Innovative Pedagogical Approaches for Diverse Learning Styles and Student-Centric Learning

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Abstract*— Amidst the aftermath of the COVID-19 pandemic, the landscape of education in India has undergone a profound transformation. Traditional methods of teaching and learning, once the bedrock of our educational system, now find themselves met with skepticism from both students and educational institutions. In response to this paradigm shift, this paper delves into the pressing need for a comprehensive overhaul of pedagogical methodologies within the context of engineering education in India. It emphasizes the pivotal role of education and pedagogy, advocating for a departure from conventional models towards a more learner-centric and adaptable framework, tailored to the nuances of the Indian education landscape. In this context, the paper sheds light on the intrinsic value of understanding diverse learning styles, particularly within the backdrop of a digitally driven era. The profound impact of digital platforms on modern education in India is explored, underscoring their potential to revolutionize and enhance the learning experience for Indian students. The paper further examines unconventional techniques that challenge the norms of education as conventionally understood, recognizing their potential to bridge the gap between students' expectations and institutional methodologies. Within the discourse of this paper, special attention is accorded to three distinctive non-conventional pedagogical approaches: 'Cyberhunt', 'Keyword Concept' and 'Role Switch Teaching'. These methodologies are scrutinized as quintessential examples of innovative strategies that can foster an intuitive and engaging learning environment within Indian classrooms. 'Cyberhunt' immerses students in experiential learning by assigning them virtual quests that mirror real-world challenges, thereby nurturing critical thinking and problem-solving skills tailored to the Indian context. Similarly, the 'Keyword Concept' approach capitalizes on cognitive associations to enhance memory retention and conceptual understanding, catering to the unique learning styles often found in India. Further, the innovative 'Role Switch' teaching methodology, which involves assigning students diverse roles in course delivery, was successfully implemented to further enrich the learning experience in the context of control engineering course.

***Keywords*— Need for Change; Learning Style; Cyber hunt; Keyword Concept**

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I. INTRODUCTION

In the present context, following the COVID-19 pandemic, traditional methods of teaching and learning are facing diminished appeal from both students and educational institutions. This has prompted a need for innovative instructional approaches to bridge this gap. This paper underscores the significance of education and pedagogical changes, particularly in the domain of engineering education, in order to cultivate a learner-centric environment. The paperalso highlights the importance of understanding diverse learning styles, the impact of digital platforms, and the utilization of unconventional teaching techniques (Cropley & Sitnikova, 2005).

In today's civilization, innovation and technology stand as two formidable pillars, crucial not only for the present but also for the future of India. As technological challenges in society evolve, engineers play a pivotal role in identifying and resolving these issues for the betterment of people's lives and communities. However, the current state of engineering education may not be adequately preparing engineers for these challenges (Hamdan & Saripudin, 2023)

The act of teaching is incomplete without the corresponding act of learning. In a world that is becoming increasingly complex, education needs to keep pace. Deficiencies in engineering education can lead to graduates who fail to grasp the connection between technology and society. Therefore, the paper emphasizes the need to enhance engineering students' skills and contribution potential through an enriched technical curriculum and an effective learning environment (Roque et al., 2023)

In today's generation, traditional teaching methods such as lectures and PowerPoint presentations are inadequate for effective learning. To address this, educators must equip themselves with diverse teaching approaches that cater to both students' preferences and teachers' preferences. The primary goal is to transition from a teacher-centric to a learner-centric approach (Subramanian & Kelly, 2019)

Education serves as the foundation of any nation. It not only imparts knowledge but also equips students to apply their skills to real-world problems. Education should foster intensive and critical thinking, enabling students to blend their knowledge with practical problem-solving (Joice, 2022).

In the context of engineering education, teaching methods need to evolve. The paper observes that the current methods do not always promote the desired learning outcomes. There is a need for innovative, integrated, conceptual, and multi-disciplinary approaches to teaching (Keiler, 2018).

Teaching and learning are interconnected, where teachers provide knowledge and students absorb it. However, classrooms often lack interactivity. Different students possess different learning styles, making it essential for educators to understand how students think and tailor their teaching accordingly (Ion et al., 2013)

Engineer classrooms host a variety of learners, each with distinct learning preferences. Effective teaching methods should accommodate this diversity. Three innovative techniques, namely 'Cyberhunt', 'Keyword Concept' and 'Role Switch", have emerged to address these challenges and provide cognitive, affective, and psychomotor learning opportunities. This paper introduces the importance of revamping engineering education in response to evolving educational needs and challenges. It emphasizes the shift from traditional teaching to learner-centric methodologies and highlights the significance of diverse teaching techniques. The subsequent sections will delve deeper into these ideas and explore the innovative methods.

