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# Reflections on Teaching Reform in Bioengineering Talent Cultivation Based on Outcome-Based Education

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***ABSTRACT:*** *With the advancement of technology and the rapid development of the era, contemporary college students are exposed to an overwhelming amount of knowledge and information. The exponential growth of internet technology has revolutionized various industries, including education. Given these changes, can university teachers still rely on teaching methods from a decade or even decades ago to meet the learning demands of today's students? Educational reform is imperative, and outcome-based teaching models have emerged as a response. Drawing from over a decade of teaching experience and insights gained from multiple curriculum reform training programs, this paper summarizes and reflects on key pedagogical considerations. The aim is to provide valuable insights for enhancing teaching practices in teaching of bioengineering.*

***KEY WARDS:*** *OBE (Outcome-Based Education), Bioengineering, Talent Cultivation, Teaching Reform, Reflections*

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## I. INTRODUCTION

The rapid advancements in bioengineering have intensified the industry's demand for high-caliber, innovative professionals. Traditional teaching models, however, tend to overemphasize theoretical knowledge transmission while under developing students' practical competencies, innovative thinking, and ability to translate learning into tangible outcomes—resulting in a persistent misalignment between academia and industry needs. Outcome-Based Education (OBE), with its backward-design approach centered on predefined learning outcomes, presents a transformative framework for cultivating bioengineering talents that meet contemporary challenges.

Reforming teaching practices is central to implementing Outcome-Based Education (OBE). By optimizing curriculum structures, strengthening hands-on training, promoting industry-academia-research collaboration, and adopting diversified assessment mechanisms, we can effectively enhance students' engineering competencies, scientific innovation capabilities, and ability to solve complex problems.This study explores pathways and strategies for teaching reform in bioengineering education, aligned with OBE principles, aiming to cultivate application-oriented and interdisciplinary professionals. The proposed framework seeks to support high-quality talent development in the bioengineering field. [1-2].

## II. Talent Cultivation Objective Setting

Outcome-Based Education (OBE) can be translated as "Competency-Oriented Education", "Goal-Oriented Education", or "Needs-Driven Education". It follows a backward design approach centered on predefined outcomes. The first critical question is: What kind of talents do we aim to cultivate? The answer lies in the outcomes (expected achievements).

"*The purpose of education lies in preparing for the future, not merely complying with international benchmarks*"

"*Future-Connected Education: The Essence of Authentic Pedagogy* "

---Eric Mazur, Harvard University[3-4]

Bioengineering is a highly interdisciplinary and application-intensive discipline. As the educationist Eric Mazur said, talent development should not merely meet current international standards but must focus on the demands of future-oriented frontier fields such as the bioeconomy, precision medicine, and sustainable development.

Outcome-Based Education (OBE) emphasizes a final learning outcomes-oriented approach, and "future-facing" bioengineering education aims to cultivate students' core competencies to meet the challenges of the upcoming biotechnology revolution. These include:(1) Innovation capability that transcends traditional disciplinary boundaries (e.g., the integration of synthetic biology and AI), (2) Practical problem-solving skills for complex engineering challenges (e.g., optimization of biopharmaceutical processes), and (3)Lifelong learning ability to adapt to rapid technological advancements. For instance, in curriculum design, we should not only teach existing gene-editing technologies but also equip students with an understanding of the underlying principles, enabling them to quickly master emerging tools that may arise in the future.

"Aligning with the Future" Demands a Dynamic Adjustment Mechanism. For bioengineering programs, this entails:(1) Establishing an industry demand early-warning system to promptly update educational objectives; (2) Integrating project-based learning to simulate future workplace scenarios; (3) Strengthening ethics education to equip students for emerging bioethical challenges. Only such a future-ready OBE model can cultivate the pivotal talent capable of driving biotechnology advancements.

