

# The significance of Technology-Enhanced Learning towards Enhancing Engineering Education

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**Abstract**— Engineering education must develop continuously to meet the demands of a technologically progressive world. Education institutions find it challenging to keep updated with the rapid technological enhancements. The technological environment has changed the way that students approach learning. This student's newfound learning approach may not be adequately addressed by traditional classroom teaching. As well traditional classroom instructions are not effectively developing students' problem-solving and critical thinking skills. Methods of assessment are limited and using typical examinations or tests to assess students' understanding of moral values and professional responsibilities might be difficult. All of this has an impact on students' Lifelong Learning. Technology-Enhanced Learning (TEL) is the incorporation of technology into the learning process in order to improve educational outcomes. By embracing TEL and utilizing different pedagogies, engineering education may successfully equip students with the skills and knowledge required to excel in the increasing technological landscape. TEL in engineering education can be improved using a variety of pedagogies. Different engineering education challenges can be addressed by using various technology-enhanced learning tools and activities in engineering courses teaching-learning process, and this paper provides insight on these tools and approaches. The paper then briefly covers their application and effectiveness. Moodle is an example of Learning Management Systems (LMS). The article discusses its application and effectiveness in the teaching-learning processes. Further, problem-based learning methodologies for improving engineering education were reviewed. Puzzles, concept maps, and novel activities were adopted as active learning practices, their significance in promoting Technology-Enhanced Learning is explained in this study.

**Keywords**—Crossword puzzle, Concept Map, Flipped Classroom, Learning Management Systems, Moodle  
**JEET Category**—: Practice

## I. INTRODUCTION

The increasing use of technology has influenced human lifestyles and has an impact on the teaching and learning process. Traditional teaching and learning methods face numerous difficulties in achieving the minimum educational outcomes. Student engagement, failure to address different learning styles, a lack of resources readily accessible to the students, and ineffective assessment and feedback techniques are the main issues traditional teaching and learning methods face. The main causes of students' disengagement from class are a lack of interest in the subject, an inability to see how the information relates to their lives, and academic pressure brought on by an expansive and extensive curriculum. Less student engagement may be caused by ineffective teaching methods as well. It is critical to remember that different people have different learning styles and may need to adjust their learning strategies as needed. Different learning styles can be catered by applying the various techniques and resources and that can be done in changing the instruction style. Students have different cognitive abilities that can affect their learning different information processing speed, different capacity of memorization, different way of problem-solving are addressed as different cognitive abilities. Every individual process the information in different way so they have different speed of understanding. Way of memorization of information is also different for every individual. Additionally, there are differences in students' ability to solve problems, there are some are strong critical academics, while others need more support.

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Teaching learning methodologies should cater to need of every individual. Resources that have simple access to students play an important role in student engagement and help students with



Fig. 1. Technology-Enhanced Learning (TEL)

different learning styles. Traditional assessment methods are tedious and time-consuming, and they are also ineffective to address the individual assessment.

Technology-enhanced learning (TEL) is the process of using technology to enhance and promote learning. In order to simplify and improve teaching and learning procedures, it includes applying various technological tools and resources into educational environments. TEL uses digital tools, software programmes, online platforms, multimedia content, and other technological innovations to deliver educational content, to engage students, and to promote interactive and collaborative learning. TEL provides a variety of learning tools to the students that helps them to learn at their own pace also helps them for studying and enhancing their understanding of complex engineering concepts. TEL enables hands-on learning which fills gap between theoretical and practical knowledge TEL boosts collaboration and interdisciplinary learning, which is important when dealing with complex engineering problems that frequently require multidisciplinary approaches. TEL also promotes customised learning experiences.

The use of learning management system (LMS) software promotes active participation of students in the teaching and learning process. (Daniela et al., 2018) It also provides a variety of techniques for student evaluation. To improve the learning experience, technology interventions and approaches to using technology are used (Kirkwood & Price, 2014). This paper has a dual purpose, first is to focus on learning management system and benefits of it. Second, the design of active learning strategies using technology and their effectiveness