II. NEED FOR CHANGE

In today's education landscape, traditional teaching methods are becoming less effective due to the widespread influence of technology in our classrooms. This calls for a fundamental reimagining of teaching methodologies, alongside an urgent embrace of technology within the educational fabric. The incorporation of virtual learning environments comprising presentations, videos, and seminars opens doors to enriched engagement, allowing students to revisit and refine their comprehension. Particularly noteworthy are digital e-learning platforms that wield substantial influence in nurturing an environment centered around student learning, thus placing students in the vanguard. These platforms empower students to access resources and seek solutions, a boon for those grappling with complex concepts. Striking a harmonious balance between technological integration and traditional pedagogy is essential, as an outright dismissal of technology remains an unviable stance(Uskov et al., 2018)

The commonplace directive, "Turn to your neighbor," often heard in classrooms, suggests a collaborative approach to problem-solving. However, its efficacy hinges on active participation from peers. The potential for discord emerges when a student's pace diverges from their neighbor's, potentially impeding the learning process. Rather than relying solely on this saying, it is sensible to introduce non-conventional teaching methodologies. Approaches such as "think-pair-share," cooperative learning, and "TAPPS" (Thinking Aloud Pair Problem Solving) demand more time investment yet offer dynamic engagement and heightened student interest. It is advisable to replace numerous individual questions with a single comprehensive inquiry that encapsulates a spectrum of concepts or principles (Dessus et al., 2008)

This section underscores the imperative to evolve pedagogically in response to technological advancements. The integration of technology and innovative teaching methodologies presents an opportunity to stimulate learning environments, fostering active participation, collaboration, and holistic understanding, all within the Indian educational context(Wiebe et al., 2012).

III. REVIEW ON FACTORS THAT ENABLE LEARNING

In the pursuit of enhancing the effectiveness of teaching and learning within the classroom, several factors emerge as pivotal catalysts. These aspects collectively contribute to a dynamic and participatory educational environment, tailored to the unique contours of the Indian context.

- Cultivating Student Motivation: A cornerstone of effective instruction involves nurturing student motivation. Research studies conducted by (Garris et al., 2002) have shown that regularly inspiring and motivating students, especially when unconventional teaching methods are employed, positively impact their engagement and learning outcomes. Furthermore, they found that constructive critique, as opposed to unwarranted criticism, fosters creativity and resilience in students.
- Significance of the Learner in an Active Environment: Interactive classrooms play a pivotal role according to (Gauci et al., 2009), prioritizing dynamic engagement by meticulously planning strategies that resonate with students' perspectives leads to improved learning outcomes. Visualizing teaching methods from students' vantage points, as suggested by (Darling-Hammond et al., 2020), has been shown to enhance student involvement and understanding. Moreover, regular feedback solicitation, as highlighted by (Remesh, 2013), serves as a potent tool for refining the teaching-learning process when novel pedagogical techniques are introduced.
- Articulating Course Objectives and Outcomes: Empirical studies such as (FitzPatrick et al., 2015) have demonstrated that presenting course objectives and outcomes at the outset empowers students with a panoramic view of their educational journey. This clarity helps align their efforts with the intended learning outcomes, thus promoting more focused learning activities.
- Adapting to Diverse Learning Styles: Research by (Bhagat et al., 2015) underscores the importance of a teacher's awareness of their own learning style. Tailoring instructional methods to encompass varied learning preferences, as suggested by (İlçin et al., 2018), has been associated with improved student engagement and performance. Additionally, (Kharb et al., 2013) found that familiarizing students with different learning styles equips them to explore a spectrum of effective learning methods.
- Leveraging Computer-Assisted Instruction: Navigating the digital landscape is crucial and Proficiency in technology, according to (Lim et al., 2023), garners students' respect and interest. Platforms such as Google Docs and Massive Open Online Courses (MOOCs), as discussed by (Hollands & Tirthali, 2014), have been shown to enhance teaching efficacy, creating a bridge between educators and digitally savvy students.
- Integrating Intervals for Optimal Engagement: Recognizing the shortened attention spans of contemporary learners, strategically incorporating intervals, as suggested by (Lodge

& Harrison, 2019), aids in information retention and reflection. This practice enhances students' cognitive assimilation and analytical ability.

