# Research on Teaching Reform of Professional Basic Courses in Engineering Based on Precision Teaching Concept in the Digital Era

Jian Pan*, Yutin Zhao, Xinwei Gao, Xinshe Qi

School of Information and Communication, National University of Defense Technology, Wuhan, China

372835803@qq.com*

**Abstract.** With the rapid development of technologies such as big data and artificial intelligence, the digital transformation of education will become one of the important aspects of teaching reform in universities. The concept of precise teaching emphasizes the comprehensive tracking of the teaching performance of teachers and students, based on relevant data generated during the teaching process, providing scientific and effective support for teaching decision-making and action. Its teaching philosophy and characteristics are well adapted to the direction of digital education development. This article focuses on the research and exploration of the application advantages, implementation strategies, and teaching models of precision teaching in professional basic courses, in order to provide useful references for curriculum teaching reform and talent cultivation in universities.

**Keywords:** Digitalization of education, Precision teaching, Teaching reform

## 1 Introduction

With the rapid development of science and technology, digital technologies such as the Internet, big data and artificial intelligence are profoundly affecting many aspects of social production and life. In 2022, the National Education Conference proposed the implementation of the national education digital strategic action to guide the full implementation of the education digital transformation practice[1]. As an important component of the "Digital China Strategy", educational digitization is an important measure to implement the strategies of revitalizing the country through science and education, strengthening the country through talent, and driving development through innovation.

In recent years, with the continuous integration and rise of new concepts and technologies such as "big data+" and "artificial intelligence+" in the field of education, teaching environments such as smart campuses, smart classrooms, and smart laboratories have rapidly popularized. New teaching scenarios such as blended learning, virtual immersive teaching, and flipped classrooms have been promoted and applied in university teaching, enriching and expanding information resources in various dimensions


D. Rad et al. (eds.), *Proceedings of the 2024 5th International Conference on Mental Health, Education and Human Development (MHEHD 2024)*, Advances in Social Science, Education and Humanities Research 857,
https://doi.org/10.2991/978-2-38476-271-2_30

such as teaching content, teaching objects, teaching time and space, and teaching evaluation, providing a good growth soil for the digital transformation of university teaching. These changes, in the process of changing traditional education models, provide a comprehensive portrait of the process of teaching and learning, continuously enhance the deep connection between teachers and students, and lay a good foundation for more accurate and effective teaching decision-making, implementation of teaching processes, and evaluation of teaching effectiveness[2-4].

## 2 New Changes in Teaching Reform in Higher Education Institutions in the Digital Information Era

With the integration of digital information technology into the entire process and various links of higher education and teaching, a series of new changes will occur in the education and teaching work of universities, mainly reflected in the following aspects: first, the innovation of teaching models under the guidance of digital technology. With the support of digital information technology, classroom teaching in universities is breaking away from the traditional teaching model of relying on fixed classroom space, textbook knowledge, and teacher lectures, and shifting towards a new teaching model characterized by the combination of virtual and real teaching space, diversified knowledge sources, and personalized learning needs of students. The second is the prominent role of educational digitization in promoting education. The use of digital information technology enables teaching objects and teaching processes to be comprehensively recorded, including information such as students' educational background, learning habits, academic performance, psychological behavior, as well as teaching resources, teaching implementation, teacher-student interaction, etc., which can become important data resources for teaching activities. The mining and utilization of these teaching data resources will undoubtedly become an important basis for scientific and accurate teaching work and improving the quality and efficiency of talent cultivation. The third is the transformation of the roles of teachers and students. With the great richness of various information platforms and means, there are many channels for students to obtain knowledge, and the proportion of learning resources provided by teachers is declining. This requires students to change their passive and follower learning state, and become explorers, initiators, and other roles in learning. Teachers also need to break away from subjective and experiential teaching in the past, and transform into guides, assistants, and other roles in learning[5]. Both teaching and learning should work together to carry out scientific and effective teaching activities.

Through comprehensive analysis, it can be seen that with the advancement of education digitization, the curriculum and teaching methods of universities will continue to innovate, the knowledge content system and teaching information resources will continue to enrich, and the personalized and differentiated learning needs of students will continue to grow. How to fully leverage the advantages of educational information resources, connect with the needs of learners, professional talent output needs, and social needs, and explore the construction of a scientific, accurate, and effective curriculum teaching model has important research significance and value[6,7].

