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Review Paper

Unconventional pedagogies for active learning to transform engineering education

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Abstract. Pedagogical practices critically shape students' learning and development of transferable skills. This review spotlighted the concepts of learner-centric unconventional pedagogic approaches for active learning and reflected on their potential benefits in higher education. Contrasting to passive knowledge acquisition in traditional lecture-based instructional methods, implementing unconventional pedagogies at the university level may generate a range of significant benefits for augmenting students' holistic learning experiences and realizing intended learning outcomes. State-of-the-art interactive pedagogies, such as experiential learning, problem-based learning, flipped classrooms, etc. can facilitate active student engagement, foster creativity, nurture critical thinking, and instill intrinsic motivation for self-directed learning among engineering students. Moreover, they help cultivate crucial leadership, teamwork, and problem-solving skills that are highly valued in dynamic workforces worldwide. By integrating real-world applications and personalized learning experiences, unconventional pedagogies may deepen students' understanding of subject materials and strengthen the connections between theoretical concepts and practical applications. This enhanced alignment prepares students more effectively for the complex and varied demands of their future careers in the ever-evolving world. Conceptual understanding and examples illustrated in this review might inspire the strategic adoption of unconventional pedagogic approaches for the holistic development of well-rounded, adaptable, and competent graduates and realize a paradigm shift in engineering education.

Keywords: Active Learning, interactive classroom, learning theory, student-centered pedagogy, self-directed learning, tertiary education.

INTRODUCTION

Concept of pedagogy

Pedagogy refers to the art and science of teaching that involves techniques, strategies, and principles employed by educators to facilitate learning and promote the intellectual, social, and emotional development of students (Shah and Campus, 2021; Ali *et al*., 2018). The terms "pedagogy" and "teaching" are often distinguished yet sometimes used synonymously. "Pedagogy is the observable act of teaching and it is an attendant discourse of educational theories, values, evidence, and justifications. It is what one needs to know and the skills one needs to command to make and justify the many different kinds of decisions of which teaching is constituted." (Alexander, 2009). Pedagogy is a complex concept encompassing teaching approaches, educational theories, learning styles, assessment methods, and student-teacher relationships in the classroom and beyond that are crucial for effective teaching and learning (Waring and Evans, 2014). Pedagogic practices involve understanding how students learn, designing effective

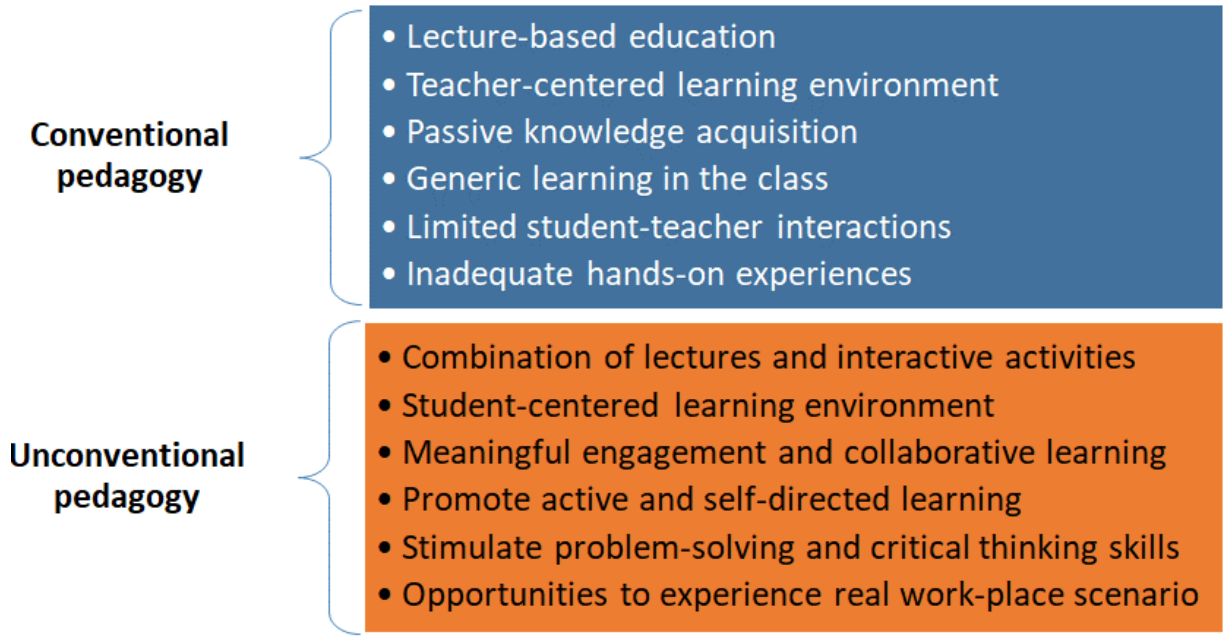

Figure 1. Contrasting views of conventional and unconventional pedagogies.