- Cultivating Creative Thinking through Open-ended Questions: Encouraging open-ended questions, as explored by (Sa'idah et al., 2021), invites students to delve beyond conventional approaches. This methodology has been found to nurture innovative thinking, fostering a vibrant intellectual ecosystem.
- Fostering Inductive Problem-Based Learning: Embracing inductive teaching, akin to the observational learning of infants, is pivotal. According to (Prince & Felder, 2006), by encouraging students to deduce principles from real-world challenges, educators incubate critical thinking, resilience, and creative problem-solving skills.
- Harnessing the Power of Peer Learning: Research by (Tullis & Goldstone, 2020) has demonstrated that harnessing the synergy of peer learning augments understanding. Students often learn more effectively when teaching peers of comparable understanding, reinforcing collaboration and shared growth.
- Personal Connection and Ongoing Support: (Son et al., 2020) found that establishing personal connections and maintaining consistent engagement with students communicates concern for their academic journey. Regular check-ins and progress tracking, as investigated by (Amerstorfer & Freiin von Münster-Kistner, 2021),amplify students' dedication and overall performance.
- A Multifaceted Mentorship Paradigm: Effective mentorship transcends academia. (Agholor et al., 2017) suggests that a mentor should guide students not only in academic pursuits but also in personal development, relationship-building, and career advancement, ensuring holistic growth.

These factors collectively constitute a comprehensive roadmap for transforming teaching and learning within the Indian educational context. By integrating these insights, educators can propel the evolution of a vibrant, inclusive, and transformative educational environment that resonates with the needs and aspirations of modern learners (Hamm & Griffith, 2012)

IV. LEARNING STYLES AND PREFERRED METHODS

A learning style represents an individual's distinct approach to perceiving, interpreting, analyzing, and retaining information. Extensive educational research has yielded a variety of theories and models dedicated to these styles, including David Kolb's Model, Honey and Mumford Model, Neil Fleming's VAK/VARK Model, Gregorc Mind Styles Model, The Dunn and Dunn Model, and Felder and Silverman's Learning Styles. Each model carries its own set of critiques and strengths. Every person is inherently unique, and this holds true for both students and teachers. Each teacher employs teaching strategies aligned with their learning style, ultimately benefiting similar learners in their classrooms. It is imperative not to label students as 'bright' or 'weak' based on instructional methods. For instance, an active learner might not possess the patience required for lengthy lectures, unlike reflective learners. While all students possess equal potential, they exhibit diverse learning styles. The different learning styles, and preferred teaching methods are listed in Table 1. Research has even identified differences in learning styles among adults, spanning across genders (R. M. Felder et al., 2000).

TABLE 1
TEACHING STRATEGIES

Learning styles	PREFERRED MATERIALS	PREFERRED METHODS
Visual, Active, Global, Intuitors	Use of images, charts, graphs, video lectures, online questionnaire	Flipped Classroom technique, E-Learning, Slides Presentation, Experimentation /Projects
Verbal /aural	Use of mnemonic devices, reference materials, outlines, flowcharts, reading aloud	Lectures, Chalk and talk, group Discussions,Quizzes, Brainstorming sessions
Read-write.	Taking short notes, working alone,write whilst studying	well-known methods while solving problems, Essays, Assignments, Unit tests
Kinesthetic /tactile, sensing	Hands-on experience, Assembling or disassembling of objects, Construction tools	Practical classes, Project-Exhibitions, Provide reference objects, Real-time examples while explanation

Gregorc advocates for teacher-educators to possess an understanding of learning styles, as this knowledge facilitates the implementation of effective teaching strategies. Gregorc also criticizes attempts to force educators and learners into altering their innate styles, arguing that such efforts may lead to negative consequences, isolation, or discomfort. Felder has also expressed concerns regarding unintended mismatches, where teachers are unaware of their own learning styles and consequently teach in a manner that favors certain students while disadvantaging others.

A helpful framework, known as the Felder-Silverman model, has been developed to assist both students and teachers in comprehending how they receive and process information. This model encompasses diverse dimensions that closely align with different learning preferences. To gain a comprehensive understanding of this model, a detailed exploration of the various learning styles is presented.

