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ENHANCING STUDENTS' LEARNING EXPERIENCE AND PROACTIVE COMPETENCE THROUGH TEACHING INNOVATION BASED ON THE CDIO APPROACH

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ABSTRACT

In the context of higher education undergoing a strong shift toward learner-centered approaches, innovating teaching methods to enhance students' learning experiences and proactive competence has become an urgent requirement. Several teaching innovations based on the Conceive – Design – Implement – Operate approach are presented in this paper, with a focus on creating learning activities that promote participation, hands-on experience, and the growth of critical thinking, problem-solving, and self-study abilities. The study examines how active learning and experiential learning can enhance the quality of education. It is based on theoretical frameworks as well as real-world applications in a few engineering and applied science courses. Based on the Conceive – Design – Implement – Operate model, the results show that students meet societal demands in the age of digital transformation by mastering specialized knowledge and developing critical soft skills.

KEYWORDS: Conceive, Design, Implement, Operate, Innovative Teaching Methods, Active Learning, Experiential Learning, Education Quality, Learner Competence.

1. INTRODUCTION

In the era of industrialization and modernization of the fourth industrial revolution, the industries of countries need a highly skilled workforce. high level. Therefore, the role of universities in general and universities in Vietnam in particular is extremely important in training high-quality human resources. high-quality human resources. Universities that train graduates must meet the needs of society, be proficient in their work, and such as having the necessary skills for the job. Therefore, the curriculum of universities must undergo improvements. about the curriculum and teaching methods in line with societal trends [1].

The Conceive – Design – Implement – Operate (CDIO) framework was established to enhance the quality of education for various fields at universities. university. CDIO was developed at the Massachusetts Institute of Technology (MIT) following a modern educational technology model, with a solid knowledge base for solving practical problems. real-world problems [1]. The main fields that need to apply the CDIO method in university education programs, especially in engineering and technology and technology: (1) Anticipating learning outcomes; (2) Organizing the learning and teaching process; (3) Building an evaluation system (Edward et al., 2007). [1]. Thus, applying innovative teaching methods is necessary to ensure that students can achieve the desired results according to the CDIO standards. desired results according to the CDIO standard.

At least three important factors make such innovation imperative:

First, in order to accomplish these new objectives, teaching and learning activities must be modified when learning outcomes change. After the program objectives have been identified, the instructor needs to answer the following questions. How to design teaching methods for students to achieve these goals? How to design teaching methods for students to achieve these goals? Teachers are required to create and implement active learning activities to enhance students' overall competencies alongside imparting subject knowledge. To promote critical thinking, teamwork, and self-directed learning, these exercises should take various forms, including group discussions, case-based learning, simulations, and project-based learning project [2].

Second, the interdisciplinary integration of the CDIO curriculum is one of its unique features. Courses must now support and enhance one another rather than being discrete knowledge units. In order to integrate not only technical knowledge but also soft skills like communication, leadership, time management, and teamwork, the CDIO framework requires systematic coordination among subjects. Additionally, CDIO places a strong emphasis on students' capacity to operate systems, design processes, and conceptualize products—all of which are essential abilities in the modern workplace. Therefore, faculty training and direction on the use of integrated teaching methods are necessary for the implementation of such an integrated program. This facilitates seamless knowledge and skill acquisition linked to real-world professional contexts by allowing lecturers to coherently align content, methodology, and assessment [3].

Third, in addition to knowledge, the intended learning outcomes also include professional attitudes and skills. In actuality, requesting that students "know how to work in teams" does not ensure that they will pick up this ability on their own. Like many other soft skills, teamwork needs to be explicitly taught through purposeful, methodical instruction. For instance, students must learn how to organize group projects, delegate responsibilities, reach decisions together, settle disputes, provide and accept feedback, and cultivate leadership. Teaching and assessment procedures should unambiguously incorporate these components. Only when students are given the chance to practice, think back on their experiences, and apply their theoretical knowledge in real-world scenarios can learning be effective [4]. The absence of thorough and organized training for faculty in contemporary teaching techniques, however, is a major problem in Vietnam. This limitation hinders the effective implementation of active teaching strategies and indirectly affects the learning outcomes of CDIO-based programs [5].

