



Some Advanced Teaching Methods to Help Students in the Engineering Discipline to Be Proactive Learners

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ABSTRACT

To assure the training quality for engineering students in order to meet the outcome criteria and satisfy the recent social requirements, we have to concern many aspects, especially teaching methods during training process. This paper presents and discusses some improving teaching methodologies that may help engineering students to learn with active learning methods, in order to receive and comprehend the knowledge, to bring into play their soft- skills and creativity. These new teaching methods could make students attracted into learning activities actively based on the organization and instruction of lecturers. The students explore fuzzy contents as well as missing skills that traditional teaching styles do not focus on. In addition, students will involve in researching on the real problems, discussing in group, generating new ideas, promote their ability and their soft-skill as communication skill, presentation skill, computer skill, etc. From that they can comprehend new professional knowledge and improve their creativity.

Keywords: *Active learning, new teaching methods, engineering student*

1. INTRODUCTION

Higher education is a top concern in the development of a nation's human resources. Enhancing the quality of education is always a topic of societal interest; it becomes increasingly urgent and is one of the major challenges that universities constantly face. How to improve the quality of undergraduate education? How can engineering students meet the developmental needs of society after graduation? One approach to improving the quality of training and standardizing engineering and technology education programs is to innovate the curriculum and teaching methods to meet output standards and societal development requirements. This is considered a necessary and inevitable solution in an era where science, engineering, and information technology are developing rapidly as they are today.

Student access to knowledge is not limited to textbooks and libraries but also through various channels such as the internet, journals, television, and mass media. Therefore, the innovation of teaching methods must focus on the central role of students, contrasting with the traditional approach where the teacher plays a central role.

From a traditional perspective, students typically passively absorb knowledge, which limits their creativity, critical thinking, exploration, multidimensional thinking, exchange of experiences, as well as the application of learned knowledge to real-life situations. Moreover, the demand for the "soft skills" of engineering students after graduation is increasing, which is a limitation that needs to be addressed to enhance the quality of today's engineers.

In advanced teaching methods, classes are organized dynamically with real-life situations and issues; students experience, observe directly, think, discuss, and problem-solve through the process of self-study and teamwork. Through this, students may absorb deeper subject knowledge, enhance and improve soft skills, and foster creativity.

The advanced teaching method is considered to be a method that stimulates and enhances the active, creative, and positive qualities of both teachers and learners. It focuses on the learner as the center, based on enhancing the guiding and organizational role of the teacher, as well as the implementing and executing role of the learner. It combines the power of modern technical means to conquer truths in all three dimensions: knowledge, skills, and attitudes. Teaching methods are considered positive if they converge on five factors: (a) clearly demonstrating the role of information sources and available resources, (b) clearly showing the learner's motivation when starting the lesson, (c) clearly indicating the nature and extent of knowledge needed to be mobilized, (d) clearly demonstrating the roles of the learner, the teacher, and the roles of interactions during the learning process, and (e) demonstrating the expected outcomes of the learners (Le Van Hao, 2008). According to this perspective, learning is not watching football; students don't learn much by sitting in class listening to lectures, memorizing lessons, pre-built exercises, receiving opened answers, or solutions; rather, students must talk about what

they are learning, write it down, relate it to past real experiences, apply it to daily life, and make what they learn a part of themselves (Chickering and Gamson, 1987). In fact, there are many positive teaching methods; in this article, we only introduce a summary of some positive teaching methods that are widely used in advanced universities around the world, aiming to contribute to the improvement of teaching methods for engineering students at the Faculty of Technology - Haiphong University.

2. ADVANCED TEACHING METHODS TO HELP STUDENTS LEARN ACTIVELY

There are many advanced teaching methods currently helping engineering students learn actively (Active learning); among them, commonly used methods at advanced universities worldwide include: Think-pair-share method, Problem-based learning method, Group-based learning method, Project-based learning method, and Case study method. The principles and basic concepts of each of these methods will be briefly outlined below.

2.1 Think – Pair - Share Method

The Think – Pair - Share method is a collaborative discussion and sharing approach developed by Frank Lyman (1987), consisting of three stages of student activities.

Think: The instructor presents a topic (issue) for the students to read materials or contemplate. Each student will have 2 - 5 minutes to think and find answers.

Pair: Students share and exchange their opinions with the person sitting next to them for a period of 3 - 5 minutes.

Share: Students share the opinions exchanged with the larger group, or the entire class, within a time frame of 4 - 5 minutes (Lyman, 1987).

The crucial aspect of this method is that the initial topics and issues presented must be clear for the students to understand what they will be thinking about in the first stage.