- Exploring Learning Styles: The Felder-Silverman model categorizes learning styles into distinct approaches that

individuals adopt when acquiring knowledge:

- Active and Reflective Learners: Active learners thrive on hands-on experiences and prefer learning through action. They exhibit impatience and gravitate towards activities like short seminars and group discussions, as opposed to lengthy lectures. Reflective learners, in contrast, exercise patience and prefer contemplation before taking action. They excel when working individually and value thorough thinking before implementation. Striking a balance between these two approaches is recommended; an excess of either can lead to errors or time management challenge.
- Sensing and Intuitive Learners: Sensing learners embrace learning through facts, established methods, and memorization of data. They seek real-life applications that offer a practical understanding of concepts. Intuitive learners, on the other hand, engage in abstract thinking and excel in recognizing connections between different ideas and theories. They avoid repetitive tasks and prefer quick thinking. Balancing between these two styles is essential, as overemphasizing one can result in over-reliance on memorization or overlooking familiar problem-solving techniques.
- Visual and Verbal Learners: Visual learners thrive when presented with visual aids such as pictures, graphs, charts, online materials, videos, and short movies. Verbal learners, in contrast, prefer learning through lectures, audio-based content, and reading aloud. Research indicates a prevalent affinity towards visual learning, highlighting the need for tools catering to visual learners.
- Sequential and Global Learners: Sequential learners embrace incremental learning through step-by-step processes and logical sequences. They seek a comprehensive understanding of concrete concepts. In contrast, global learners absorb knowledge without being limited by immediate connections and later integrate the information to form a holistic view. These learners excel in complex problem-solving and possess an abstract understanding of subjects. Global learners benefit from the freedom to develop their problem-solving methods. It's worth noting that individuals may display tendencies towards both sequential and global styles, sometimes identifying as global learners based on quick assessments.

The Felder-Soloman Index of Learning Styles is widely preferred due to its comprehensive description and its ability to establish strong, moderate, and balanced correlations among different learning styles(R. Felder & Silverman, 2002). This index/questionnaire was utilized through online Google Forms to conduct a survey among 180 students from an Engineering institute in South Karnataka. The responses from this survey are shown in Table 2 and they provide valuable information about the diverse learning style patterns exhibited by engineering students.

Table 2: Distribution of different Learning Styles in Classroom from the survey conducted.

Learning Style	Percentage
Visual	22
Verbal	7
Sequential	12
Global	10
Active	12
Reflective	12
Sensing	13
Intuitive	12

It's important to note that each individual possesses a unique amalgamation of Active/Reflective, Sensing/Intuitive, Visual/Verbal, and Sequential/Global learning styles. Moreover, these styles exhibit varying degrees of correlation—ranging from Strong to Mild or achieving a Well-Balanced equilibrium.

The chart prominently underscores the diverse framework of learning styles coexisting within a classroom environment, with a pronounced inclination towards visual learning preferences as opposed to verbal modes. Consequently, educators are tasked with crafting instructional materials and methodologies that resonate with this multifaceted array of learners sharing the same educational space.

For instance, a well-rounded approach to teaching might involve initiating a class session with a focused discussion on topic objectives and desired outcomes. This initial segment would cater to sequential learners, who thrive on comprehending the broader context. Subsequent segments could encompass dynamic presentations comprising visual aids such as charts, graphs, and videos, a strategy well-suited for accommodating the preferences of visual learners. Strategic pauses for reflection following question prompts would promote creative thinking and innovation, thereby catering to the cognitive needs of diverse learners. Culminating the class with a group discussion would effectively engage active, global, and intuitive learners, nurturing a collaborative learning environment.

While this approach demands meticulous planning and skillful execution, its potential to kindle curiosity and foster engagement among learners marks a departure from conventional lecture-based methods.

V. NON-CONVENTIONAL PEDAGOGY APPROACHES

As established earlier, the educational landscape is evolving, driven by transformations in both the student body and the world at large. Despite these changes, teaching strategies have remained largely stagnant, prompting a compelling need for pedagogical evolution. In response, educators are engaging in ongoing research to reshape learning experiences, aiming for greater effectiveness. This section delves into the emergence of non-conventional pedagogical methods that address this evolving educational landscape.

- Evolving Pedagogical Practices: In the face of evolving

student demographics and a rapidly changing world, there is a growing realization that traditional teaching approaches need to adapt. Educational practices that have been effective for years may no longer fully resonate with the diverse range of students entering classrooms today. The integration of technology and innovative instructional methodologies is a critical facet of modern education. Educators are called upon to reevaluate and reinvent their pedagogical strategies to align with the shifting dynamics of the learning environment.