## III. Reflections on Curriculum Development

Benchmarking Excellence: Building "Double First-Class" Universities. To establish world-class universities, we must first develop first-class courses, first-class programs, and first-class disciplines—these are the fundamental pillars supporting our "Double First-Class" initiative. Ultimately, success hinges on high-quality curriculum design and delivery, ensuring students truly acquire knowledge and develop into the talent needed for the future, aligning with desired outcomes. Many faculty members believe that "teaching well" is sufficient for curriculum development. But this raises a critical question: What does "teaching well" actually mean? As educators, we all strive to: Prepare lessons diligently, deliver lectures conscientiously, Grade assignments meticulously, and Encourage student engagement. But how effective is this traditional teaching approach? Consider the following two examples(Table1 and Table2):

Table1：Survey of working professionals: most beneficial aspects of university education

| type | Percentage |
|---|---|
| Off-campus Internships and Social Activities | 37% |
| Peer Interaction and Communication | 22% |
| Independent Study | 15.3% |
| Faculty Mentorship | 11.7% |
| Classroom Instruction | 13.6% |

*Prof. Yan GuangcaiEast China Normal University，2016.1[5]*

Table2：Ranking table of academic achievements of different types of outstanding talents（%）

| Class academic performance ranking | Director-General Level and Above | Senior Professional Title and Above | Senior Corporate Management |
|---|---|---|---|
| Top three | 10.6 | 19.6 | 9.7 |
| Six or so | 23.7 | 19 | 17.6 |

| | | | |
|---|---|---|---|
| Ten or so | 28.9 | 35.2 | 37.4 |
| Fifteen or so | 18.4 | 17.3 | 24.8 |
| After twenty | 18.4 | 8.8 | 10.5 |

*Fifty-Year Analysis of 985 University Student Performance: Correlating Academic Excellence with Leadership in Government, Enterprise, and Academia - A Tsinghua Big Data Study", 2016 [6]*

From Tables 1-2, it can be observed that the talent cultivated through traditional classroom teaching and evaluation systems does not fully align with outcome-oriented demands or future workforce needs. This underscores the critical importance of curriculum development. I believe the OBE (Outcome-Based Education) teaching philosophy was proposed precisely to address this issue. So, how should classroom teaching methods be reformed?

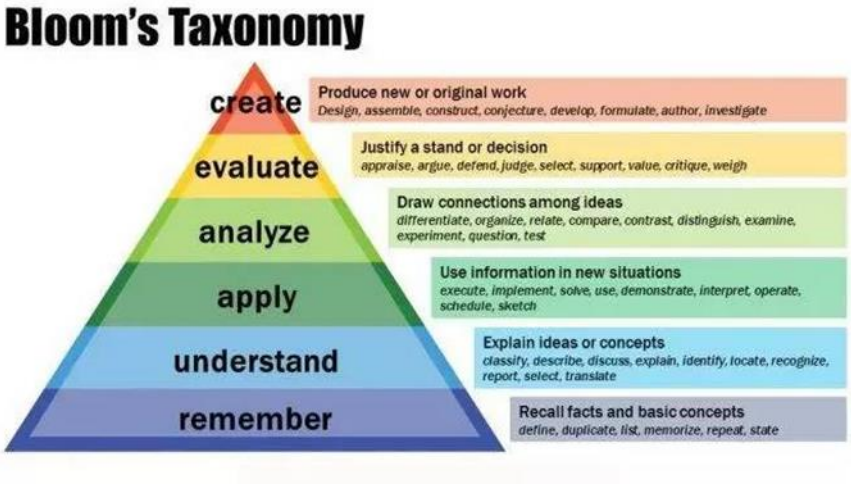


Figure1. Bloom's Taxonomy of Educational Objectives [7-8]

（**Note**: Benjamin Bloom was a renowned contemporary American psychologist, educationist, and Professor of Education at the University of Chicago. He served as President of the American Educational Research Association (AERA) and was an expert in assessment and curriculum for the International Association for the Evaluation of Educational Achievement (IEA).）

In the learning taxonomy model, the foundational levels—remembering and understanding—merely represent basic knowledge acquisition. The higher-order cognitive skills (applying, analyzing, evaluating, and creating) constitute comprehensive competencies essential for cultivating future-ready talent. How can we operationalize this across all teaching phases? As previously noted, off-campus internships and social activities (37%) and peer interactions (22%) significantly enhance skill development. However, these initiatives require substantive enhancement beyond token participation—students must engage in authentic production-based learning. Moreover, shouldn't we prioritize reforming classroom teaching, which dominates students' time? With rapid technological advancement and societal evolution, traditional pedagogies struggle to align with contemporary learners' needs. A methodological transformation is imperative.