instructional approaches, and creating supportive learning environments to ensure holistic education for the learners. A broad spectrum of pedagogical approaches exists, ranging from traditional lecture-style teaching to more student-centered and experiential learning, and the application can vary depending on educational philosophies, cultural contexts, subject areas, and the stages of the learners. Pedagogy is an evolving field that continues exploring innovative teaching and learning approaches and it aims to facilitate meaningful learning experiences that enable students to acquire knowledge, develop skills, and cultivate attitudes and values to thrive personally and professionally (Kabulova, 2023; Vasquez, 2006).

Distinguishing conventional and unconventional pedagogic approaches

Typically, conventional pedagogies emphasize the passive knowledge transfer from educators to learners. It mainly adopts a transmissive view of teaching and passive knowledge acquisition by learners, where delivery of content is the major purpose of the learning experiences (Loughran, 2013). Traditional pedagogic approaches mainly revolve around lecture-based classroom environments where a teacher is the center of education and takes control of the learning process as an expert (Zhao and Potter, 2016). Lecture-based learning is arguably the oldest instructional technique in higher education settings, widely adopted across college and university curricula (Omelicheva and Avdeyeva, 2008). While such a conventional approach helps learners build a solid foundation of knowledge, student-teacher interactions in and beyond the classroom might not be adequate, and the individual and varied needs of the students are not often satisfied appropriately (Haley, 2020). Traditional pedagogic approaches often lack the opportunities for collaborative assignments and hands-on practices, crucial for developing essential skills in graduates. Consequently, lecture-based education might be inadequate or even in some cases encourage superficial learning and memorization of facts to solely pass the assessments or exams. However, research suggests that this approach might not realize deep learning of relevant concepts and is often ineffective for students to apply and integrate knowledge in problem-solving situations (Shreeve, 2008).

In contrast, unconventional or innovative pedagogies can be referred to as alternative interactive approaches to teaching and learning that differ from conventional pathways of imparting knowledge and passive learning (Figure 1). Unconventional pedagogies may integrate lecture-based learning and interactive activities to significantly increase student engagement, realizing a major shift from passive learning to fostering intrinsic motivation and attentiveness. They prioritize self-directed learning and critical thinking by encouraging problem-solving, analysis, and evaluation, leading to a deeper understanding of the subject contents and practical application of acquired knowledge. Engaging students in self-directed learning is essential to foster their knowledge-building and develop their skills as competent graduates. Nurturing meaningful engagement positively impacts students' learning behavior, empowering them to become active learners who take charge of their learning materials, tools, and various aspects of the learning process (Choi *et*

al., 2021). “In more active forms of learning, for instance, learners make their own time-planning, they choose to learn goals and activities they like, they test their progress, they take care of learning and understanding on their own, and they reflect on errors and successes.” (Van Hout-Wolters *et al*., 2000). Apart from the theoretical knowledge acquisition in conventional settings, unconventional pedagogies incorporate hands-on exercises and experiential learning practices to promote better retention of information and concepts by actively involving students and highlighting practical relevance. By encouraging students to think outside the box and engage in open-ended tasks, these pedagogies nurture creativity and encourage students to develop their unique ideas, broaden perspectives, and explore innovative solutions. Many unconventional pedagogies emphasize collaborative learning, which enhances students' abilities to work effectively in teams, communicate their ideas, and engage in constructive dialogue (García-Peñalvo *et al.*, 2019). Such skills are essential for success in professional settings where teamwork and effective communication are highly valued. Pedagogic practices can be tailored to meet the individual needs and interests of students, which allows for flexible and personalized learning, enabling learners to explore relevant topics of their choice, set their own learning pace, and engage in activities that align with their preferences and strengths (Iyer *et al*., 2022). Unconventional pedagogies bridge the gap between theory and practice by connecting learning to real-world scenarios or applications. By incorporating authentic problem-based exercises, case studies, simulations, or community engagement, students can observe the practical implications of their learning, making it more meaningful and impactful. In a nutshell, unconventional pedagogic approaches intend to create interactive classrooms with higher engagement, deeper understanding, critical thinking, and reflection (Dutta *et al*., 2022a). Unconventional pedagogies place students as the prime center of education. These approaches are more focused on the individual potential of a student rather than a generalized lecture-based pedagogy in a traditional classroom environment. Significantly, educators’ role in such approaches is considerably redefined as a mentor or guide who facilitates the learning process and enables students’ individual growth compared to a traditional teaching role aimed mainly at imparting education through the delivery of content (Murphy, 2003).