- Seamless Integration of Technology: A notable advancement in pedagogical practices involves the seamless incorporation of technology into the learning process. Digital learning platforms and e-learning tools have gained substantial traction, particularly among students immersed in the electronic realm. Harnessing the full potential of technology requires not only providing teachers with comprehensive training on these tools but also offering learners supplementary guidance on navigating technological resources. Utilizing devices like tablets and computers can significantly enhance the learning experience, bridging the gap between traditional teaching methods and contemporary learning preferences. The integration of web technologies emerges as a powerful educational tool that optimizes classroom interactions. Therefore, infusing technology into conventional curricula becomes crucial to ensuring efficiency and up-to-date relevance.
- Pioneering Non-Conventional Strategies: The subsequent exploration of non-conventional teaching methods stems from a desire to adapt pedagogical practices to the changing educational landscape. These innovative strategies have been put to the test within the context of an institute in South Karnataka. Through their implementation, educators seek to bridge the gap between traditional teaching methods and the evolving learning preferences of students. Such strategies not only cater to the diverse learning styles present in a modern classroom but also offer a glimpse into the potential future of education.

1. CYBERHUNT

In an era marked by remarkable technological advancements, the landscape of education has witnessed a significant transformation. From the evolution of supercomputers to the ubiquity of smartphones, technology has permeated every facet of our lives, including education. This transformation extends to students who are deeply immersed in the world of the internet, often leveraging resources like Google to enhance their learning experiences. Even at the kindergarten and primary levels, computer games and puzzles are employed as tools for education.

Implementation of Cyber hunt: To enrich the learning experience and bridge the gap between theoretical knowledge and practical application, we introduced the innovative Cyber Hunt method into the Strength of Materials course with around 60 students. This pedagogical approach leveraged the ubiquitous presence of technology in students' lives, allowing them to use their personal cellphones as tools for learning. The implementation process encompassed the following key steps:

- Group Formation: Students were organized into small groups of 3 to 5 individuals. Each group member was assigned a distinct role, such as leader, recorder, devil's advocate, and checker. This approach fostered collaborative learning dynamics and ensured that students actively engaged with course material.
- Problem Selection: Real-world engineering problems related to the course content were carefully selected. These problems ranged in complexity, enabling students to apply their knowledge progressively.
- Time-Bound Challenges: Groups were presented with specific problems and allotted a stipulated time frame to arrive at solutions. During this time, students were encouraged to use their cellphones to access online journals and learning resources.
- Solution Presentation: Teams that successfully found solutions within the given time frame were invited to present their findings to the entire class. This encouraged knowledge sharing and the dissemination of problem-solving approaches.

Real-World Problems Allocated: The success of the Cyber hunt method depends on the selection of real-world engineering problems that align with the learning objectives of the Strength of Materials course. Notable examples of problems allotted to student groups included:

- Design of a Load-Bearing Bracket: Students were tasked with designing a load-bearing bracket for a rooftop solar panel installation. The challenge encompassed calculating bending stress under varying wind loads and optimizing dimensions for strength and weight.
- Bridge Truss Analysis: Groups analyzed the load-bearing capacity and potential points of failure in a truss structure. This problem encouraged the application of axial and shear stress analysis.
- Material Selection for a Bicycle Frame: Students selected materials for a bicycle frame, considering material properties, weight, and cost to ensure structural integrity and durability.
- Stress Analysis of a Suspension System: The challenge involved analyzing the stress distribution in a vehicle's suspension system under different road conditions, prioritizing safety and performance.
- Deflection Analysis of a Cantilever Beam: Students analyzed the deflection of a cantilever beam used in construction, determining deflection under varying loads and proposing design modifications if necessary.

The Cyber hunt method successfully integrated real-world engineering challenges with course content, promoting self-directed learning, teamwork, and practical problem-solving skills. The positive reception and outcomes observed among students attest to the method's effectiveness in enhancing the delivery of Strength of Materials course.

In an age where digital resources are abundant, the traditional reliance on libraries and textbooks for knowledge has evolved

into a dynamic process of internet-driven learning. Today's students must not only possess a solid foundation of fundamental concepts but also master the art of navigating the vast digital landscape to access, evaluate, and apply information effectively. The Cyber hunt method, as demonstrated in this study, not only fosters self-directed learning and teamwork but also equips students with the essential skill of discerning reliable information from the digital domain. In the real-world scenarios they will encounter, the ability to access and utilize information from the digital world is paramount. Gone are the days of searching through libraries; what matters is the capability to acquire the right knowledge at the right time from the wealth of data available online. It not only empowers students to take charge of their learning journey but also nurtures skills crucial for the digital age. The method's success lies not only in its innovative nature but also in its potential to evolve and adapt in response to feedback and changing educational paradigms.