## II. LEARNING -MANAGEMENT SYSTEM (LMS)

LMS (Learning Management System) is a software or also can be called as online technology used to design, schedule, implement, and assess a definite learning activity. Typically, an instructor can utilize a learning management system to make and deliver content, to monitor student engagement, and evaluate student performance online. The LMS may also provide students with entrée to interactive features like discussion boards, video conferencing, and exchanged discussions (Alias & Zainuddin, 2005). Moodle is a well-

known open-source Learning Management System / e-learning platform. The acronym "Moodle" refers to "Modular Object-Oriented Dynamic Learning Environment." It was originated by Martin Dougiamas in 2002 with the intention of developing an adaptable and user-friendly system for educators to deliver online courses and facilitate effective online learning experiences (Simanullang & Rajagukguk, 2020)

### A. Key Features of Moodle

- Moodle provides different tools for creating and managing courses, organizing content, and configuring learning modules.
- Moodle help administrators to manage user accounts, roles, and permissions, facilitating student enrolment and data management.
- Moodle includes tools for creating and sharing course content such as text, multimedia files, documents, and interactive activities.
- Moodle provides communication tools such as forums, messaging, chat, and video conferencing to assist students and instructors in collaborating and working together.
- Quizzes, assignments, and surveys are among the assessment methods available in Moodle. It enables professors to create and grade assessments, as well as track and provide feedback to students.
- Moodle allows instructors to create a grade book to help them manage and calculate grades, create customizable grade scales, and generate reports.
- Instructors can customize course themes, layouts, and navigation in Moodle, allowing them to create courses that reflect their preferences and branding.
- It has features for tracking and analysing data on student engagement and performance, allowing instructors to make informed decisions and intervene when necessary.
- Moodle is user-friendly and accessible on a variety of devices, allowing students and instructors to access course materials and participate in activities from smartphones and tablets.

Moodle has three different levels of uses and each own has its own set of features for different accessibility and usage. The administrator can manage the platform, the instructor can work

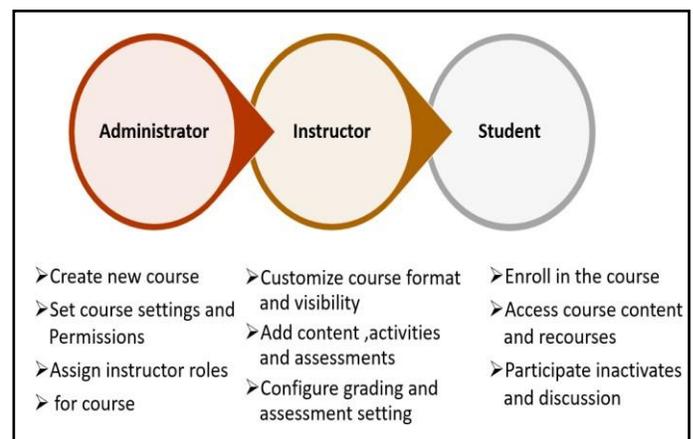


Fig. 2. Role of Administrator, Instructor and Student on Moodle as a trainer, facilitator, or promoter, and the student has a role as

### B. Utilization of Moodle for Organization

Moodle is being utilised by the organisation to create and deliver content, monitor student engagement, and assess student performance online (Bhadri & Patil, 2022). Administrators create courses based on the curriculum structure. The administrator then adds the instructors of those courses and provides them the right to modify the course. A single course can have many instructors; thus the administrator can add several instructors. Instructors update the course content and add course study material. The instructors must enrol students in these courses. After enrolling in the course, students will have access to the course contents and study materials. Moodle allows instructors to make numerous announcements to students. Instructors can create activities such as quizzes, tests, and assignments with deadlines on Moodle also Moodle can be used to grade quizzes and assignments. Students can receive

