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Technology-Enhanced Self-Study Learning Tool: An Approach to Improve Students Skills

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***Abstract* – In the engineering education system, the student's learning styles and abilities to acquire new skill sets have been transformed drastically due to the rising use of technology. The study provides a novel approach to self-learning through the use of technology-enhanced techniques aimed to improve student skills. The tool leverages digital platforms and interactive resources to create an engaging and personalized learning environment. This paper presents an examination of the effectiveness of a technology-enhanced self-study learning tool in enhancing student abilities such as knowledge, use of IT tools, communication, and information sharing across several disciplines. The tool's architecture integrates adaptive learning, multimedia content, and assessment mechanisms that adapt to individual learning styles and pace. This study intends to evaluate the tool's influence on improving students' knowledge, retention, and application of subject matter by examining user interactions and performance data. The methodology used is focused on a particular topic, data collection through the use of all multimedia resources, presentation, posting of videos, peer review, and comments on each task to improve abilities. With the deployment of technology-enhanced techniques, students' skills were observed to improve; around 8% of students' skills were improved in the internal evaluation.**

Keywords— Technology enhanced tool; self-learning; learning by doing; enhanced skills; flexible learning framework

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I. INTRODUCTION

The National Education Policy (NEP) 2020 of India serves as a visionary blueprint for revolutionizing the nation's educational landscape, placing a strong emphasis on the integration of technology and the promotion of skill-based learning. This policy envisions an education system that is not only responsive to the dynamic demands of the 21st century but also empowers learners to cultivate a diverse set of skills that will equip them for both academic success and real-world challenges. In line with the transformative goals of NEP 2020, the research investigates the strategic possibilities of technology-enhanced self-study learning to enhance student skills and align education with the policy's principles. The policy emphasizes that the aim of education is not solely the accumulation of knowledge but the holistic development of individuals as confident, well-rounded, and adaptable citizens.

Technology, as a powerful enabler of change, is intricately woven into the fabric of NEP 2020. The policy recognizes the potential of technology to democratize education, making it accessible and personalized to the diverse needs of learners. It advocates for the integration of digital tools to facilitate experiential and self-paced learning, enabling students to take ownership of their

educational journey. This vision resonates with the concept of technology-enhanced self-study learning tools, which encapsulates the essence of personalized, student-centric learning aligned with the policy's aspirations. The NEP policy emphasizes that around 25% syllabus can be learned by self-study.

The traditional "chalk and talk" method of classroom teaching-learning is ineffective for the advancement of engineering education (Freeman et al., 2014; Waldrop, 2015). Active learning methods, such as group problem-solving and demonstrative examples, have become crucial components of classroom instruction to increase students' learning (Pawar et al. 2023; Kober, 2015). Additionally, to enhance students' learning, active learning techniques like "peer learning" and "think-pair-share" are growing in popularity among educators (Lom, 2012). According to Handelsman et al. (2004), many laboratory tasks at the moment feature a predetermined learning framework and a fixed set of instructions. By integrating practical activities like lab sessions, learning experiences in science and technology can be improved (Freeman et al., 2014).

According to a study conducted at a Spanish business school, implementing practical learning activities enhances academic performance and aids students' understanding of theoretical topics (Rodriguez and Morant, 2019). Recently articles were published on the technology-enhanced project-based learning (TEPBL) approach that used 3D printing, laser cutting, advanced analysis softwares, and experiential learning as a teaching tool for undergraduate mechanical engineering students (Patil and Powar, 2023; Powar and Patil, 2022; Pawar et al. 2020). Siddalingeshwar et. al., 2023 presented effect of assignments on student skill like communication skills and ability to engage in life-long learning. The constructive learning by integrating theory and practice to enhance PG student skills are also presented. (Raravi and Madhusudan, 2017).