In summary, within the implementation of the CDIO model at technical and technological universities in Vietnam, innovating teaching methods is a crucial factor that directly influences students' ability to meet learning outcomes. Lecturers must not only transform their roles in the classroom but also continuously update, develop, and apply advanced teaching methods. At the same time, strong institutional support is needed to develop teaching capabilities, improve infrastructure, and create a dynamic, interactive, and practice-oriented learning environment. Only then can universities fulfill their mission of producing high-quality human resources for the knowledge-based economy that Vietnam is striving toward.

2. RESEARCH METHODS

The following research techniques are used in this study:

- Document analysis: Gathering and examining prior research and theoretical materials on CDIO, active learning, and experiential learning.
- Practical survey: Surveying instructors and students at various universities using the CDIO approach with an emphasis on assessing the efficacy of creative teaching strategies.
- Qualitative analysis involves combining and evaluating survey data to determine what factors affect students' levels of experiential engagement and proactiveness.

3. THEORETICAL FOUNDATIONS OF ACTIVE TEACHING METHODS

3.1. Concept of Active Teaching Methods

In the context of current higher education reforms, the demand for developing effective teaching methods that maximize learner engagement is becoming increasingly urgent. One prominent trend is the shift from traditional teaching models to active, learner-centered approaches. Active teaching methods—also referred to as active learning—are widely used worldwide to describe teaching approaches that emphasize the active, proactive, and creative involvement of learners in the process of acquiring knowledge.

The core of this method lies in the concept of "*activeness*"—not simply self-discipline, but a state in which learners actively engage in learning activities with autonomy, self-direction, and self-discovery. Contrary to the passive model, where learners mainly receive information from lecturers, active teaching encourages students to become the actual agents in the learning process [6]. They do not merely "*listen*" and "*take notes,*" but also "*discuss,*" "*debate,*" "*solve problems,*" "*experiment,*" "*create,*" and "*self-assess.*"

However, to effectively implement this method, instructors must invest more in preparing lectures, designing learning activities, and creating an appropriate learning environment. Active teaching does not imply relinquishing the instructor's role; on the contrary, teachers must act as organizers, guides, supporters, and motivators. This is clearly reflected in the construction of detailed course syllabi. Rather than being a list of content to be taught, the syllabus should be viewed as an integrated learning plan, where activities are designed to help students achieve learning outcomes in knowledge, skills, and attitudes.

Accordingly, instructors should create diverse learning opportunities such as group discussions, simulations, project-based assignments, peer critique, class presentations, or peer-teaching activities. These experiences help students not only acquire knowledge but also develop critical thinking, collaboration, communication, and problem-solving skills. They have the opportunity to raise questions, pose hypotheses, and test them through individual and group learning experiences. Students get a better grasp of their learning goals, what they are learning, how they are learning, and why the learning is important in such a setting.

Promoting intrinsic motivation for learning is one of the fundamental principles of active teaching. Students progressively form learning habits based on true personal needs rather than learning for grades or outside pressures. This is an important starting point for developing lifelong learning, which is a necessary skill in the quickly evolving world of today.

The efficacy of this strategy has been confirmed by numerous national and international studies. Active learning, for example, allows students to access knowledge at a deeper level—that is, they do not merely memorize facts but also try to explain, connect, and apply them in real-life situations (Edward et al., 2007). The connection between students' learning activities and learning outcomes was highlighted by Biggs (2003). Learners' retention and comprehension of information greatly improve when they participate in multisensory activities, especially when they are required to explain concepts to others [7].

Additionally, students' overall development is positively impacted by active teaching. Students develop time management, critical thinking, teamwork, and adaptability in challenging situations through research assignments, real-world projects, or simulated scenarios. In an education system that is globally integrated and outcome-based, these are critical competencies.

In conclusion, active teaching is not just a method but an educational philosophy in which students are at the center, teachers serve as facilitators, and the classroom is set up to support all-around growth. For this method to be effective, synchronized changes are needed in teaching philosophy, curriculum design, classroom management, and assessment practices. Only then can higher education truly transform toward quality, modernity, and humanity.

