern approaches in the teaching-learning process.

Design thinking was discussed by Judy Matthews and Cara Wrigley (2017) as an approach used in higher education. The researchers used various design thinking approaches to create a preliminary map of some of the higher education business programs. Stanislav Avsec (2021) investigated design thinking as a transformative learning approach and found that design thinking, when supported by transformative learning theory, can be conducive to the development of higher order thinking skills and meaningful learning experiences that influence a pedagogical shift and perspective of pre-service teachers from a variety of majors. Teaching design thinking to students, according to Jacqueline E. McLaughlin et al. (2019), is a skill-based tool to prepare students for problem-solving in complex healthcare environments and to create, implement, and refine health professions curricula and training programs. Aparna Lahiria et al. (2021) discussed the significance of design thinking competencies in dynamic project environments, as well as key reasons for project failure, such as a lack of communication, an inability to understand business objectives, and an inability to manage customer expectations. According to

Ameer Sarwa and Patrick Thomas Fraser (2019), design thinking may be best studied from a sociological or science, technology, and social studies perspective. Ineta Luka (2014) discussed the origins of design thinking, its characteristics, and its applications in pedagogy. A. Varun and Sivakumar Krishnan (2021) discussed the diagnostic approach used by educators to identify interventions appropriate for specific topics, which serves as the foundation for Outcome-Based Education. Their research disproved that as a basis for selecting topics where alternative learning designs could be implemented in the future. Sandeep Desai (2021) discussed the effective use of WhatsApp to improve student participation and enrich students' learning of a Fluid Mechanics and Fluid Machinery Course. His assessment impact demonstrates that course results and attainment of course outcomes were significantly improved, and his initiative aided in establishing a better personal connection with the students. Thomas Wing and Jaime Sand (2019) reviewed assessment strategies in online learning and explained summative assessment has been traditionally used where formative assessment is necessary to improve these outcomes and better inform teaching.

The literature shows the major contribution of the researcher in finding the effective use of modern applications in the teaching-learning process and discusses the influence on the same. The current study aims to improve the overall effectiveness and participation of students in the learning process by combining a design thinking approach with ICT tools. For the metrology and control engineering course, a class was created to make the platform available to students for uploading assignments and discussion during and after college hours. Students can express their concerns, share information, and communicate with their teachers and peers at any time and from any location.

III. METHOD

A. Participants

The research was conducted at the Rajarambapu Institute of Technology in Rajaramnagar, Sangli, Maharashtra. The observations were made with a total of 62 students (in one group of 04 students) in their fifth semester of metrology and control engineering courses. Ineta Luka used the design thinking approach, as shown in fig.1, to teach and learn in this study (2014).

In another instance, the faculty discussed all the steps that indicated the flow of the design thinking process.

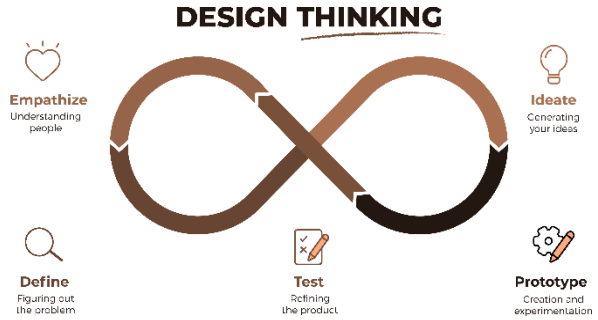

Fig. 1. Design thinking process.

B. Procedure

To ensure effective lecture delivery, the teacher normalized their lecture material using PowerPoint presentations. The lecturer has synchronized their lecture delivery method and modern tools used in the lecture. During the semester, the design thinking approach can be used to engage in design problems and practical procedures while teaching the open loop control system and closed loop control system points. There were time constraints during the teaching-learning process, and we were unable to get time for individual student involvement. Initially, the faculty discussed their lecture agenda and explained the planned syllabus points. Where faculty asked students to form groups and brainstorm ideas about open loop control systems and closed loop control systems. As shown in fig.2, many ideas emerged from that discussion, including a water flow control system, a smoke detector, a parking system, an automatic dustbin, soil moisture testing, and so on.