Transformative challenges in engineering education

Higher education institutions are increasingly adopting interdisciplinary curricula for engineering students to incorporate a wide range of knowledge and methodologies from various disciplines and enhance their placement opportunities (Singh *et al.*, 2014). This approach equips students with the necessary skills to navigate complex] work environments effectively. In today's rapidly evolving and technology-enhanced world, learners must acquire subject-specific knowledge and develop transferable skills such as critical thinking, creativity, collaboration, and adaptability. However, designing interdisciplinary curricula for engineering students can be challenging for educators. This difficulty may arise from obstacles such as finding suitable materials and guidelines for integrating different disciplines, managing the complexity of the curricula, time constraints, and concerns that integrating interdisciplinary content will require a significant investment of time and effort in a traditional classroom setting. Educators may feel uncertain about the effectiveness of content delivery and evaluation methods due to a lack of familiarity with pedagogical approaches and strategies that promote interdisciplinary learning (Navarro *et al*., 2016). The primary focus of transforming engineering education is enhancing students' engagement, intrinsic motivation, and self-directed learning abilities. To nurture these desirable attributes among engineering students, unconventional pedagogical techniques and strategies can be employed (Pereira *et al.*, 2018). Nevertheless, encouraging the adoption of an alternative pedagogy can present additional challenges. Educators may not be inclined to modify their teaching methods substantially, and even those interested in pedagogical reform may have concerns that need to be addressed before or during the implementation process (Golter *et al*., 2012).

Scope of this review

Pedagogy extends beyond formal education and encompasses the development of lifelong learning skills. Pedagogies that foster lifelong learning equip students to continue learning independently and adapt to new challenges and opportunities. Educators have conceptualized and experimented with various unconventional pedagogies in diverse settings to bring a paradigm shift in higher education. However, selecting and implementing appropriate and effective pedagogical strategies tailored to specific groups of learners is crucial to promoting active learning and critical thinking, fostering meaningful learning experiences, and cultivating their attributes for lifelong learning. This review highlights unique pedagogical methods that hold significant potential in engineering education. Concepts and benefits of the selected approaches will be introduced, along with relevant examples of their implementation at the university level. By providing insights into contemporary pedagogic practices, this review can serve as a valuable resource for educators and learners seeking applicable strategies for engineering education.