3.2. Characteristics of Active Teaching in the CDIO Approach

Active teaching is one of the key directions in higher education innovation today, aiming to

enhance learner centrality and improve training quality. The CDIO approach not only emphasizes professional competencies but also requires the development of critical thinking, teamwork, and lifelong learning skills. The following are the core characteristics of active teaching within the CDIO framework:

1. Learner-centered teaching and learning

In active teaching, students take center stage—not as passive recipients but as active agents in the learning process. They participate in activities designed, organized, and guided by instructors to explore and construct knowledge autonomously, rather than merely receiving information. When placed in situations that mirror real life and professional practice, students are given opportunities to observe, discuss, experiment, and solve problems through their own reasoning. This allows them not only to grasp content but also to understand the process of "*knowledge creation*"—a key element in modern education.

2. Fostering self-directed learning

The focus on fostering students' self-learning strategies is one of the unique characteristics of active teaching. Given the speed at which knowledge is growing, teachers are unable to cover everything in the classroom. Encouraging students to take the initiative to seek out new information and learn how to learn is more important. It is crucial to start teaching students how to learn on their own early in the curriculum. Students who have the capacity, inclination, and desire to learn on their own acquire lifelong learning skills, which are essential in the age of globalization and digital transformation. Students who know how to learn are more engaged, proactive, and creative in their academic and research endeavors.

3. Integration of individual and collaborative learning

Modern learning environments require a flexible combination of individual and group activities. In any classroom, differences in ability, knowledge levels, and learning pace are inevitable. Active teaching embraces differentiation while also creating opportunities for cooperative learning. Students can share, argue, and gain knowledge from each other through group discussions, learning projects, and simulated scenarios. Peer and instructor interactions improve teamwork skills, foster critical thinking, and enrich the learning process—all of which are critical for real-world work settings. Additionally, students benefit from cooperative learning by developing coordination, persuasion, and conflict resolution skills that are not possible with solo learning alone [8].

4. Instructor as facilitator and learning activity designer

In active teaching, instructors no longer serve primarily as content transmitters but as designers, organizers, and supporters of the learning process. They provide direction, create opportunities, and encourage students throughout their learning journey. Lesson planning, creating learning activities that are in line with CDIO learning outcomes, and choosing suitable assessment techniques all require time from instructors prior to class. Students actively complete learning assignments in class, with teachers serving as mentors and facilitators. In order to ensure effectiveness, teachers must also keep an eye on their students' progress in self-learning outside of the classroom, give feedback, and modify activities as necessary [9]. As a result, the instructor's job becomes more complex and calls for strong pedagogical abilities, commitment, and time to establish a stimulating and dynamic learning environment.

5. Combining instructor evaluation with student self- and peer-assessment

With active teaching, students participate in the evaluation process and the instructor is no longer the only one responsible for assessment. Self-assessment training enables students to identify their areas of strength and weakness and modify their learning approaches accordingly. Peer evaluation also improves communication, critical thinking, and analytical abilities. Formative evaluation, not just summative results, should be the main focus of assessments in active teaching. This encourages students to participate actively by giving them more chances to show their progress throughout the semester. A more thorough assessment of learners' competencies is also made possible by diversifying assessment tools, such as learning journals, project reports, presentations, and learning products.

3.3. SOME ACTIVE TEACHING METHODS

Teaching strategies are crucial in fostering students' capacity for self-learning, critical thinking, communication, and problem-solving during the CDIO approach to higher education reform. One of the most significant trends is the shift from traditional teacher-centered instruction to learner-centered education, in which active learning and experiential learning methods are increasingly applied.

Within the scope of this article, we categorize active teaching methods into two main groups: (1) Methods that promote active learning and (2) Methods that promote experiential learning, with a focus on introducing several prominent approaches currently applied in many advanced universities [10].

4. METHODS THAT PROMOTE ACTIVE LEARNING

4.1. Brainstorming

Brainstorming is a method that maximizes each person's creative thinking by encouraging students to come up with as many ideas as they can in a brief amount of time. Osborn (1963) defined brainstorming as the process of coming up with ideas by combining group input with personal initiative. In the classroom, the teacher poses an interesting scenario or problem and asks the class to quickly enumerate potential solutions or ideas without immediately assessing their viability.