The self-learning approaches based on assignment tool proposed for autonomous institutions (Shindhe and Kulkarni, 2017), based on learn by yourself for software packages (Freitas et al., 2017) based on review paper (Raravi and, Prabhuswamimath, 2018), are published. The self-directed learning (SDL) helped to promote lifelong learning skills in students. (Boyer et al., 2013). Khiat et al., 2015 developed conceptualized model and validated a learning diagnostic test in the context of SIM University (UniSIM), an adult learning institution, in Singapore. The peer assessment and self-assessment: effective learning tools in higher education are presented and observed that students recognized the usefulness of acting as peer assessors, but believed that self-assessment (SA) helped them more than peer-assessment (PA). (Sande and Llorente, 2014). The researcher study has found that the perception of the stakeholders regarding the use of internet as the self- learning tool is favorable. (Roy, 2022).

This study seeks to ascertain the impact of the implementation of technology-enhanced self-study learning tools. By embracing these tools, educational institutions have the opportunity to create an ecosystem that nurtures the development of cognitive, socio-emotional, and practical skills outlined in the policy. The technology-enhanced approach allows for the seamless integration of experiential learning, collaborative activities, and adaptive assessments (Pawar & Patil 2021; Pawar et al. 2020; Kulkarni et al. 2020). It has been noted that students must study on their own, continuously, engage in the material, develop their presenting abilities, and do assignments within the allotted time. Technology tools may help with all of them, encouraging self-study and ongoing participation. Understanding the role of technology-enhanced self-study learning tools becomes paramount. This study delves into the design, implementation, and impact of these tools, offering insights into their potential to drive skill development, enhance student engagement, and cultivate a culture of independent and continuous learning for the course Gas Turbine and Jet Propulsion of T. Y. B. Tech. students.

II. METHODOLOGY

The technology-enhanced self-study learning tools were implemented for the students of T. Y. B. Tech for the course Gas Turbine and Jet Propulsion. Figure 1 shows the methodology used to execute the tool. This study looks at how well a technology-enhanced self-study learning tool may improve students' knowledge, IT tool usage, communication skills, and ability to share information across several disciplines.

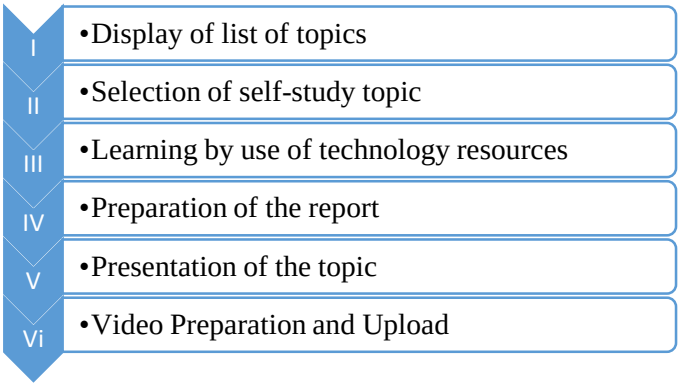

Figure 1 Methodology used to execute the technology-enhanced self-study learning tool

A. Display of self-study topics:

The self-learning topics for the selected courses gas turbine and jet propulsion were identified and shared with the students. The self-learning topics were selected by considering the context of the course syllabus and contemporary development in that field.

B. Selection of the self-study topic

As an elective, a total of 18 students were enrolled in this course. Each student was asked to choose a topic from the shared list. Topics chosen for self-study were not covered in normal classroom instruction. The topics presented are proportional to the number of active students in the batch. Following course faculty clearance, the themes were selected.

C. Learning by use of technology resources

The final themes chosen by the students from the shared list were then displayed on the Moodle server for additional consideration. Each student gathered knowledge about the appropriate topic from a variety of sources, including reference books, the internet, a YouTube channel, Google, and Research Gate. Individually, students are gathering the necessary information required to learn the latest technologies in the selected field.

D. Preparation of the report

Based on the data collected, the students were expected to write a three to four-page report. The report should comprise an introduction of the topic, working principle, schematic sketch of the model, applications, and pros or cons of the areas. After completing the report, students are supposed to upload it on the Moodle server, an online education management platform.

E. Presentation of the topic

The student is asked to deliver the prepared topic in front of the class. Each presentation had a time limit of 10 minutes. The course teacher assessed the performance of each student using evaluation rubrics.