UNCONVENTIONAL PEDAGOGIES: CONCEPTS AND POTENTIAL LEARNING BENEFITS

Experiential learning

Experiential learning is a modern pedagogical approach

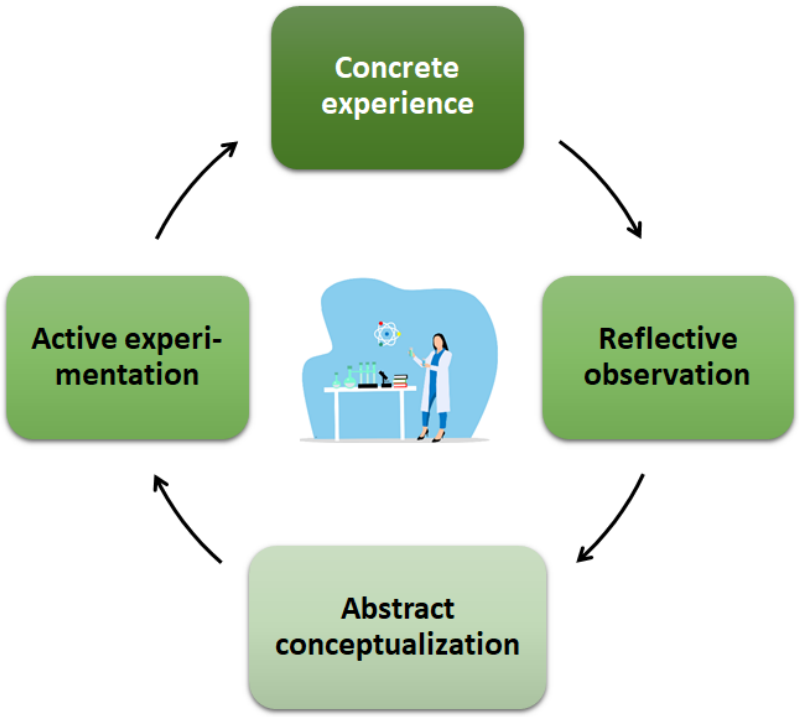

Figure 2. Kolb's experiential learning cycle (Adapted from Kolb, 1984).

that incorporates 'learning by doing' or 'learning through experiences'. Renowned educational theorist Kolb (1984) suggested experiential learning theory that defines learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience". The proposed learning cycle (Figure 2) involves concrete experience, reflective observation, conceptualization, and active experimentation (Kolb, 1984). It starts with engaging in experiences that enable participants to observe, analyze, and review what they have experienced or practiced. Afterward, they critically reflect to connect their experiences to relevant theory or previous experiences, which is a crucial part of experiential learning (Fowler, 2008). This approach considers learning as an ongoing process in which theory and practice are continuously conceptualized and reconceptualized, while each iteration of this cycle deepens a student's understanding and facilitates their overall learning journey (Bartle, 2015). Through experiential learning, students can actively engage themselves in authentic learning experiences that bridge the gap between theory and practice. As active participants in their learning, learners can integrate and apply their knowledge beyond the classroom environment (Matsuo, 2015). Experiential learning increases student engagement, improves learning effectiveness, and enhances essential work and life skills. Experiential learning can facilitate student learning across various contexts, such as campus-based activities, project-based initiatives, work-integrated learning, and community engagement (Beard, 2008). It would be advantageous to identify experiences that align with students' interests and motivations, and such experiences should be designed in a way that encourages learners to take initiative, make decisions, and take responsibility for their outcomes. Through experiential learning, students get chances to learn from natural consequences, as well as from mistakes and successes. Implementing experiential learning was reported to bring desirable outcomes for engineering students. For instance, a mechanical engineering course was redesigned to facilitate the practice of experiential learning theory among students. The design of project and workshop activities have been carefully restructured to provide students with direct hands-on experiences. Additionally, focused reflection has been incorporated into the learning process to support students in constructing knowledge based on their experiences and observations. Applying the experiential pedagogic approach helped create a more engaging and effective learning environment for students in the course (Li *et al*., 2019). In another relevant study, experiential learning augmented leadership skills among engineering graduates. It brought positive changes at the individual, organizational, and societal levels, which helped to prepare themselves for future careers (Desai *et al*., 2018). A qualitative study indicated that crucial learning experiences of an experiential nature were capable of engendering transformative learning outcomes for undergraduate students in the engineering discipline. However, opportunities for such transformative

Figure 3. Gibbs' reflective cycle (Adapted from Gibbs, 1988).

learning must be thoughtfully designed and deliberately incorporated into student's educational journey at the university level. By purposefully crafting these experiences, educators can ensure that students have access to diverse and impactful learning opportunities beyond passive instruction, ultimately enhancing their overall educational experience and preparing them for future endeavors (Tien *et al*., 2021).

Reflective learning

The reflective pedagogic approach aims to transform students into reflective and self-directed learners, enhancing their competence and learning achievements. Reflective learning was signified as "The process of having students engaged in some activities that purposefully drive them to reflect upon ideas and how they use them. Requiring students to regularly assess their own understanding and skill at handling concepts or problems in a particular discipline." (Collins and O'Brien, 2003). Reflection is vital in enhancing students' understanding of concepts, broadening their perspectives, and making informed decisions for future activities based on their learning experiences. Gibbs (1988) proposed a reflective learning model that outlines six stages of reflection, as illustrated in Figure 3. Students may initiate learning by describing the situation, encompassing their overall learning experience. In the subsequent stage, they delve into their thoughts and emotions during the experience, followed by an evaluation and analysis stage, where students reflect on both positive and negative aspects of the experience and examine the underlying reasons to stimulate their thoughts. Finally, students summarize the learning experience, reflect on alternative approaches, and develop a plan for adjusting their actions to achieve better outcomes in similar future learning environments (Gibbs, 1988). Reflection empowers students to act upon their realizations and resolutions. Reflection can be conducted both individually and collectively. In the individual reflection process, students engage in self-reflection, questioning their learning philosophy and making connections between their existing assumptions and knowledge and their current learning activities. In contrast, collaborative reflection can take place during group activities where students have the opportunity to receive feedback and assessments from their peers. Such peer-based reflection promotes the exploration of diverse perspectives on a subject of interest and enables students to understand why and how others may observe things differently. Through collective reflection, students' own assumptions may be challenged by their peers, prompting them to reassess their initial perspectives and expand their understanding of relevant knowledge (Chang, 2019). For instance, combining self-reflection and peer feedback in a Civil and Environmental Engineering module allowed