Because it promotes student participation, sparks curiosity and creativity, and helps uncover students' past knowledge of the subject, this approach works especially well at the start of a new lesson. This approach encourages innovative thinking and the capacity to suggest solutions, which is consistent with CDIO learning objectives.

4.2. Think – Pair – Share

Before presenting ideas to the class as a whole, teachers can improve student interaction by using the Think-Pair-Share method. Three steps are involved in the process, according to Lyman (1987): thinking alone (Think), talking with a partner (Pair), and sharing with the group (Share). After the teacher presents a scenario or question, students think about it on their own, have a pair discussion, and then present the results to the class [11].

Students can practice listening, voice their opinions, gain confidence, and hone their critical thinking abilities with this approach. It works particularly well in varied classroom settings, guaranteeing that every student has a chance to contribute. According to the CDIO, this method helps people improve their critical thinking, communication, and logical idea expression abilities.

4.3. Problem-Based Learning (PBL)

Students can learn by investigating, evaluating, and resolving real-world issues through problem-based learning. Hmelo-Silver (2004) asserts that the purpose of PBL is to teach students how to learn, collaborate with others, and exercise critical thinking in addition to helping them discover the right answer. The teacher facilitates PBL by giving students the materials and instruments they need to conduct independent research and present their findings.

Students can improve their self-learning abilities, identify and formulate problems, suggest suitable solutions, and hone their communication and teamwork skills by working through open-ended and multifaceted problems. PBL is an ideal method for achieving CDIO learning outcomes such as problem-solving, creativity, and decision-making in uncertain conditions.

4.4. Group-Based Learning

In university, self-study in groups is very important for students to develop self-learning, self-research, and critical thinking skills. Hey students. In each group, students can divide learning tasks, research, and present in front of other students, or support each other... other students in their studies. These groups vary in size and scale depending on the subject matter and the duration of the study. subject and according to the study time. Through presentations, students increasingly develop and refine their skills. debate, organizational work, and academic evaluation. This is an effective learning support method from there, it is possible to identify and nurture talented students.

4.5. Role-Playing

Students use role-playing to practice decision-making, communication, and problem-solving skills by assuming particular roles or participating in simulated scenarios. According to Kritzerow (1990), this method works well for helping students develop soft skills like persuasion, negotiation, and conflict resolution while letting them experience attitudes and feelings in a secure simulation setting.

This method not only enhances students' awareness of social roles but also improves their ability to understand and evaluate themselves and others. Role-playing helps students improve communication, critical thinking, and adaptability in uncertain environments—key competencies within the CDIO framework.

The active teaching methods described above can be flexibly combined within a course or module depending on specific learning objectives. The choice and layout of instructional activities should be in line with the desired learning objectives in order to guarantee that students gain the knowledge as well as the abilities, dispositions, and ways of thinking required to adjust to future work settings. In order to successfully apply these strategies, the instructor is

essential in inspiring students, setting up adaptable learning spaces, and assisting them in boldly pursuing their knowledge.

5. RESULTS AND DISCUSSION

4.1. Results of Applying Active Teaching Methods

1. Promoting Active Learning through Instructional Design

One of the core features of the CDIO approach is to encourage students to become active learners by engaging in clearly guided and practice-oriented learning activities. During implementation, methods such as project-based learning, problem-based learning, simulation-based learning, and case studies have been widely adopted at several surveyed universities.

Specifically, in group-based learning activities, students are assigned to develop a small technical product, such as designing a simple electrical system model or a production plan. Rather than passively receiving knowledge, students must integrate knowledge from various courses, collaborate with peers, and independently search for information to complete the assigned tasks. In addition, realistic simulated scenarios, such as handling technical issues or managing production teams, help students take on the role of problem-solvers, thereby developing decision-making skills and critical thinking.