This method has the advantage of being easily implemented in any classroom structure; everyone can participate in sharing their opinions, fostering confidence for students to express their thoughts. It helps students focus on the topic being studied, understand what they are learning and how much they have understood the issue. Sometimes, it may even raise new issues for the lesson.

2.2 Problem-Based Learning Method

This method emerged in 1970 at Hamilton University in Canada and was subsequently rapidly developed at Maastricht University in the Netherlands. Problem-based learning is defined as in-depth study of a certain learning topic with the purpose not only to find correct answers to questions, but also to learn and explore more about related knowledge on that topic (Hmelo-Silver, 2004).

When implementing this method, students must engage in self-directed learning and research to understand necessary information from various sources (such as textbooks, papers, articles, online information, and experts in related fields) to help solve the problem. Then, students must apply the knowledge they have learned and researched to solve and gain deeper understanding of the problem. After completing this learning process, students will develop skills in self-learning, self-assessment, and evaluation of others, which are essential skills for effective independent learning.

Several factors determine the quality of applying this method:

- (a) Analyzing the initial problem and gathering knowledge through discussions in small groups,
- (b) Searching and processing collected information,
- (c) Constructing and organizing knowledge,
- (d) Building social knowledge, and
- (e) Encouraging curiosity about related issues (Schmidt, 1993).

This learning method helps students become more proficient, acquiring new knowledge while developing proactive thinking, self-awareness, responsibility, and proposing creative solutions. It also prepares them with the ability to adapt to social realities, timely identify and effectively solve arising problems (Hmelo-Silver, 2004).

2.3 Group-Based Learning Method

Teaching based on group activities is currently one of the positive methods aimed at encouraging students to actively participate in social life, avoiding passivity and dependence. With this method, students work together in small groups, and each member has the opportunity to participate in the assigned task without direct supervision from the instructor.

When using the group-based learning method, instructors can divide the class into groups of 5 to 7 people. Depending on the requirements and objectives of the learning situation, groups are divided according to the topics of the course. Members within each group must work according to the guidelines set

by the instructor or by the group itself. In each group, every member must actively engage in tasks with clearly defined responsibilities, not relying on a few individuals who may be more knowledgeable and proactive. While working in groups, members must help each other understand the problem in a competitive atmosphere with other groups. When one group presents, the remaining groups must ask counter-questions or propose questions to clarify the issue. Lessons become a process of mutual learning rather than passive reception from the instructor.

This method helps students in groups share their own experiences, collectively build new perceptions, develop teamwork skills, communication skills, and social skills.

2.4 Project-Based Learning

Project-based learning is currently widely used in advanced universities worldwide. With this method, teaching and learning are organized through projects or real-life tasks. Projects are understood as complex tasks involving questions and problems that stimulate learners to explore and discover (Jones et al., 1996). This method may include design-implement experiences, where learners engage in designing, decision-making, or surveying activities related to the project.

Through project-based learning, students work in teams to explore issues related to real life. Subsequently, they present their findings to the class and share what they have accomplished in the project. During presentations, students may use audio-visual aids, a play, a handwritten report, a website, or a created product. Project-based learning emphasizes long-term, interdisciplinary learning activities often associated with issues arising from current life.

Instructors (guides) play a crucial role in providing sample projects, defining content boundaries, and guiding students towards the project's objectives. They help students understand the real picture and the tasks to be accomplished, as well as evaluate each individual's participation in the project.

Project-based learning provides opportunities for students to pursue their interests, make their own decisions about answers or solutions to project-related problems, and deepen their understanding of the project. Additionally, this method helps students develop design-implementation skills, soft skills such as communication, presentation, report writing, argumentation, as well as lifelong learning skills.

2.5 Concept Mapping Method

Concept mapping is a method used to illustrate the connections between concepts (clusters of terms) in a topic, a subject, or a project. The instructor presents a topic and asks each student to propose clusters of terms (concepts) related to the topic and construct a concept map. Then, students share their concept maps with other students in the class and discuss together. Constructing concept maps requires students to identify and build information, establish meaningful relationships between isolated pieces of information related to the topic (Darmofal et al., 2002).

This method helps students enhance their thinking skills and develop new ideas, as well as develop skills in organizing and structuring ideas before writing a report on a topic.

2.6 The Fish Bowl Method

This method is often applied at the end of a class session. Each student is asked to write a question related to the topic just covered. Students may ask questions about parts they do not fully understand or questions applying the topic to real-life scenarios. These questions are then placed in a bowl. The instructor randomly selects a few questions to answer for the students or asks other students to answer. The remaining questions are compiled by the instructor and answered for students in the next class session (James Collofelo, 2012).

This method helps students pay more attention during the learning process and provides an opportunity for students to ask questions they feel unsure about, as some students may be hesitant to ask questions in front of the class.