students to better understand their learning behavior. They could identify their intrinsic learning needs and areas for improvement based on their introspection and then leverage the constructive feedback provided by their teammates to enhance the overall learning experiences (Dutta *et al*., 2023). A recent study elucidated the impact of a reflexive-learning-based leadership development program on promoting collective reflexivity and its implications for organizational leadership and structures in engineering innovation. The program comprises four fundamental steps: acknowledging problems, reassessing assumptions, considering alternatives, and developing new perspectives. The findings highlighted how a reflexive-learning-based leadership development program can cultivate important traits in leaders, such as ambiguity tolerance and interdisciplinary knowledge, which are crucial for fostering innovation (Wei, 2024).

Blended learning

The blended learning approach refers to integrating face-to-face classroom learning experiences with online learning activities. Online education offers appealing advantages such as flexibility, control over time and location, and better work-life balance, while it can also accommodate a large number of students. However, remote learning has limitations in terms of satisfactory student-teacher interactions and limited support for practical skill development. In contrast, traditional classroom settings may struggle to accommodate the increasing number of students across various disciplines, which is often observed in higher education institutions. The blended instructional model combines the strengths of both methods by merging traditional classroom settings and on-site activities that require physical presence with remote learning through digital platforms. This approach aims to extract the best aspects of each method to optimize the learning experiences (Garrison and Kanuka, 2004; Nielsen, 2008). As an alternative to exclusive distance learning, blended learning provides students with abundant opportunities to engage in hands-on experiences through "learning by doing" activities, which allows for the integration of active learning, collaboration, and meaningful connections. By incorporating these elements, hybrid/blended learning creates an environment conducive to achieving the desired learning outcomes (Singh *et al*., 2021). Instructors must significantly adapt their online and in-person teaching skills in a hybrid or blended learning environment. They may deliver lectures online, provide verified learning resources, and facilitate group discussions. In contrast, during face-to-face sessions, instructors need to focus on enhancing student engagement and developing practical skills through nurturing student-teacher and peer-to-peer interactions. This blending of digital and in-person modalities creates unique challenges for instructors in designing and implementing meaningful learning activities. A key challenge is facilitating a student-centric approach rather than a traditional teacher-driven model while maintaining the right balance of instructor and student control over the learning process (Hung and Chou, 2015). Notably, during the COVID-19 pandemic, the implementation of blended learning approaches became increasingly prevalent in educational settings globally and played a crucial role in maintaining continuity of learning amid the challenges posed by the pandemic. In a relevant case, engineering students highly appreciated the encouraging and flexible blended learning approach implemented by the course instructors, which supported students' active engagement and self-directed learning amidst disruptions posed by the pandemic. Students' experience in the course indicates great potential for integrating blended learning models into future curriculum design within higher education settings (Dutta *et al*., 2022b). Although flexible learning through digital platforms is highly appreciated, students face challenges in comprehending complex concepts when face-to-face activities are limited during blended learning, emphasizing the need for additional support from the instructor (Batisere *et al*., 2023). To successfully implement hybrid/blended learning, instructors must design interactive online learning activities and carefully plan in-person sessions to maximize student engagement and practical experiences (Kallick, 2017).