Fig.2. prototype using the Design thinking approach

However, due to time constraints, not everyone was able to participate in the discussion. So that class dojo, as shown in fig.3, fig.4, and fig.5, overcome that difficulty by providing a virtual platform for students to share their views, participate, and ask difficulties as assigned groups. The points for the discussion were also made in the group discussion. Once the discussion was completed, a student used Socrative to answer all questions based on the Multiple-choice quizzes that can be administered, with 10 questions per quiz. The teacher collects all of the answers and observations from the class dojo applications. Later, the teacher has a discussion about it.

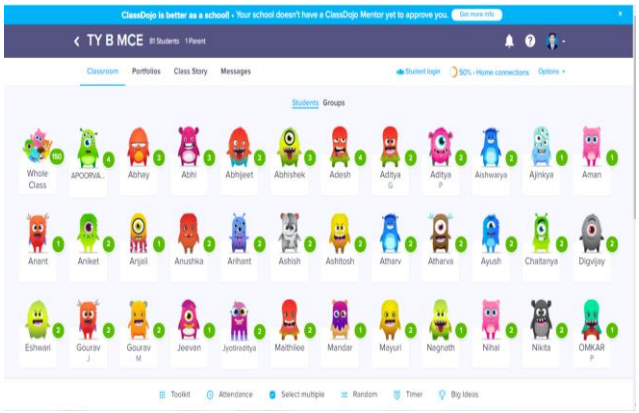

Fig.3. virtual Class dojo platform

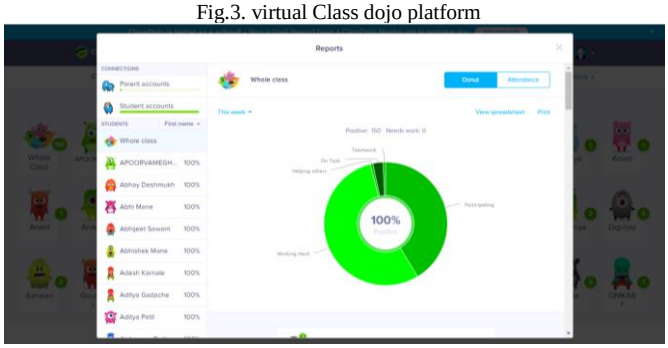

Fig. 4. Class dojo Responses

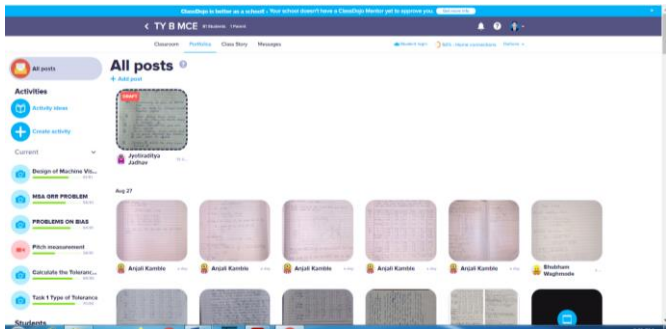

Fig. 5. Student discussion uploaded on Class Dojo

Fig.6. Quiz conduction using Socrative

ClassDojo is a tool that allows teachers to create virtual classrooms or groups where they can share and communicate with students through videos, photos, and other media. It's worth noting that ClassDojo enables teachers to record feedback on students' skills, create a portfolio for students, and send messages to students about corrective actions and what steps should be taken.

Socrative is a web-based application that allows teachers to quickly assess students' learning styles and needs. Socrative is a smart student response system that enables teachers to collect data from their students via smartphones, laptops, and tablets. It is used as a feedback collection tool because it provides immediate feedback through formative assessments.

Students were asked to provide feedback on a Socrative application in class. A questionnaire with 05 questions was created. The survey was administered at the conclusion of the lecture. The survey asked students about their impressions of the Socrative class dojo and the benefits of using the design thinking approach. The opinion survey is used to assess the poll's effectiveness (Megha Kolhekar 2021). The opinion survey is a collection of questions, charts, and diagrams that the instructor can use. The study must demonstrate the effectiveness of the process summarized in table 1.