Learning methods can be categorized into: Attending Passive – The traditional teacher-centered approach where students primarily listen and absorb information. Manipulating Active – Students engage with the material through problem-solving or hands-on tasks. Generating Constructive – Learners construct knowledge by summarizing, explaining, or applying concepts. Collaborating Interactive – Peer discussions, group projects, and cooperative problem-solving. Many high-quality courses ("gold-standard courses") now employ Generative and Interactive Learning, which are student-centered (SC) approaches. Research shows that these two methods significantly enhance knowledge acquisition, comprehension, extension, and competency development. To maximize effectiveness, these methods should be integrated with blended learning: Pre-class online learning (students acquire foundational knowledge independently) and In-class group discussions & problem-solving (deepening understanding through collaboration).

The overall course design proposed by Prof. Huang Hui from Beijing Jiaotong University—the BOPPPS instructional model (see Figure 2) has deeply inspired me[9]. By integrating BOPPPS with student-centered

generative and interactive learning, students not only master core knowledge but also develop learning agility, critical thinking, innovation, communication skills, and teamwork. These higher-order competencies are precisely what future-ready talents require. This is not to undermine the importance of foundational knowledge—on the contrary, it is even more critical. For instance, China's "Strengthening Basic Disciplines" initiative in top universities emphasizes mathematics, physics, chemistry, and biology, integrating them with engineering to cultivate talent for national strategic needs in fundamental sciences. As a bioengineering discipline, we must further strengthen STEM foundations while advancing pedagogical innovation.

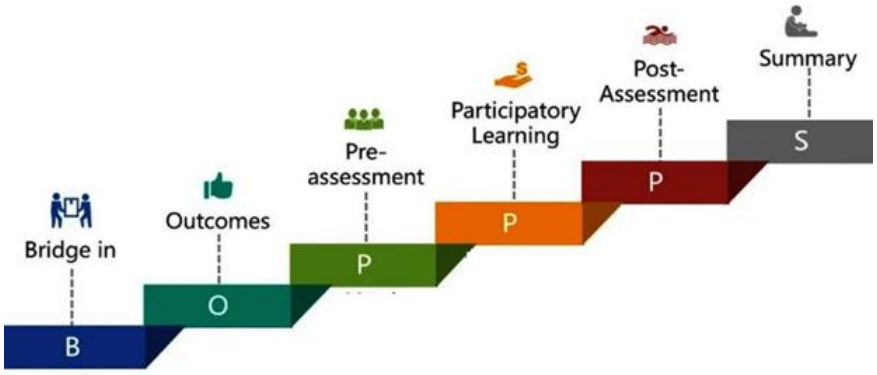


Figure 2. BOPPPS

## IV. Reflections on Curriculum Development

Table 1 data shows that faculty guidance accounts for 11.7% of most beneficial aspects of university education, which I consider to represent remarkably high implementation efficiency. Because our generation in college, the real contact with professional teachers time is not very long. In recent years, through the tutorial system [10-11], college student innovation and entrepreneurship project [12], graduation project [13] and other teaching links, many students can have relatively long contact with professional teachers. Through careful observation, we can find that students who often have contact with teachers, including daily communication, experiments with teachers, etc., often have special ideas and good employment positions. Because you can learn a lot of knowledge by communicating with teachers. How can the aforementioned strong base education in colleges and universities be realized? Professor Li Junfeng proposed that basic courses should be taught and students should be given enough time for extracurricular study. In order to learn a course well, at least three times of extended study time is needed. On the other hand, we should increase contact and communication opportunities with teachers, and make use of all available opportunities to communicate and guide in time. All these show that the role of teachers' personal guidance is very important for personnel training [14-15].