Flipped classroom

The flipped classroom approach is a specific type of blended learning strategy that reverses the sequences of learning activities compared to a traditional learning environment. In a conventional classroom setting, the teacher usually undertakes the role of the lesson leader, the center of attention, and the primary source of information during class time. Traditional instructional models predominantly rely on lecture-style presentations for individual lessons, which often restricts student engagement to independent or small group activities focused on applying innovative concepts. However, in a flipped classroom, students are first exposed to the instructional contents such as reading materials, video content, etc., typically as homework before attending the lesson in the class. During the actual class time, the focus of students shifts to interactive and collaborative activities, such as discussions, problem-solving exercises, group work, or hands-on experiments (Talbert and Bergmann, 2017). In a flipped classroom, the teacher undertakes the role of a facilitator, offering guidance, answering questions, and addressing misconceptions during these in-class engagements. The flipped classroom model aims to optimize face-to-face interactions by shifting content delivery outside of class, where students can access it independently. The main perception of the scheme is to use in-person class time more effectively for in-depth

comprehension, application, and collaboration rather than primarily for delivering content (Chen *et a*l., 2014). Various studies have explored using the flipped classroom model in engineering education, with generally positive results. At the University of Toronto, a flipped classroom approach was applied for a third-year engineering course, and students reported flexible learning at their own pace beyond the classroom while they could invest themselves better during the actual classroom activities. In contrast, from the instructor's perspective, blended learning helped overcome the burden of time limitations within the classroom and positively impacted students' learning. The instructor could identify early whether the students are facing challenges or having difficulty understanding concepts. Remarkably, students asked more questions in a flipped classroom compared to a traditional lecture-based classroom (Harris and Park, 2016). Other reported benefits of the flipped classroom approach in engineering education include high student satisfaction and improved performance, a deeper understanding of the learning contents, and improved problem-solving and critical thinking skills (Baytiey and Naja, 2017; Kerr, 2015; Toto, 2009).

Problem-based learning

Problem-based learning (PBL) has gained significant attention as a contemporary pedagogical approach in various fields and learning environments. It serves as a bridge between traditional classroom settings and the intricacies of real-world workplace scenarios. PBL has sparked considerable interest among researchers who seek to explore its impact on improving students' learning outcomes and fostering the development of problem-solving skills (Yew and Goh, 2016). PBL is an educational approach that places students at the focus of the learning process, encouraging active engagement and self-directed learning. Students tackle meaningful, real-life problems, stimulating their conceptual understanding and learning abilities more effectively than traditional instructor-centered or lecture-based methods. PBL incorporates interactive and situation-oriented activities that promote student communication and collaboration, fostering skills necessary for their future careers (Pepper, 2014). Typically, learning begins with a problem that requires resolution, and students work together to solve the problem. "In PBL, student learning centers on a complex problem that does not have a single correct answer. Students work in collaborative groups to identify what they need to learn in order to solve a problem. They engage in self-directed learning and then apply their new knowledge to the problem and reflect on what they learned and the effectiveness of the strategies employed. The teacher acts to facilitate the learning process rather than to provide knowledge." (Hmelo-Silver, 2004). PBL is primarily designed to accommodate the learning style aligned with the constructivist approach to education. The theory of constructivism suggests that the learning process is subjective and unique to each individual, and students construct their own understanding based on their prior experiences and knowledge. "Constructivists believe that knowledge is essentially subjective in nature, constructed from our perceptions and mutually agreed upon conventions. According to this view, we construct new knowledge rather than acquire it via memorisation or through transmission from those who know to those who don't know" (Bates, 2019). The constructivist learning style emphasizes the flexible application of prior knowledge in the present setting rather than simply recalling pre-determined schemas or patterns. Constructive learning encourages students to apply their learning to real-world contexts, allowing them to create personal implications and understanding through their own experiences and meaningful interactions. As a result, students develop interpretations of the external world based on their individual experiences (Bednar *et al*., 1991). Dutta *et al*. (2022a) integrated a PBL assessment in a civil engineering course and revealed enhancement in students' learning attributes in a self-reported questionnaire survey. Comparing pre- and post-test survey scores, students' constructive learning enhancement was observed in each of the following categories: (i) create own learning based on past experiences, (ii) applying what is learned in the lecture to the real world, (iii) Create meaning and understanding through active learning activities, (iv) Make flexible use of pre-existing knowledge to formulate engineering solutions, and (v) transfer the acquired engineering knowledge and skills to solve new problems. Tsang *et al.* (2018) incorporated a problem-based project in an engineering curriculum that increased students' participation, collaboration, and proactive learning, which was otherwise challenging in the case of large-class settings. A major motivation behind their engagement was attributed to the applicability of their engineering knowledge in a real-life setting. The students appreciated the flexibility allowed in the project design and exploration of engineering practices, nevertheless, they faced challenges considering the complexity of the tasks in the project that reciprocated real workplace scenarios. When applied to another group of engineering students, the PBL approach also promoted soft skill development such as communication skills, teamwork, and critical thinking skills, which are highly desired in complex workplace scenarios (Idrus and Abdullah, 2018).