F. Making Video and Upload on Moodle

Students developed a comprehensive presentation video by integrating constructional elements of the issue, functioning principles, applications, benefits and drawbacks of the topic, and what he/she learned, among other things. These videos were made available on the MOODLE learning management system. The uploaded video can be observed by presenting group and work on their exposure, voice, gesture and posture skills. The uploaded material can be also available all time to other students as a resource data.

Each student was given a time restriction for completing each component of this activity, as stated in Table I. Before grading each student, the course teacher viewed the MOODLE video that had been uploaded. Utilizing the full potential of practical sessions, this activity provides students with a flexible learning framework and fosters creativity and critical thinking.

TABLE I: ACTIVITY TIME

Activity Number	Activity	Allotted Time (h)
1	Display of list of topics	48
2	Selection of self-study topic	72
3	Learning by use of technology resources	96
4	Preparation of the report	48
5	Presentation of the topic	48
6	Making Video and Upload on Moodle	72

III. COURSE STRUCTURE OF GAS TURBINE AND JET PROPULSION

Being an autonomous institution, the Outcome-Based Education (OBE) model has been implemented for the program. The usage of OBE demonstrates that students can compete successfully at the national and international levels (Terrang et al. 2015). Table II displays the unit-wise weightage for assessing the gas turbine and jet propulsion courses. In present study unit-wise equal weightage is considered. The course covers fundamental gas turbine and jet propulsion cycles, compressors and turbines, and combustion.

TABLE II: COURSE CONTENT TOPIC-WISE

Unit Number	Title	Weightage
1	Gas turbine Cycles and their Analysis	0.167
2	Jet Propulsion Cycles and their Analysis	0.167
3	Compressors –Centrifugal type	0.167
4	Compressors - Axial Flow type	0.167
5	Combustion System	0.167
6	Axial and Radial Flow Turbines	0.167

Table III represents a list of course outcomes (COs) for the gas turbine and jet propulsion course. The COs provide abilities that students will be able to get after

completing this course.

TABLE III: COS OF THE COURSE

CO No.	CO Statement
CO1	Explain the fundamentals of rotating machines and jet propulsion
CO2	Analyze the thermodynamic cycle of turbomachines
CO3	Solve problems on gas turbine and jet propulsion

The suggested technological improvement self-study learning activity comprises information gathering from learning resources, understanding of the chosen topic, usage of IT tools, and students' communication and presenting abilities. This will improve knowledge of undelivered information in class as well as content outside of the syllabus.

Every course in an institute is evaluated using an in-semester exam (ISE), unit tests 1 & 2 (UT1 & UT2), and an end-of-semester exam (ESE). Table IV displays the various methods of evaluation and the weighted method of conduct for the gas turbine and jet propulsion course.

TABLE IV: EVALUATION MODE WITH WEIGHTAGE

Evaluation	Mode of Conduct	Max. Marks	Weightage	Units with Weightage
ISE	Quiz, technological enhancement self-study learning activity	20	20%	All Units
UT1	Written exam	25	15%	Unit 1 (0.5), Unit 2 (0.5)
UT2	Written exam	25	15%	Unit 3 (0.5), Unit 4 (0.5)
ESE	Written exam	50	50%	Unit 1 to 4 (0.15 each), Unit 5 to 6 (0.2 each)

The technological enhancement self-study learning activity was conducted as a part of the ISE evaluation for the gas turbine and jet propulsion course. As shown in Table V, ISE was evaluated using a four-criterion rubric with a five-scale grading system.