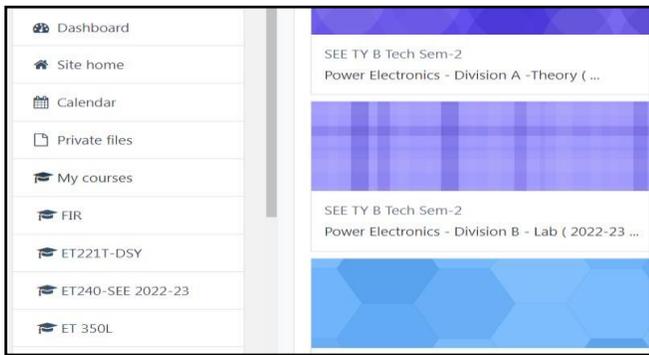


Fig. 3. Course Assignment by Administrator to the Instructor

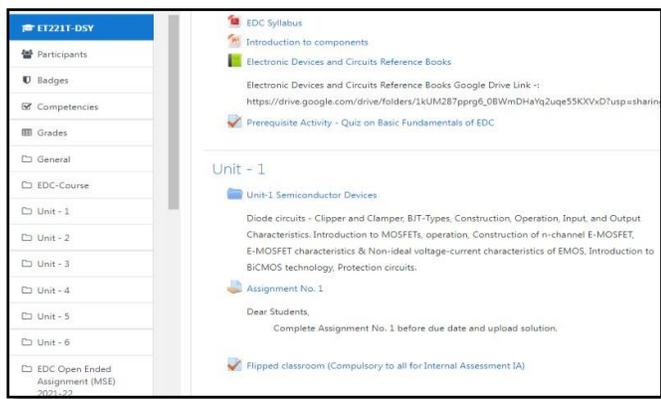


Fig. 4. Course Design by Instructor on Moodle

feedback and comments from teachers on their assignment submissions. Students can also submit revised submissions if necessary.

Figure 3, 4 and 5 are the specimens of instructor task done on Moodle like dashboard, Course preparation, Assessment.

### C. Effectiveness of Moodle Utilization

Moodle has been demonstrated to be highly effective from many kinds of perspectives within an organization. From the

perspective of an administrator, Moodle provides a centralized platform for managing and organizing courses, user accounts, and resources. It allows administrators to easily set up and configure the system, create user roles and missions, and monitor the overall performance of the learning environment. Administrators can also generate reports and monitor analytics to gain insights into course engagement and student progress, enabling them to make data-driven decisions and improve the organization's overall learning outcomes. Moodle provides a variety of tools for content creation, course customization, and student engagement which are useful to the instructor. Quizzes, assignments, and discussion boards can all be easily created by instructors. They can also monitor and assess student progress, provide timely feedback, and help students communicate and collaborate. Instructors can create engaging and personalized learning experiences because of Moodle's user-friendly interface and extensive features, which improves instructor's teaching. Moodle is an easy-to-use platform that allows students to access course materials, participate in activities, and interact with instructors and peers. Students can view and download course materials, complete assignments, and take quizzes and exams all in one place. Moodle features such as

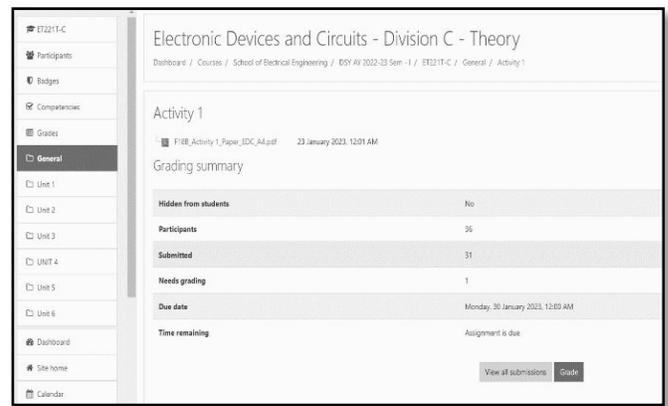


Fig. 5. Assignment Assessment by Instructure on Moodle

discussion forums, messaging, and group work encourage active learning. In addition, having access to course materials and activities at any time and on any location increases flexibility and allows for self-paced learning.

### III. TECHNOLOGY ENHANCED ACTIVITY: FLIPPED CLASSROOM

Jon Bergmann and Aaron Sams, two Colorado chemical teachers, invented the term "Flipped Classroom" in 2007. They began using software for screen capturing and then from it they create Power Point presentations and narration, which students downloaded for self-study. This approach addresses the issue of students who were frequently absent and to assist students in making up classes. The model was found to be effective, so they expanded it to allow students to watch the video at home to preview the teaching materials before designing interactive learning activities in the classroom, such as discussion, practise, problem solving, and individual guidance (Lee, 2017)

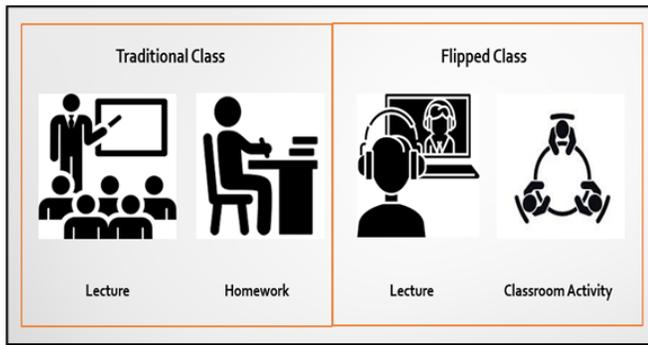


Fig. 6. Flipped Classroom

The flipped classroom is a technology-enhanced pedagogy which is made up of two components first is direct computer-based individual instruction outside the classroom via video lectures and second is interactive group learning activities inside the classroom (Lo & Hew, 2017) .