To optimize the Cyber hunt approach, certain recommendations are worth considering. These include ensuring robust connectivity, allocating adequate time for problem-solving, assigning diverse roles within groups, continuous improvement through feedback, and structured integration into the curriculum.

The Cyber hunt approach garnered positive feedback from participants of the third semester. The feedback questionnaire was collected on a 5-point scale (1 = Strongly Disagree, 5 = Strongly Agree) using Google Forms. The consolidated response from the students in percentage is shown in Table 3.

Table 3: Feedback response for Cyberhunt Activity

Feedback Questionnaire	Feedback %
The opportunity to use my cellphone during the activity helped me explore new online resources	93.1
Working in a group during Cyber hunt allowed me to share ideas and collaborate effectively.	91.5
The assigned roles within the group (leader, recorder, devil's advocate, checker) contributed to a balanced and coordinated effort.	94.2
I found Cyber hunt to be an engaging and enjoyable learning experience.	97.5
The Cyber hunt activity enhanced my understanding of the subject matter and promoted Lifelong/self-learning	94
Cyber hunt improved my ability to search for reliable information on the internet.	96.6

The feedback responses reflect a highly positive reception of the Cyber hunt activity among the students. The activity was not only engaging but also effective in enhancing various aspects of their learning experience, including collaborative skills, problem-solving abilities, and digital literacy. These findings validate the value of such innovative teaching approaches in modern education.

2. KEYWORD CONCEPT

The "Keyword Concept" method serves as a pedagogical approach aimed at enriching students' grasp of concepts by tapping into both their conscious and subconscious minds. This method acknowledges that a student's mentality encompasses two distinct aspects: the conscious mind, which pertains to present-moment awareness, and the subconscious mind, which holds a repository of accessible information. Access to this information is achieved through directed attention or memory recall, a process that aids in stimulating the subconscious mind. During the course of a lecture, students naturally possess an inquisitive mindset. This aspect is leveraged by the "Keyword Concept" technique, which facilitates the transition of thought processes from the conscious to the subconscious realm. Building upon the insights shared in the preceding section, where we discussed various learning styles, this method particularly resonates with reflective and visual learners. For these learners, revisiting previously taught concepts is not only a means of maintaining content continuity but also a strategy for reinforcing memory and understanding.

Implementation of “Keyword Concept” Technique: Finite Element Method (FEM) is a crucial subject in Mechanical Engineering, known for its challenging nature. This part focuses on the practical implementation of the "Keyword Concept" method within the FEM course which had around 60 students, aimed at improving students' conceptual understanding.

- Course Context: The study was conducted within the framework of a Finite Element Method course for Mechanical Engineering students.
- Integration of "Keyword Concept" Method: The "Keyword Concept" method was introduced as a pedagogical tool to reinforce FEM concepts. Engineering-related keywords were incorporated into the course curriculum, and their positive understanding was encapsulated in sentences by students.
- Implementation Process: The implementation involved a systematic process where FEM-related keywords were presented using PowerPoint slides for a brief 15-second duration. Students then composed sentences to express their understanding of the displayed FEM keyword. This process was repeated for 30 to 45 keywords, strategically drawn from the FEM course's content.
- Structured Organization: The FEM keywords were organized in a structured format, ensuring a diverse range of FEM concepts was covered. The entire process, from keyword presentation to sentence composition, was time-efficient, typically taking 8 to 12 minutes per session.
- Interactive Evaluation: Following keyword presentations, interactive evaluation sessions were conducted. Selected students discussed the sentences they had composed, facilitating the validation of comprehension of FEM concepts, and addressing any potential misconceptions.

A sample of keywords related to FEM, which were employed during the implementation, includes:

- Mesh Generation: Encouraged students to think about

meshing strategies and element types.

- Stress Analysis: Prompted students to consider stress distribution in structures under various loads.
- Boundary Conditions: Focused on specifying appropriate boundary conditions for FEM simulations.
- Convergence Analysis: Encouraged discussions on convergence criteria and solution refinement.
- Numerical Integration: Fostered reflections on how numerical integration impacts solution accuracy.
- Element Types: Prompted considerations about choosing appropriate elements for specific simulations.
- Material Properties: Encouraged reflections on the significance of accurate material data.
- Eigenvalue Analysis: Focused on discussions related to eigenvalues and their relevance in FEM.