TABLE V: ISE EVALUAITON RUBRICS

Criteria	Proficient (4 to 5)	Adequate (2 to 3)	Substandard (0 to 1)
Active Involvement	The student had shown active participation at all phases of the activity. The students have performed all the activities.	The student participated in all phases of the activity but did not present the topic.	The student had participated in the activity but did not prepare a presentation and had not presented
Quality of Work Accomplished	Consistently produced work of the highest caliber throughout each stage of the project, meeting deadlines on time, and keeping routine clean.	Kept the work's quality high and its mistake rate low. The majority of the time meets the deadline	The activity was only of fair quality. Struggled to meet the deadline and made mistakes throughout every stage of the task.
Knowledge and Report preparation	Exhibits excellent knowledge and analytical skills. The report prepared was well and submitted on time	Exhibits good knowledge and analytical skills.	Exhibits average knowledge and analytical skills.
IT tools, Presentation, and	The work and report submitted	The work and report submitted	Exhibits work with a fair use of

communication	exhibit excellent use of IT tools. Presented excellently and have the best communication skills	exhibit excellent use of IT tools and well-presented but fair communication skills	IT tools and poor communication skills.

IV. RESULTS AND DISCUSSION

A. Report submission and presentations

The standard report template was prepared and guidelines were given to the students for the preparation of the report.

Figure 2 Snapshot of the reports submitted on Moodle.

The students were asked to follow the template and timeline for the submission of the report on Moodle. Figure 2 shows the snapshot of the reports submitted on Moodle. It is observed that all students followed the guidelines properly and submitted reports on time. The course faculty examined the state of the report uploaded at the conclusion of the timeline and rated it accordingly.

Each student of course was asked to give a presentation on the topic and prepare a video of the same.

B. Assessment of the activity:

The course faculty assessed the student's performance using evaluation rubrics. The rubrics used for assessment are shown in Table V. Figure 3 depicts the students' assessment marks on a 10-point scale. The 12% of students secured 10 out of 10 marks, whereas 65% of students were between 8 to 9 marks.

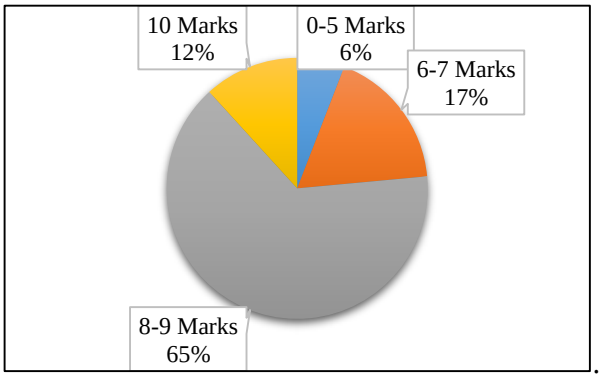

Figure 3 Assessment on a 10 scale for this batch of students

C. Enhancement in ISE Marks

The ISE scores of students for this activity for PAY (Previous Academic Year 2021-2022) and CAY are compared (Current Academic Year 2022-2023). Figure 4 represents the ISE marks of the students. The maximum assessment mark was ten. In comparison to the PAY, in CAY 15% of students were seen to be transferred to a higher grade.

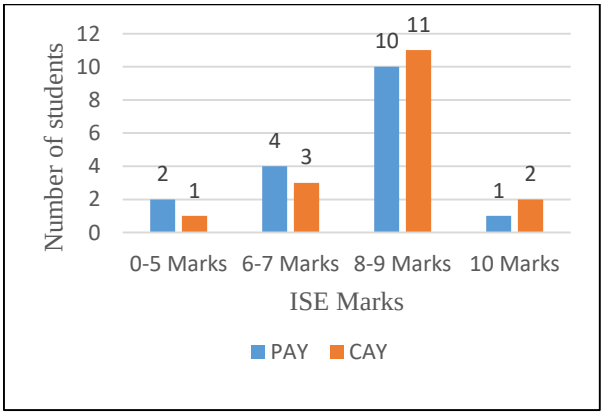

Figure 4 ISE Marks of the students

It is noticed that students' ISE marks in CAY have increased over PAY as a result of technologically advanced self-study learning activities. The design of the tool incorporates multimedia material, adaptive learning,

and evaluation processes that adjust to each learner's unique pace and learning style. The concepts covered in this activity help to enhance the student's comprehension and as a result, improve their In-semester and End-semester examination performance. The impact of the tool on enhancing students' understanding, recall, and application of the material is assesed by looking at performance information and user interactions.