#### A. Implementation of Flipped Classroom activity

Flipped class activity was implemented in one of the Electronics engineering courses. A quiz was given before to this work to check the student's understanding of the topic. Students were given URLs to NPTEL videos related to the topic for this topic. Students were told they may watch these films whenever they wanted and as many times as they required. Students were

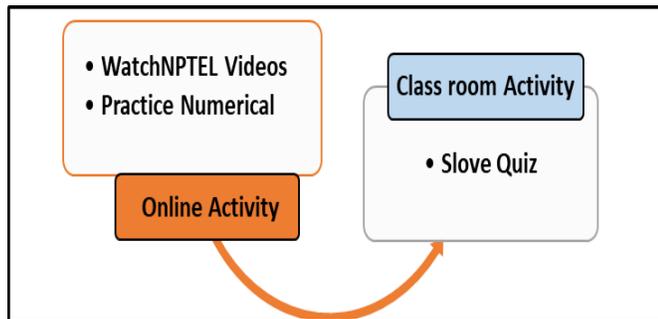


Fig. 7. Flipped Classroom Activity –based on NPTEL videos

also told to practice numerical problems based on this topic with help of given videos. After a week, another quiz was given to measure pupils' comprehension of the same topic

#### B. Effectiveness of Flipped classroom activity

This activity was carried out with 135 students, and the quiz results were verified before and after the activity. Before the activity, the quiz results showed that 13% of students had low marks, 31% had moderate marks, and 55% had high marks. Following the flipped classroom activity on the same topic, another quiz was administered, and the results were improved because 2% of the students received lower marks, 22% received moderate marks, and 75% received high marks. Figure 8 shows student performance before and after activity.

Flipped class rooms allow students to learn at their own convenience outside of class and ensures a better understanding of the concepts before moving on. This personalised approach will suit different ways of learning and abilities. when classes

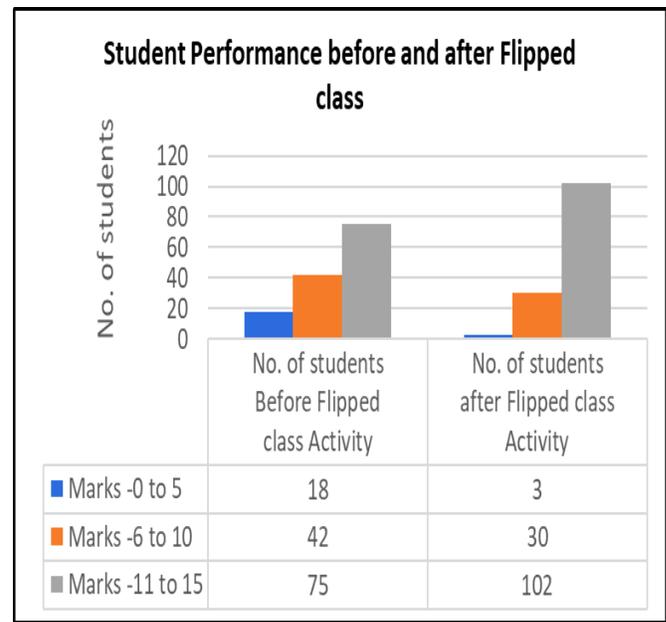


Fig. 8. Flipped Classroom Activity – Performance of students

are flipped ,students can arrive prepared and have more class time gave to discussions and problem solving. Students are encouraged to apply what they've learned, analyse the information, and to develop higher-order thinking skills.

#### IV. INNOVATIVE TEACHING LEARNING ACTIVITIES WITH THE AID OF TECHNOLOGY

Innovative teaching and learning activities that apply technology can boost student engagement and knowledge retention significantly. Crossword puzzles and concept mapping are two examples of such activities.