Personalized learning

A personalized learning environment aims to accommodate the student's individual and diverse learning needs instead of generic learning in a lecture-based system. Considering different pre-university systems and the diversity of students, universities often require fine adjustments in teaching and learning practices to

accommodate varied student needs. Recognizing each student's uniqueness, this pedagogic approach allows for tailored learning paths catering to individual learning styles, pace, and preferences. Catering to the diverse learning abilities and preferences of students is crucial for the effectiveness of the tertiary-level learning and teaching system (Kühn, 2017). In modern educational settings, abundant information and resources necessitate personalization of the learning process, facilitated by emerging technologies and new web-based/online platforms. Learners are increasingly turning to trusted networks comprising peers, professionals, and external experts in the relevant field as knowledge becomes distributed across these connections and networks (Dabbagh and Kitsantas, 2012; Leone, 2013). To ensure maximum educational benefits and completely develop students' potential, efficient management of learning resources and fostering meaningful interactions between student peers, instructors, and experts is indispensable. By promoting active engagement with emerging learning resources and technologies, teachers can encourage students to systematically explore pertinent and verifiable online sources to supplement their learning and connect with relevant professionals, cultivating a responsive personal learning environment. This type of learning environment is commonly referred to as a "Personal Learning Environment and Network (PLE&N)" (Valtonen *et al.*, 2012; Tsang and Tsui, 2017). A relevant study denoted PLE&N as "A combination of social media-enabled systems, applications, and services which help learners to take control of their learning by aggregating, manipulating, and creating digital contents and learning artifacts and sharing them with others." (Saadatmand and Kumpulainen, 2013). The key focus should be satisfying diverse student needs and preferences and leveraging trusted networks and connections for knowledge sharing. The incorporation of modern web-based technologies is crucial for the advancement of the PLE&N platform. "Advancements in technology provide a variety of tools for people to develop their own learning systems. Many of these tools include Web 2.0 tools, which are pervasive, ubiquitous, and bottom-up. Learners have the freedom and responsibilities to decide and select which tools best fit their learning purposes." (Tsui *et al*., 2013). Leveraging the web-based platform, PLE&N allows students greater autonomy and control over their educational experiences, allowing them to co-create knowledge by combining efforts from the network to support their academic growth and achievement. By actively designing the PLE&N platform and knowledge construction, students might have a greater responsibility toward their learning (Lim and Newby, 2020). PLE&N, as a pedagogical approach, is underpinned by accurate and updated knowledge distribution throughout the network, reflecting the connective learning theory. "Connectivism is driven by the understanding that decisions are based on rapidly altering foundations. New information is continually being acquired. The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical." (Siemens, 2017). The connectivist pedagogy implies knowledge as a network of ideas. It defines learning as a process of connecting relevant information sources, which aligns well with the network-based and technology-enhanced PLE&N concept as a pedagogic approach. Recent studies demonstrated that postings and contributions on the PLE&N platform enhanced students' understanding of the subject knowledge, and contents were highly relevant to their field of study (Dutta *et al*., 2024; Tsang and Tsui (2017). Furthermore, PLE&N implementation positively influences students' connective learning experiences in acquiring new knowledge, identifying knowledge gaps, and growing their knowledge networks through meaningful connections with diverse resources. As evidenced in the study, PLE&N strengthened students' self-directed and life-long learning attributes (Dutta *et al*., 2024).

CONCLUSIONS

This review presents the concepts and advantages of interactive student-centered pedagogic approaches that place learners at the core of the learning process. Employing such instructional methods might significantly benefit students in terms of engagement, retention of acquired knowledge, active and self-directed learning, and development of essential skills for future careers of engineering graduates. However, the selection and application of pedagogic methods may be determined based on the intended learning outcomes of the specific subject in a program. Considerably, transitioning from a traditional role in a lecture-based classroom to a facilitator in an interactive classroom could bring enormous challenges for teachers. Despite challenges, implementing unconventional pedagogies in engineering curricula might empower students, prepare them for thriving careers, and foster their lifelong learning attributes. In this case, a conceptual understanding of diverse pedagogic approaches presented in this review may guide educators and learners to make informed choices for enhancing interdisciplinary knowledge and maximizing the learning potential of engineering students.

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