TABLE I
EFFECTIVENESS STATISTICS

Methodology	Effectiveness (0 to 1)
Design thinking with ICT	0.8917

IV. RESULTS

The following implements were used to achieve the expected outcomes of this initiative to use a design thinking approach with modern ICT tools such as class-dojo and Socrative application;

A. Analysis of student responses to feedback

B. Calculate the learning coefficient to determine students' comprehension.

C. Comparison of previous year course learning outcomes attainment.

A. Analysis of student responses to feedback

Table 2 shows the results of the feedback session at the end of the session. According to these tables, students believe that collaborative learning has a significant impact on their learning performance. The students voiced their thoughts on class engagement and activity. They also comprehend concepts, facilitate group work, and comprehend their level of knowledge.

TABLE II
FEEDBACK FROM THE STUDENTS

Sr. no.	Particular	Poor	Fair	Good	Excellent
1	To what extent do you understand the flow of the session?	0	10	10	42
2	Is it made you more collaborative?	0	09	20	33
3	Whether design thinking helped you to increase your understanding level with the ICT tools?	0	5	18	40
4	Is my classmates and faculty interactions made me feel valuable?	0	6	20	37
5	Can this improve my comprehension of the	2	7	24	30

concepts studied in class?

B. Determine the understanding of students by calculating the learning coefficient.

Learning Coefficient is used to determine the understanding of the students in courses. It is given by the equation, Learning Coefficient= Effectiveness * Interactive Classes percentage. It is noted that the interactive class percentage is calculated by opinion scores (Megha Kolhekar, 2021) as shown in Fig.7.

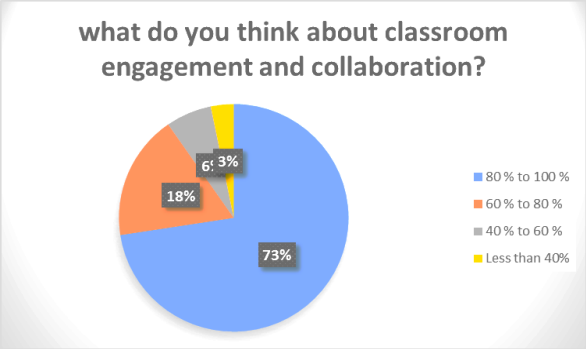

Fig.7. Opinion scores pie chart

According to this pie chart,
[(1*45) + (11*0.8) + (4*0.5) + (2*0.3)]/62=90.96% sessions considered to be interactive. The average percentage (more than 80%) of the score of the students is 73%. The assigned weightage 1 to 80 to 100%, weightage 0.8 to 60 to 80%, weightage 0.5 to 40 to 60 % and weightage 0.3 to less than 40 %.

C. Previous year course learning outcomes attainment comparison.

The course learning outcome attainment can be calculated for the CO4 which is related to the feedback control system and their comparison as shown in table 3. The comparison shows improvement in course learning outcomes and that reflects the overall outcomes of the learning can be improved.
Total 19 Marks allocated to the CO4 and average marks of the 62 students obtained as 17.896. So Average attainment of the CO4 is 94.19%

CO Code	CO Statement	AY:2020-21 Attainment %	AY:2021-22 Attainment %
CO4	4. Explain the feedback control system.	86.22	94.19

V. CONCLUSION

The study was carried out to assess the impact of the design thinking approach with ICT tools such as class-dojo and Socrative application on the student's learning coefficient, active participation in the course, course results, and course outcomes. The study yielded the following results:

- It was discovered that students' experiential and joy of learning approach to the use of design thinking approach with ICT tools has benefited to enhance their confidence, understanding level, interest in learning, and participation when it was used for teaching and learning.
- CO4 course attainment was higher this year than in previous years. This year's average course attainment increments increased by 7.97%.
- The students' feedback and comments aided in determining that the students were pleased to participate in the discussion with their peers, and that they were able to share their views or any other extra details and receive solutions for the same.
- It is critical to note that the use of the design thinking approach with ICT tools has aided in the creation of effective interactive communication with students when compared to other methods.
- Finally, an idea to prepare design thinking with ICT tools is an innovative, systematic approach to implementing combined learning in a metrology course to increase engagement in design problems and practical procedures.
- This current study applies to the classroom study mentioned in the paper. Global data and comparisons with other institutes are not within the scope of the study. So that would be the next phase of the research.

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