##### A. Concept Map

A concept map is a visual representation that helps individuals organize and connect their understanding of concepts or ideas. It consists of nodes or boxes representing concepts and lines or arrows indicating the relationships between them. Several tools can be used to create concept maps, such as Mind Meister, an online platform that enables collaborative concept mapping with a user-friendly interface and customization options. Coggle is another web-based tool that offers intuitive concept mapping features, including real-time collaboration and file attachments. XMind is a comprehensive concept mapping software with various templates and customization options. Additionally, presentation software like Microsoft PowerPoint or Google Slides can be used to create basic concept maps using shapes and text boxes. These tools empower learners to visually organize their knowledge and explore the relationships between different concepts effectively (Kalhor & Shakibaei, 2012) .

Concept maps provide a visual representation of the relationships between concepts and Concept maps help visual learners understand complex information by making it more accessible and understandable. Concept mapping aids in the organization and structuring of knowledge by allowing learners

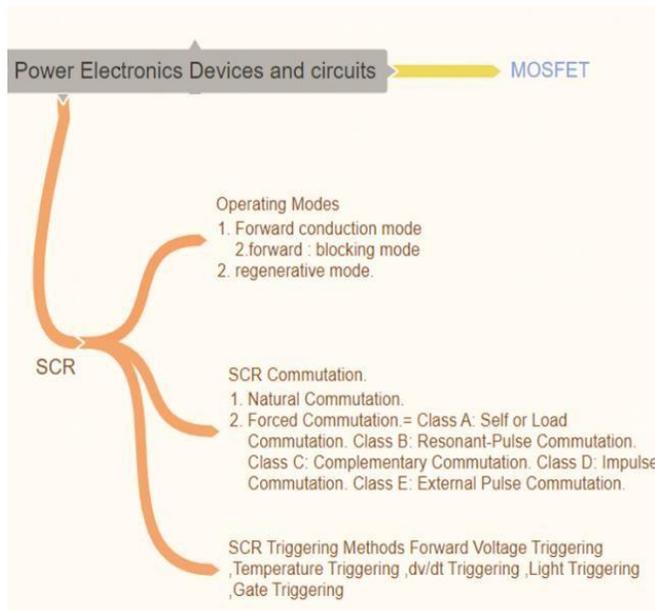


Fig. 9. Example of Concept Map

to make meaningful connections between various concepts. It improves both critical thinking and creativity (Selvi & Joice, 2022)

TABLE I

RUBRICS FOR CONCEPT MAP

| Criteria              | Excellent (5)                                                                                    | Good (3-4)                                                                             | Needs Improvement (1-2)                                                               |
|-----------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Content Understanding | Demonstrates a profound understanding of the topic, including intricate details and connections. | Shows a solid grasp of the content, with accurate representation and some connections. | Displays a limited understanding of the content, missing key details and connections. |
| Clarity               | Concepts and relationships are presented with exceptional clarity and precision.                 | The concept map is clear, but some elements may require closer attention for clarity.  | Concepts and relationships are unclear, making it challenging to follow the map.      |
| Creativity            | Demonstrates exceptional creativity in representing concepts and relationships.                  | Shows creativity in the representation of concepts, making the map visually engaging.  | Lacks creativity, and the representation is mundane or overly simplistic.             |
| Accuracy              | All information is accurate, with no factual errors or misconceptions.                           | Information is mostly accurate, with minor inaccuracies or omissions.                  | Contains significant inaccuracies, misconceptions, or missing essential information.  |

Rubrics for concept map assessment is given in table 1. Assessment was done for content understanding by the students, clarity, creativity and accuracy of information. Activity was conducted before theory examination. Making a concept map before an exam can help students study more efficiently because it helps them organize information visually and simplify difficult subjects. It helps students think more deeply and retain the information by pointing out areas in which they might be ignorant. Additionally helpful for reviewing, the concept map saves time by arranging important information in an easily understood format. Students who create and review concept maps report feeling more confident about their knowledge, less anxious about the test, and more prepared to perform well on exam day.

### B. Crossword Puzzle

A crossword puzzle is a type of word game in which you fill in words horizontally and vertically based on clues. It is made up of a grid of squares, each representing a letter in a word. Clues for both horizontal and vertical words are provided, assisting players in determining the correct words to fill in the puzzle grid. Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). First, use the equation editor to create the equation. Then select the “Equation” markup style. Press the tab key and write the equation number in parentheses (Crossman & Crossman, 1983).