Through practical implementation, several key observations have emerged:

- The "Keyword Concept" method effectively engages students by encouraging sustained reflection on specific concepts, both in isolation and in relation to broader topics.
- The time constraint imposed by the 15-second display period for each keyword encourages heightened cognitive processing. This, in turn, contributes to the development of higher intelligence quotient and innovative thinking among students.
- Owing to the varying levels of conceptual understanding associated with different keywords, student perspectives naturally differ. This diversity underscores the richness of discussions and exchanges during the evaluation phase.
- Notably, this technique ignites the creative faculties of students, inspiring them to explore alternative viewpoints and engage in meaningful discussions with both their peers and educators.
- The interactive discussions also lead to the identification of multiple approaches to address a single keyword, thereby fostering a comprehensive and multifaceted understanding of the subject matter.

There are several key takeaways that can shape the implementation of the approach,

- End-of-Module Integration: Implementing the "Keyword Concept" at the conclusion of every module or lesson can serve as an invaluable tool for information summarization. By revisiting core concepts, students not only reinforce their understanding but also build confidence in their knowledge.
- Embracing Technological Integration: The "Keyword Concept" approach can further evolve by integrating various online quiz tools. This enhancement can transform the learning experience into a highly interactive and engaging process. Through technology, we can adapt and meet the evolving needs of our digitally native student body.
- Careful Keyword Curation: Educators must meticulously curate a comprehensive list of keywords for each course topic. This preparation ensures that the "Keyword Concept" method maximizes student benefits by targeting essential concepts and promoting in-depth understanding.

The student feedback was gathered for the above approach which yielded highly positive results. The feedback questionnaire employed a 5-point scale (1 = Strongly Disagree, 5 = Strongly Agree) using Google Forms and the aggregated student responses, presented as percentages, are summarized in Table 4.

Table 4: Feedback response for Keyword Concept Activity

Feedback Questionnaire	Feedback %
To what extent did the "Keyword Concept" activity stimulate your subconscious mind and encourage thoughtful reflection on specific concepts?	96.1
How effectively did the "Keyword Concept" method assist in transitioning your thought processes from conscious awareness to deeper understanding?	95.6
To what degree did the use of keywordsfor 15-second intervals increase your cognitive processing and encourage innovative thinking?	95.7
How well did the interaction during the evaluation phase enhance your understanding of the discussed concepts and address potential misconceptions?	98.5
To what extent did the "Keyword Concept" approach encourage engagement with your peers and lead to discussions on alternative viewpoints?	96.6
Overall, how effective was the "Keyword Concept" method in deepening your conceptual understanding and promoting active interaction in the learning process?	97

3. ROLE SWITCH TEACHING

This innovative teaching approach involves a continuous rotation of roles between students and the instructor throughout a course. The goal is to create a dynamic and engaging learning environment where students actively participate in teaching and decision-making processes, thus fostering a deeper understanding of the subject matter.

The following methodology was followed to teach the Control Engineering course for Mechanical Engineering Students:

- Preparation: The foundational step in implementing Role Switch Teaching was meticulous course design. We adopted a modular framework that precisely aligned with the syllabus topics in Control Engineering, ensuring seamless integration of this pedagogical innovation. Each module was carefully constructed to facilitate the dynamic exchange of roles and foster active student engagement.
- Strategic Topic Integration: To achieve a purposeful connection between the teaching strategy and the curriculum, we strategically aligned specific roles with

each course module. This alignment ensured that the roles

directly complemented the content covered in that module. For example, during the "Introduction to Control Systems and System Modelling" module, the "Instructor for the Day" role was assigned to facilitate an in-depth exploration of open-loop and closed-loop systems, directly corresponding to the module's learning objectives.

- Role Assignment: At the outset of each module, students were assigned roles that encapsulated the essence of the topic. This assignment was carefully designed to not only engage students actively but also to promote peer-to-peer learning and collaborative problem-solving. Roles included "Question Master," "Content Analyzer," "Case Study Presenter," "Simulator Operator," and "Controller Designer," each tailored to the specific learning outcomes of the corresponding module.

