

A New “Target-Seeking Style” Teaching Idea for Teaching General Education Courses in Large Categories in Engineering Universities

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Abstract: General education is a crucial aspect of undergraduate education, providing both knowledge and quality education. General education courses, encompassing all majors and grades, form the cornerstone of undergraduate education in engineering universities. Especially amidst the current evolution of undergraduate education and talent cultivation within engineering universities, under the new circumstances arising from initiatives such as the plan for nurturing outstanding engineers, the establishment of new engineering disciplines, and the implementation of enrollment and undergraduate course development, the teaching of large-category general education courses assumes a pivotal role. It contributes significantly to advancing academic disciplines and majors, fostering the scientific literacy of undergraduates, nurturing a spirit of inquiry, and enhancing their ability to make informed decisions regarding majors and careers. This paper delves into the fundamental purpose and significance of teaching general education courses in engineering universities under these new circumstances, focusing on the typical challenges encountered in the teaching process. Subsequently, the authors utilize the teaching of a large-category general education course, namely “Introduction to Nanomaterials and Their Development Frontiers,” as a platform for pedagogical reform. They propose a novel “target-seeking style” teaching approach for general education courses within broader categories and explore innovative teaching methodologies aimed at addressing the common challenges associated with these courses. Ultimately, the aim is to cultivate a balanced blend of specialization and generalization among undergraduate students, thereby addressing the common issues encountered in general education teaching and realizing the overarching goal of fostering high-quality technical talents with a well-rounded skill set at the undergraduate level.

Keywords: General education; General education course teaching; New teaching ideas; New teaching mode

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1. The importance of general education in engineering colleges under new circumstances

During the twentieth session of the Political Bureau of the Communist Party of China Central Committee, the emphasis on the strategy of building a strong education country was highlighted. It was stated that “Building

a strong education country is a strategic precursor to building a socialist modernization power in all aspects, achieving a high level of scientific and technological self-reliance and self-sufficiency, promoting the common wealth of all the people, and comprehensively advancing the great rejuvenation of the Chinese nation with a foundation in Chinese modernization.” Simultaneously, a strategic deployment was made to further strengthen science education, engineering education, and the independent training of top-notch innovative talents, providing talent support for solving China’s key core technology challenges ^[1].

For the construction of a robust educational country, the foundation lies in basic education, with higher education serving as the leader ^[2]. Engineering universities, occupying a crucial position in higher education implementation, have a core objective of cultivating high-quality technical talents essential for social and economic development.

The current landscape of undergraduate education and development in engineering universities is marked by new circumstances, including the implementation of programs for training excellent engineers, the establishment of new engineering disciplines, and the execution of broad-based undergraduate enrollment and training. The objective of the program for cultivating excellent engineers in engineering education is to nurture versatile engineering talents with innovative capabilities adaptable to economic and social development, spanning undergraduates, master’s, and doctoral levels ^[3,4].

Concurrently, the establishment of new engineering disciplines aims to cultivate diversified and innovative engineering talents through interdisciplinary intersection and integration, building upon traditional engineering disciplines ^[5,6]. To facilitate these objectives, many engineering universities have adopted large-scale enrollment in the college entrance examination, amalgamating disciplines with similar majors into broader categories ^[7]. For example, some universities have combined several disciplines including industrial engineering, industrial design, flight vehicle manufacturing engineering, and micro-electro-mechanical manufacturing engineering into a large mechanical category for college entrance examination enrollment ^[8]. Freshmen enrolled in a major category first go through one to two years of public courses and large general education courses for basic training, followed by carrying out their major distribution according to their learning interests, prerequisite courses, academic performance, and other conditions for professional streaming.

Curriculum education, comprising both professional and general education, constitutes the primary content of undergraduate education in current engineering universities ^[9]. In response to these new developments, general education assumes a crucial role in aiding students in choosing appropriate disciplines, promoting interdisciplinary synergy, constructing diverse knowledge systems, and nurturing composite talents. Consequently, general education is no longer merely auxiliary to professional education but an integral component of undergraduate education. The integration of these two educational facets synergistically fosters undergraduate knowledge enhancement and quality improvement, facilitating the cultivation of high-quality talents and laying a robust foundation for the development of technical expertise ^[10,11].