D. CO Attainment Analysis

The CO attainment for the course gas turbine and jet propulsion was calculated for CAY and compared with PAY. Figure 5 represents the CO attainment of this course for CAY and PAY.

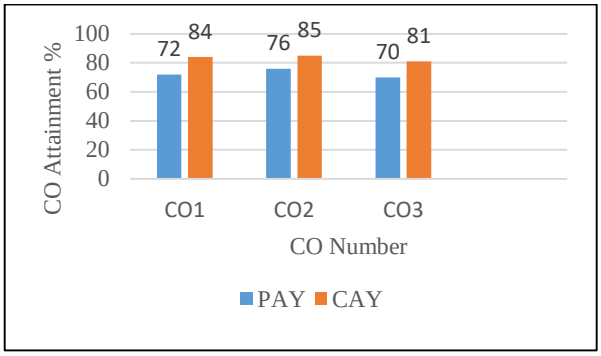

Figure 5. CO Attainment analysis for PAY and CAY

The contribution of present tool in the CO attainment is only through ISE mode and weightage is 20%. The other mode contribution is common in both academic years. According to the CO attainment analysis, the technological enhancement self-study learning activity done in CAY had higher attainment of CO1, CO2, and CO3 than the PAY. CO attainment has grown by 16%, 11%, and 15% for CO1, CO2, and CO3, respectively. This improvement in CO is due to learning from the whole curriculum of this course, including active instruction in the classroom and self-study. Students showed increased interest and participation in each activity as a result of the usage of technology to facilitate self-study. This activity work focuses on comprehension of units 1–6, hence it demonstrated significant growth in CO achievement. Furthermore, the course activity held in the initial few weeks of the semester increased student interest and engagement, allowing students to better grasp the remaining aspects of the course. The effectivesness of this tool only towards CO attainment is not separately calculated. Hence, assuming other modes contribution same and improvement in CO attainment due to this tool are presented.

E. Student feedback

The feedback of the students was also recorded in order to examine the influence of technology augmentation on self-study learning activity. This group of students was provided access to a student assessment that had a questionnaire with 07 items on it, and their responses were recorded. The feedback questionnaire and student responses recorded are presented in Table VI.

TABLE VI: STUDENT FEEDBACK SUMMARY

Sr. No.	Questions	No. of Students Responded	
		Yes	No
1	Did you have information about the self-study tool prior to the technological enhancement self-study learning activity conducted?	17	01
2	Have you used all possible resource material to collect the information about the selected topic?	16	02
3	Did you learn the content which is not taught in the class?	18	00
4	Do you agree with the methodology used to learn is joyful learning?	14	04
5	Did you enjoy the technological enhancement self-study learning activity conducted?	17	01
6	Are you now well aware of the topic selected?	18	00
7	Do you agree that you can retain self-learning knowledge gained through this activity beyond the semester time frame?	17	01

F. Improvement in the student skills

The improvement in the students' skills was noted during the activity due to the application of technology augmentation in a self-study learning activity. Skills like communication, oral presentation, knowledge enhancement, use of IT tools and planning, time management, ethics, and peer review through feedback are enhanced. All of these skill enhancements are evaluated using rubrics and feedback analysis.

V. CONCLUSION

It is concluded that students have a thorough knowledge of the topics presented in the activity after

using a technology-enhanced self-study learning strategy to acquire information not taught in class. It fostered students' creativity by demolishing inflexible learning frameworks and offering flexible learning environments. It has been quantitatively demonstrated that student's performance has improved significantly. The findings revealed that,

- The ISE marks of the students in this CAY improved to 80.38% in comparison with 71.26% of PAY.
- The three COs attainment of this course is enhanced by 16%, 11%, and 15%.
- The communication and oral presentation skills of the students are improved.
- In comparison to the PAY batch, this exercise increased competencies such as activity completion on time, ethics, peer review, and IT tool usage.

As a result, it is believed that using technology to study new topics greatly improves student learning skills.

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