## V. Moral education

The essence of education resides in cultivating character and nurturing talent, with moral integrity as the cardinal principle of human capital development. This concept requires education not only to impart knowledge, but also to cultivate students' core values, feelings of family and country, and social responsibility。In practice, moral education is integrated into curriculum teaching, campus culture and social practice. Teachers should set an example and become moral models for students. Schools need to improve the evaluation system of moral education and pay attention to students' moral development and behavior practice. At the same time, family education and social education work together to form a whole-person, whole-process, all-round education mechanism. Moral cultivation embodies the essential pursuit of education-cultivating new people with both virtue and ability to take on the great responsibility of national rejuvenation. Only by virtue casting soul, to culture people, can we truly realize the mission of educating people for the Party and educating talents for the country.

## VI. Conclusion

There is no small thing in teaching, and there are too many problems to think about in teaching.Here I would like to introduce a sentence from Professor Wu Nengbiao, Dean of Academic Affairs of Southwest University [16]：

*Education is not only a conscience, but also a duty.*

For "education", it is not enough to live up to one's conscience, there are students, parents, and social responsibilities, So we as teachers can focus on those two things, Teaching can certainly improve a lot, Because teaching is a big responsibility. Finally, I quote again a sentence from Professor Li Junfeng, dean of Xingjian College of Tsinghua University：

*The creativity of teaching work needs institutional and cultural recognition ！*
*Avoid excessive material incentives while ensuring the dedicated receive due recognition. ！*

It is hoped that all teachers, from individual teachers to professional, college and school levels, will strive to achieve normal management of teaching, improve teaching objectives, and achieve the goal of talent training.

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## REFERENCES

[1]. Li, W., Zhang, H.,(2021). "Exploration of Practical Teaching Reform in Bioengineering Based on the OBE Concept", Journal of Higher Engineering Education Research, (4): 45-50.
[2]. Wang, L.,(2023). "Research on the Application of Outcome-Based Education in Engineering Talent Cultivation", Journal of Higher Education in China, (12): 78-82.
[3]. MAZUR, E.,(2014). "Assessment: The silent killer of learning[EB/OL]", https://www.ted.com/talks/eric_mazur_assessment_the_silent_killer_of_learning.
[4]. MAZUR, E., (1997). "Peer instruction: A user's manual", Upper Saddle River: Prentice Hall.
[5]. Yan, G.C.,(2016)."What Constitutes the Most Beneficial Learning Experience During University? — An Empirical Investigation at a Research-Intensive University", Journal of Educational Research. (1): 55-63.
[6]. Li, F.L.,(2018)."《From Classroom to Career: Linking Academic Achievement to Professional Success in Selective Universities》 From Transcripts to Trajectories: A Multi-Institutional Study of Student Outcomes in China's Elite Universities.
[7]. Anderson, Lorin W., David, R., (2001). "Krathwohl, editors. "A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives", Longman.
[8]. Anderson et al., (2008). "《The Revised Version of Bloom's Taxonomy of Educational Objectives》", Beijing: Foreign Language Teaching and Research Press (FLTRP).
[9]. British Columbia Institute of Technology. (2014). "ISW facilitator handbook (4th ed.)", BCIT Learning and Teaching Centre.
[10]. Brockliss, L. W. B., (2016). "The University of Oxford: A History. Oxford University Press".
[11]. [Crisp, G., Cruz, I., (2009). "Mentoring College Students: A Critical Review of the Literature", ASHE Higher Education Report, 35(6): 1-130.
[12]. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017), "Entrepreneurship (10th ed.). McGraw-Hill".
[13]. Anderson, L. W., & Krathwohl, D. R., (2001). "A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy. Longman".
[14]. Li.J.F., (2021). "The Educational Philosophy and Implementation Framework of the Academy System under China's "Strong Foundations Program",《Journal of University Teaching in China》, (5): 25-30.
[15]. Li, J., Wang, H., (2023)."How to Sustain Teaching Enthusiasm in Research Universities: A Case Study of Tsinghua XINGJIAN College". Higher Education Policy, 36(1): 78-95.
[16]. Wu.N.B.,(2021). "Reconstructing Educational Responsibilities in Teacher Education Program Accreditation", Journal of Teacher Education Research. 33(4): 12-18.