Large-category general education courses, specific to particular disciplines and offered to undergraduates across all majors and levels in engineering universities, form the cornerstone of general education. To promote engineering education’s advancement under these new circumstances and enhance the effectiveness of undergraduate training, numerous engineering universities nationwide have instituted a plethora of general education courses. For instance, at the authors’ university, approximately 600 general education courses are offered annually. Given that the educational outcomes of these courses directly impact talent cultivation results in engineering universities, enhancing the teaching quality of general education courses holds significant practical importance in advancing university education and talent cultivation.

2. Problems and causes of current teaching in general courses of large categories

Based on the authors' teaching experience in general education courses in the field of material science and engineering and survey results from other general education courses, several critical issues in the teaching process of large-category general education courses have been identified. The primary problem is the lack of clarity in teaching and learning objectives. Additionally, a significant challenge is the disconnect between teaching and learning practices. Specifically, the discrepancy arises from teachers delivering content that does not align with students' interests or needs, resulting in students failing to acquire the necessary knowledge and skills from these courses.

The ambiguity in teaching objectives for general education courses stems from a misunderstanding of their importance and function in both teaching and learning processes. Most general education courses are elective, and some closely resemble major courses. Evaluation methods often exclude exams, leading many students to view these courses as easy credit options rather than essential components of their education. Furthermore, some institutions do not consider results from general education courses in merits, awards, or graduation point calculations. To realize the substantive role of general education in talent cultivation, both teachers and students must develop a correct and thorough understanding of its purpose. Teachers should approach general education courses with the right mindset, and students should select them accordingly. The subsequent section will delve into the primary objectives and significance of teaching general education courses in conjunction with the new challenges and requirements of engineering universities' current development.

This section focuses on analyzing teaching and learning issues in large-category general education courses and their underlying causes. From the teachers' perspective, these courses typically involve specialized knowledge across various disciplines. However, with students from different grades and majors, discrepancies in understanding basic course knowledge are common. Traditional teaching methods often lead to two scenarios deviating from educational objectives: either courses become overly broad and shallow or excessively detailed and complex. Consequently, some students struggle to grasp the content, while others find it superficial.

Regarding the learning outcomes of students, differences in grades and majors lead to varying levels of comprehension of basic course knowledge. Many students express difficulty understanding general studies courses in certain majors, with some only taking these courses for easy credits rather than genuine interest. Most students find it challenging to delve deeply into specific course content within the class cycle. For instance, a first-year student planning to major in mechanical engineering may struggle with a general education mathematics course, finding the theoretical nature of lectures overwhelming and failing to grasp foundational concepts due to limited class time. This not only impedes understanding but also diminishes interest in learning.

Current teaching methods for large-category general education courses typically include classroom lectures, post-course reading, homework, laboratory visits, and teacher-student interactions. While these methods enhance teaching effectiveness to some extent, they often fail to engage students or integrate teaching outcomes with scientific research and real-life practice, hindering the fulfillment of general education requirements and goals.

3. New exploration of the purpose and significance of teaching general courses in large categories under new circumstances

Through the authors' survey, it has been observed that most engineering universities have introduced numerous general education courses with the primary aim of augmenting undergraduates' subject knowledge and broadening their scientific horizons. These courses serve to supplement the limited class hours of public and specialized courses. However, the authors argue that solely focusing on knowledge dissemination and

increasing class hours is insufficient to harness the full potential of general education in enhancing talent quality and advancing disciplinary development, especially in the evolving landscape of university education.

To fundamentally enhance the effectiveness of general education in engineering, there is a need to clarify the purpose and philosophy of general education teaching comprehensively. In light of the new requirements and circumstances in undergraduate education, the authors have conducted a new exploration of the purpose and significance of general education. This exploration is informed by years of teaching experience in large-category general education courses in the field of material science and engineering and the developmental trajectory of undergraduate students.

- (1) Disseminating scientific knowledge and enhancing scientific literacy: Improving scientific spirit and cultural literacy is crucial for societal development. While basic physics and chemistry courses for junior students aim to augment their knowledge base, professional courses for senior students aim to enhance their expertise. General courses cater to students across majors and grades, focusing on bolstering scientific spirit and cultural literacy. The authors advocate for making large-category general courses compulsory, ensuring engineering majors complete a set number of credits in these courses before graduation.
- (2) Reserving subject knowledge and enhancing students' ability to choose suitable disciplines: Large-category enrollment in many engineering colleges offers freshmen the opportunity to choose specific professional departments in their sophomore year. Despite this, many students still face confusion during major selection, leading to suboptimal choices and poor learning outcomes. Encouraging freshmen to take appropriate general education courses in their first year can guide them toward suitable majors during subsequent distributions, fostering better learning situations.
- (3) Cultivating the spirit of learning and promoting interdisciplinary intersection: Large-category general courses provide a comprehensive knowledge system in related professional fields, expanding students' horizons, promoting knowledge integration, and enhancing their application abilities. These courses stimulate a spirit of continuous learning, improving the efficiency of training high-quality technical and composite talents in engineering colleges.
- (4) Establishing concepts of family, country, and social responsibility: General courses serve as important platforms for ideological education. Teachers can integrate the history of science and technology with societal development into their teaching, fostering scientific spirit and patriotic sentiments among students.