Key Topics in Control Engineering and Roles:

1. Introduction to Control Systems and System Modelling:
- Role: "Instructor for the Day"
- Outcome: Comprehensive exploration of open-loop and closed-loop systems, fostering a deep understanding of these foundational Control Engineering concepts.
2. Time Response Analysis of Control Systems:
- Role: "Question Master"
- Outcome: Dynamic discussions on first order and second-order system responses, significantly enhancing students' grasp of these complex topics.
3. Block Diagrams and Signal Flow Graphs:
- Role: "Content Analyzer"
- Outcome: Skillful summarization of discussions on signal flow graphs and block diagram reduction, aiding students in synthesizing intricate concepts.
4. Stability of Linear Control Systems:
- Role: "Case Study Presenter"
- Outcome: Prompting collaborative application of stability concepts in real-world scenarios, enhancing problem-solving skills and providing insights into practical aspects of Control Engineering.
5. Frequency Response Analysis:
- Role: "Simulator Operator"
- Outcome: Facilitating hands-on experience with frequency response analysis tools, enabling students to analyze control systems' behavior in the frequency domain.
6. Digital Control Systems:
- Role: "Controller Designer"
- Outcome: Guiding the design of digital controllers and exploring their implementation in practical control systems, bridging the gap between theory and application

The dynamic rotation of roles ensured active student participation and a deeper understanding of Control Engineering principles. Students exhibited enhanced mastery of Control Engineering topics, including open-loop and closed-loop systems, time response analysis, signal flow graphs, block diagram reduction, stability concepts, frequency response analysis, and digital control systems. This approach not only reinforced comprehension but also nurtured critical thinking skills, equipping students with a solid foundation in Control Engineering.

The feedback questionnaire employed a 5-point scale (1 = Strongly Disagree, 5 = Strongly Agree) using Google Forms and the aggregated student responses, presented as percentages, are summarizedin Table 5.

Table 5: Feedback response for Role Switch Activity

Feedback Questionnaire	Feedback %
The dynamic role-based learning approach enhanced my engagement with the course content and encouraged active participation.	94.3
Collaborating with peers in different roles deepened my understanding of control engineering concepts.	96.7
The methodology facilitated a seamless integration of theoretical concepts with real-world applications, enhancing my practical knowledge.	92.1
Transitioning between various roles provided a comprehensive perspective on the topics covered and promoted a holistic learning experience.	96.5
Overall, the dynamic learningmethodology positively contributed to my grasp of control engineering principles and their practical implications.	96

Analyzing the feedback, it's clear that the dynamic role-based learning approach in Control Engineering led to strong engagement, deeper collaborative understanding, effective integration of theory with practical knowledge, and a comprehensive learning experience through role transitions.

VI. CONCLUSION

In the ever-evolving landscape of education, it is imperative to adapt teaching methodologies that align with the dynamic needs of students. The traditional lecture-based approach is gradually being replaced by more interactive and engaging methods. The exploration of various teaching techniques, such as Understanding Learning Styles, Cyber-hunt, and Keyword Concept, underscores the significance of tailoring education to suit individual preferences. The insights derived from these strategies emphasize that learners possess distinct styles, strengths, and preferences, which must be acknowledged for effective knowledge transfer.

The Learning Styles framework elucidated the multiplicity of approaches that both learners and educators can employ. By appreciating the diversity of learning styles and understanding their implications, instructors can create a harmonious classroom where all students can thrive. Furthermore, the Cyber-hunt activity showcased the power of technology in transforming the learning process. Harnessing the ubiquity of digital devices, this activity engaged students, encouraging collaborative problem-solving and enhancing their digital

literacy. The Keyword Concept, on the other hand, harnessed the potential of focused engagement. By challenging students to swiftly encapsulate concepts in limited time, this technique nurtured critical thinking and quick recall abilities. It epitomized the shift towards shorter, dynamic engagements that resonate with the modern student. The successful implementation of the Role Switch teaching methodology, which involves assigning students diverse roles in course delivery, further reinforces the adaptability of pedagogical approaches to meet the evolving needs of students.

The results of the feedback questionnaires reflect the success of these methodologies in engaging students and enhancing their learning experiences. The positive response validates the need for a departure from conventional teaching methods and the adoption of innovative approaches. As the feedback percentages indicate, students found value in activities that promoted self-learning, collaboration, and practical application of knowledge.

These innovative pedagogical techniques, from understanding learning styles to implementing digital-driven activities, serve as steppingstones towards a more engaging and effective educational journey. The path forward lies in a blended approach, harnessing the strengths of each method to provide a comprehensive and enriching learning experience for the engineers of tomorrow.

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