According to a survey of 120 students from three engineering faculties at a large university, 82% of students said that they understood the material better when they were actively involved in the learning process through problem-solving, group projects, and discussions. When they were actively involved in creating knowledge rather than just passively listening, the majority of students reported feeling more motivated. Additionally, rather than being restricted to strict frameworks, students greatly valued the freedom to make decisions and offer solutions.

This illustrates how effectively planned learning exercises can radically change the learner's perspective on knowledge from passive consumption to active creation.

2. Experiential Learning through Real-World Contexts

The experiential component is not only dynamic but also essential to the development of learners' overall competencies. The process by which knowledge is produced by direct participation in practical activities and reflection on individual experiences is known as experiential learning, according to David Kolb's theory.

Students gain a better understanding of the connection between theoretical knowledge and practical application when real-world scenarios are incorporated into the course material. Students enrolled in technical courses have the chance to visit businesses, factories, and specialized labs. They can also engage in practical activities like testing new models, assembling equipment, and taking technical measurements. Notably, workplace simulations, which require students to make decisions and deal with real-life situations, have proven especially successful in helping them develop professional skills. According to survey results, after engaging in experiential activities as opposed to traditional lectures, 76% of students felt more comfortable applying their knowledge to particular situations.

Some students also shared that "real experiences" made them more engaged with the subject, reduced the stress of theoretical learning, and improved knowledge retention.

Classroom models tied to real-world practice also enhance the connection between universities and businesses, allowing students to better understand future job requirements and plan their personal development paths more effectively.

3. The Role of Instructors in Pedagogical Innovation

The role of the instructor needs to be properly reinterpreted in order to apply active and experiential learning techniques. In addition to imparting knowledge, instructors in the CDIO framework also create learning environments, plan activities, and assist students in learning in an interactive and self-directed manner.

Teachers must create a variety of difficult learning scenarios that inspire students' creativity and inquiry. Additionally, they must be adaptable in their teaching strategies, able to modify lessons to fit the real skill levels of their students and the classroom environment. One important component is the capacity to inspire pupils. According to the study's observations and interviews with instructors, teachers who actively used active learning techniques tended to create open classroom spaces that promoted student expression, critical thinking, and initiative. In addition to increasing students' excitement, this offered chances to practice critical thinking, communication, and teamwork—all of which are critical 21st century skills.

4. Implementation Issues and Suggestions

Despite the many advantages of the CDIO-based

instructional approach, there are still a number of obstacles to overcome before it can be put into practice. First, compared to traditional lectures, creating active and experiential learning sessions usually takes a lot more time and work. Teachers are required to plan extracurricular learning activities, develop suitable assessment instruments, and create learning scenarios.

Second, not all students are ready to change their learning habits. Many still struggle with discussions, group work, or adapting to experiential learning. This necessitates continuous support from instructors and encouragement from the academic environment.

Third, facilities and technical infrastructure at some institutions remain inadequate to meet the requirements of these new methods. Flexible classroom organization, open learning spaces, hands-on equipment, and simulation software are often lacking or inconsistent.

To address these issues, the study proposes several solutions:

- **Institutional support:** Universities should provide training programs for instructors on modern teaching methods and support the design of CDIO-aligned course modules.
- **Curriculum design:** Soft skills, teamwork, and problem-solving components should be integrated into the curriculum from the first academic year.
- **Infrastructure investment:** Priority should be given to building flexible classrooms equipped with appropriate simulation and laboratory tools.
- **Student orientation:** Introductory programs should help students familiarize themselves with active learning methods and improve their self-directed learning skills.

5.2. Some Considerations When Applying Active Teaching Methods

a. A course can flexibly apply diverse learning formats

One of the key principles in modern educational organization is the flexibility and diversity in applying teaching and learning methods. In practice, there is no single teaching method that is perfect or suitable for all situations. Each method has its own strengths as well as certain limitations. Therefore, combining multiple methods within a single course is necessary to maximize student learning outcomes.