4. An exploration of the “target-seeking style” teaching model for teaching general education courses in large categories

As frontline educators deeply involved in teaching general education courses for large material science and engineering classes, the authors have adopted the course “Introduction to Nanomaterials and Their Development Frontiers” as a platform for teaching reform. They introduce a novel “target-seeking style” teaching approach and explore a new mode of teaching for large general education courses. Through this endeavor, they aim to address the issue of separation between teaching and learning commonly encountered in such courses. By organically integrating teaching and learning, they aim to fully harness the advantages of general education in talent cultivation and achieve educational goals encompassing both “general” (cultivating scientific literacy) and “knowledge” (consolidating disciplinary knowledge).

The “target-seeking style” teaching idea, inspired by missile guidance technology, revolutionizes general education course teaching. This approach ensures that the teacher's content aligns directly with the learning expectations and goals of undergraduates. Continuous and dynamic feedback mechanisms during teaching enable

alignment between teaching content and students' learning objectives, fostering interest and clarity in learning purposes. This method not only enhances undergraduates' subject knowledge but also facilitates the transformation of knowledge into skills, thereby enhancing the educational effectiveness of general education courses.

The authors summarize the implementation of the “target-seeking style” teaching method in their general education course based on their teaching practice. In the initial class, teachers provide a comprehensive overview of the course content and related disciplines, prompting undergraduates to propose core problems or learning objectives based on their interests and majors. Through group discussions and individual guidance, undergraduates refine their learning objectives, enabling teachers to tailor teaching content to meet these objectives. Subsequent classes focus on in-depth exploration of selected topics, with teachers integrating lectures, literature reading, experiments, and student presentations to enhance understanding and application of knowledge.

For instance, in the “Introduction to Nanomaterials and Their Development Frontiers” course, undergraduates are introduced to various types and applications of nanomaterials, including more than ten types of nanomaterials such as nanomaterials for energy applications, nanostructured biomaterials, magnetic nanomaterials, carbon nanomaterials, and nanocomposites. Students propose specific problems or learning objectives related to these topics, which are addressed through a combination of lectures, literature readings, and practical experiments tailored to individual interests and learning goals. For instance, after listening to the overview of nanomaterials, an undergraduate who majored in aerospace wanted to deeply understand the application of nanofluids in the aerospace fields after learning the basic knowledge of nanofluids. In response to the undergraduate's learning needs, the authors first focused on the concepts, structures, classifications, and applications of nanofluids and other basic knowledge during the course, and used the literature on the application of magnetic fluid seal in the aerospace field as the undergraduate's post-course literature reading, and then helped the undergraduate directly understand the principles of magnetic fluids and their potential applications in the aerospace field through simple experiments.

In summary, the “target-seeking style” teaching model encourages undergraduates to explore their learning interests and objectives within the course syllabus, enhancing their learning spirit and promoting interdisciplinary knowledge acquisition. By breaking down the barriers between teaching and learning, this approach significantly enhances teaching effectiveness and fosters the development of undergraduates in engineering universities in the new era.

5. Conclusion

As frontline educators dedicated to teaching major general education courses, the authors have meticulously analyzed the common challenges encountered in the teaching process of these courses and their underlying causes. They have also conducted a thorough examination of the significant role played by major general education courses in the educational and teaching processes of engineering universities amidst the evolving landscape of higher education. Furthermore, they have introduced a novel “target-seeking style” teaching approach for large general education courses.

Through their teaching practice, the authors have demonstrated that the “target-seeking style” teaching holds promise in addressing the issue of separation between teaching and learning prevalent in current teaching methods for large general education courses. This approach not only ignites students' interest in learning but also fosters the seamless integration of teaching and learning, thereby fundamentally enhancing the effectiveness of teaching large general education courses.

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Disclosure statement

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