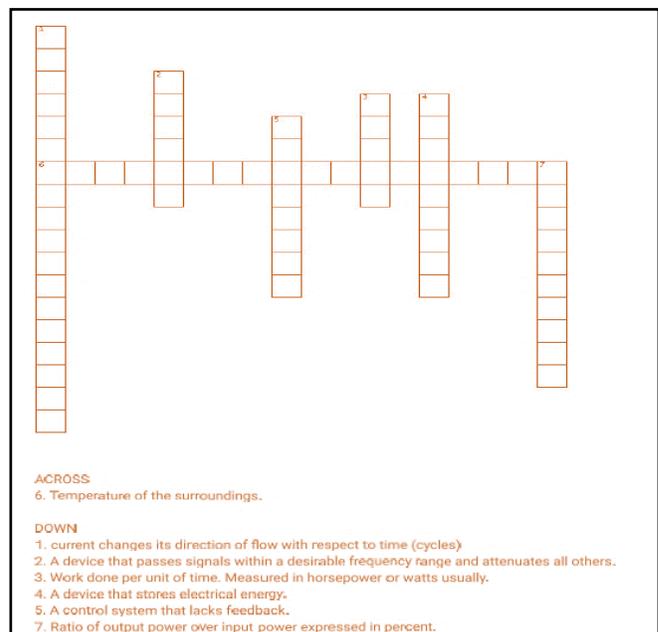


Fig. 10. Example of Crossword Puzzle

Crossword puzzles can be created using a variety of tools. Crossword puzzle generators online, such as Eclipse Crossword or Crossword Hobbyist, provide user-friendly interfaces and customizable options for creating interactive puzzles with clues and answers. These puzzle generators frequently allow for the puzzles to be saved, shared, and printed (Saran & Kumar, 2015)

A crossword puzzle is an enjoyable and interactive way to engage students in their learning. It encourages students while making learning more enjoyable, resulting in increased student

TABLE II  
RUBRICS FOR CROSSWORD PUZZLE

| Criteria                      | EXCELLENT (5)                                                         | Good (3,4)                                                       | Needs Improvement (1,2)                                                               |
|-------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Completion within Time        | Completes the puzzle accurately within the allotted time frame.       | Mostly completes the puzzle accurately within the allotted time. | Makes limited progress within the time frame; significant sections remain incomplete. |
| Accuracy of Completed Portion | The completed portion is entirely accurate and relevant to the clues. | The completed portion is mostly accurate, with few minor errors. | Many inaccuracies in the completed portion, impacting overall correctness.            |

engagement. Students effectively recall information and link it to specific clues in crossword puzzles, which stimulates memory recall and improves long-term memory, making it an effective memorization method.

Crossword puzzles were conducted as a fun game to help students remember tricky words related to important stuff they're learning. When students fill in the puzzle blanks by remembering and using what they know, it's like practicing and getting better at it. The puzzles make it easier to remember because they connect hard words to things students already know. Also, seeing the words in the puzzle helps create pictures in the mind, making it easier to remember. Solving these puzzles is like solving little problems, and it helps students remember things for a long time. Plus, it's enjoyable, which makes learning more fun and keeps students interested. Students can also use these puzzles to check how well they understand tough concepts.

## V. CONCLUSION

The use of Learning Management Systems (LMS) and Technology-Enhanced Learning (TEL) methods for activity design has completely transformed the educational landscape. Using an LMS, educators can streamline course management, effectively deliver content, and track student progress. TEL methods improve learning by using multimedia elements, encouraging collaboration, and providing flexible access to educational resources.

The combination of LMS and TEL methods increases student engaging, interactive, and personalized learning activities that promote critical thinking and active participation. The incorporation of TEL tools into the learning process, such as crossword puzzles and concept map, provides many benefits. Crossword puzzles are a fun and interactive way for students to practice and remember information and knowledge. Concept maps, on the other hand, enable students to visually arrange and connect ideas, resulting in a more in-depth understanding of complex concepts. These technology-enhanced learning (TEL) tools promote active learning, critical thinking, and information

retention. Educators can create dynamic and effective learning activities that increase student engagement and facilitate meaningful comprehension of the subject matter by using crossword puzzles and concept maps.

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