2.7 Case Studies

The case study method is widely used and suitable for teaching engineering and technology fields. The main components of this method rely on real-life situations of both instructors and students. Students read the case studies, discuss with peers and in small groups, combining group methods to identify issues within the presented scenarios. The primary purpose of case studies is to describe and exchange experiences on problem-solving methods and conflicts encountered during task execution. By presenting various situations that need to be resolved within a certain time frame and with limited resources, students are put in positions where they need to make decisions or collaborate and seek support from group members to find rational solutions. The diversity of presented situations not only encourages students to demonstrate initiative and creativity but also provides mental comfort and enjoyment when participating in class (Nguyễn Thành Hải et al., 2010). This method helps students easily absorb, deeply understand, and remember lecture content longer than traditional teaching methods, enhancing their ability to exchange, judge, estimate, and analyze problems and propose solutions.

3. EFFECTIVE METHODS OF KNOWLEDGE ACQUISITION FOR LEARNERS USING ADVANCED LEARNING METHODS

The relationship between learning activities and the effectiveness of knowledge acquisition by learners is illustrated in Figure 1 (Edgar Dale, 1969). The rate of knowledge acquisition by learners increases significantly when multisensory approaches to learning are applied, when there is exchange of opinions and statements, and especially when learners are directly engaged in practical tasks.

Active teaching and learning involve organizing diverse and rich learning activities to enhance students' comprehension abilities.

4. SOME ADVANTAGES AND CHALLENGES WHEN APPLYING ADVANCED TEACHING METHODS

In the process of implementing and applying positive teaching methods, the issue for educators is how to select teaching methods that are suitable for the course outcomes, the available resources, and the classroom organization conditions. Educators may choose to apply a specific teaching method, or they may use multiple methods simultaneously for a course to achieve its objectives. Below, we present some advantages and challenges in deploying and implementing active teaching methods.

4.1 Some advantages and benefits

The application of active teaching methods brings significant effectiveness in students' comprehension abilities as well as other soft skills. Some advantages and benefits when applying these methods in teaching engineering students may include:

Helping students actively acquire knowledge through individual work, teamwork, discussing and solving problems. Consequently, students will gain a deeper understanding of the subject matter, remember it longer, and have better practical application skills.

Enhancing soft skills for students: teamwork skills, communication skills, presentation skills, decision-making and problem-solving skills, computer and specialized software skills, as well as other social skills. Additionally, students will gain more confidence in expressing their personal and group opinions in front of the class, in front of audiences; building valuable skills for students to prepare for real-world work environments after graduation.

Active teaching methods require students to engage more in class through thinking, seeking information, group discussions, etc., so the phenomenon of students working individually during class has significantly decreased.

Innovating teaching methods always comes with assessment methods, assessing students based on their weekly learning abilities also creates pressure, encouraging students to participate more actively in class.

Active teaching methods not only help students master knowledge but also help instructors gather more new ideas, new issues from reality, from students. This provides instructors with good opportunities to self-study and improve their experiences and knowledge.

Furthermore, a significant advantage of applying active teaching methods is building a friendly, positive, dynamic, healthy competitive learning environment and mutual support among students. This will attract more students to participate in classes; students will not get bored and participate better in learning activities.

4.2 Some challenges

Active learning methods are still relatively new to students, so sometimes we encounter certain difficulties, which can be listed as follows:

Having too many students in the classroom makes it difficult to apply some improved teaching methods.

Some students may not cooperate with the instructor during the learning process.

Instructors need to have detailed plans, specific teaching methods, and distribute the program structure to ensure continuous progression, reduce theory, and increase practical application, which is a necessary requirement for the process of innovating teaching methods.

Some subjects have difficult content to guide students to learn actively, so instructors need to be flexible to avoid misdirecting the issue.

Instructors need more time to develop content, create situations, problems, and methods to engage students in learning activities. Additionally, it takes quite a bit of time to assess students' progress and results.

5. CONCLUSION

Innovating teaching methods is essential and urgent in the current period to enhance the quality of education. However, each teaching method, whether classical or modern, emphasizes some aspects of the teaching-learning mechanism or emphasizes certain roles of the teacher or the learner. Regardless of how effective a method is, there are still some aspects that teachers and learners have not fully explored. Therefore, in our opinion, there is no ideal teaching method. Each method has its advantages and disadvantages, so instructors should develop their own suitable method based on the objectives,

nature of the issues to be discussed, the composition of the student group, available teaching resources and tools, and ultimately their own preferences, in order to meet the learning outcomes and the demands of society. Allow me to conclude this article with a famous quote by William Butler Yeats: "Education is not the filling of a pail, but the lighting of a fire." - W.B. Yeats.

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