Each teaching approach emphasizes a different facet of the learning process: traditional lecturing is still crucial for imparting fundamental knowledge, while project-based learning develops collaboration and problem-solving abilities and discussion-based learning sharpens critical thinking. Therefore, teachers should be flexible in their method selection and combination, taking into account the goals of the course, the content, the abilities of the students, the classroom environment, and their own teaching style. In the Massachusetts Institute of Technology (MIT) course "Advanced Aerodynamics," for instance, instructors used a combination of four approaches: (1) assigning pre-class reading and research questions; (2) using concept questions with an electronic response system to assess in-class understanding; (3) implementing project-based learning to develop design and application skills; and (4) administering oral exams at the end of the course to assess students' integrative competence (Edward et al., 2007). In addition to improving learning motivation, this strategy supports the CDIO learning outcomes framework.

Choosing the best teaching strategies for each unique learning objective is a significant challenge for educators using CDIO-based instruction. In order to solve this, educators must examine every level 4 outcome in the CDIO syllabus and match it with the advantages of active teaching techniques.

In fact, one method may help achieve multiple outcomes, and conversely, one outcome may be achieved using various methods (Steven et al., 2002).

Understanding the nature and integrative capacity of different teaching methods enables instructors to proactively design effective teaching plans. In the following section, we will illustrate specific examples of selecting and applying active teaching methods corresponding to particular CDIO learning outcomes, providing practical references for faculty in the process of innovating teaching methods at technical universities.

b. Requirements for Classroom Conditions When Applying Active Teaching Methods

The application of active teaching methods depends not only on the pedagogical competence of lecturers but also requires suitable classroom conditions. Methods like project-based learning, group discussions, simulations, and case studies tend to work best in small-class settings, usually with 30 to 40 students, according to a number of experimental studies and contemporary teaching theories. Lecturers can interact closely with students in these settings and readily track each group's and individual's learning outcomes. Nonetheless, many classes in the typical university setting of today are

large, frequently consisting of 80–100 students or more. To guarantee efficacy, particular support measures are required when implementing active teaching techniques in such large classes. Using teaching assistants to help lecturers with student grouping, learning progress tracking, or experiential activity facilitation is one popular approach. Furthermore, technology use is essential. Large classes at major American universities frequently have Personal Response Systems (PRS), also referred to as "clickers," which enable students to instantly answer the lecturer's multiple-choice questions in real time. With the help of this tool, instructors can quickly gauge their students' comprehension without interfering with the lesson's flow.

Physical infrastructure becomes even more important in technical major classes where students must have access to highly experiential activities like technical case analysis, system operation, and model design.

Classrooms must be fully equipped with machines, laboratory devices, simulation software, and flexible spaces for group work. A lack of these facilities significantly reduces the effectiveness of experiential learning.

On the other hand, some methods, such as project-based learning or service-learning, require students to participate in real-world activities outside the classroom. In such cases, the university's role in connecting with businesses, social organizations, and practice institutions is of great importance. Choosing the right internship partners and accompanying units not only provides students with opportunities to apply their knowledge in practice but also expands career opportunities and enhances communication and problem-solving skills in professional environments.

In summary, for active and experiential teaching methods to achieve their full potential, institutions must invest seriously in classroom conditions in terms of human resources, physical facilities, and external partnerships. This not only helps improve the quality of education but also promotes the innovation of higher education towards comprehensive competency development for learners.

5. CONCLUSION

The innovation of teaching methods based on the CDIO approach is becoming an inevitable trend to enhance the quality of higher education in the context of increasing demands from the labor market. Research findings and practical implementation show that active and experiential learning methods not only help students acquire knowledge more effectively but also contribute to the comprehensive development of individual competencies. In particular, students become more involved in the learning process and learn how to analyze, make decisions, and work in teams when they are put in real-world scenarios through projects, case studies, simulations, or hands-on experiences. Soft skills like communication, critical thinking, and flexibility in real-world work settings are also improved and practiced. However, careful planning and concerted efforts from all stakeholders are required for these approaches to produce long-lasting results. Institutions must make the necessary infrastructure investments, create flexible curricula, train faculty in CDIO-based course design techniques, and assist students in becoming more proactive in their own development and acquainting themselves with new learning approaches.

It can be affirmed that innovating teaching methods following the CDIO approach not only enhances the learning experience but also helps students develop professional competencies and modern thinking—essential requirements in today's context of integration and digital transformation.

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