## 3 The Application Value of Precision Teaching in Higher Education Curriculum Teaching under the Digital Background

The concept of Precision Teaching was initially proposed by American scholar Linsley in the 1960s. Its core idea is to track the learning process and performance of students, obtain relevant data by pre designing the process to be measured, and use it as a basis to provide data feedback and support decision-making for teaching. At first, precision teaching was used in the United States to assess the learning performance and effectiveness of certain special types of students. Later, it was gradually referenced by other types of disciplines such as linguistics, medicine, and basic education, and expanded to different types of teaching effectiveness evaluations. The research on precision teaching started relatively late in China, but it has developed rapidly with the help of modern information technology[2,8].

With the continuous deepening of research on precision teaching by domestic and foreign scholars, the academic community's positioning and views on precision teaching are gradually converging. It can be seen that in classroom teaching, "precision" is a necessary condition for teaching implementation, and the core key is to accurately measure and track student learning performance, pay attention to individual learning processes, and achieve "precision teaching" for teachers and "personalized learning" for students[9]. In the current era of digital education development, the concept of precision teaching has a good fit with the teaching practice of universities. In teaching practice, it is advocated to use information technology and means to comprehensively collect and analyze student individual data, teaching process data, and effectiveness evaluation data[10]. These data will be a powerful basis for both teachers and students to make teaching decisions, carry out teaching practices, evaluate and improve teaching actions.

As a new paradigm of teaching, precision teaching has the main advantage of mining evidence that is relevant to the teaching object, guiding teachers to combine their personal professional qualities and teaching experience with the actual and personalized needs of the teaching object in the teaching process, and improving the objectivity and scientificity of teaching decisions and behaviors. Especially in the era of digital education, precision teaching has abundant advantages in data resources and environmental support conditions. Carrying out teaching practices based on the concept of precision teaching in university classrooms will be one of the important paths to improve the scientific, targeted, and effective nature of teaching work[11,12].

## 4 The Practical Feasibility of Carrying out Precision Teaching Based on Professional Basic Courses in Engineering

Professional basic courses serve as a bridge between prerequisite basic courses and subsequent professional courses in the teaching system of universities. Their core role

is to help students construct the necessary knowledge and skills before entering the professional field of study, and cultivate the comprehensive qualities required for professional learning. The professional basic courses in engineering usually include theoretical courses and practical courses, which have the characteristics of integrating theory and practice, interdisciplinary basic knowledge, and have a strong cultivation and shaping effect on the comprehensive ability and professional value pursuit of learners.

Currently, universities have a high enthusiasm for responding to the digital transformation of education, and the information environment and technological means on campus are also greatly enriched. This provides good convenience for the collection and analysis of various types of information, and also lays a good foundation for the integration of precision teaching into professional basic course teaching. Professional basic courses are carried out on the premise that students have completed the prerequisite basic course learning. At the beginning of implementation, the course can obtain a lot of effective teaching data, such as investigation of students' learning situation, personality characteristics, learning style, prerequisite course grades, etc; In the implementation process, professional basic courses usually have a long learning time span, frequent switching between different spaces such as classrooms and laboratories. The interaction between teachers and students, individual development of students, and team collaboration experience are relatively sufficient. These links will accumulate teaching data from multiple dimensions for course teaching, providing good teaching decision-making and implementation basis for supporting student-centered precision teaching mode. Teachers can fully understand the individual characteristics and development needs of students, dynamically adjust teaching strategies, and scientifically carry out teaching practices. At the same time, precision teaching can effectively build a feedback and regulation mechanism between teaching and learning. Teachers can use digital information technology to monitor the knowledge, skills, emotions, attitudes, and values of students, and record data on teacher-student interaction, student expression, team collaboration, and event experiences during the teaching process. These data can help both teachers and students establish a good interactive feedback mechanism at different stages of teaching, such as before, during, and after, and can assist teachers in more scientific assessment of teaching situations, promoting dynamic optimization and adjustment of teaching. Based on comprehensive analysis, conducting precise teaching in professional basic courses has good adaptability and feasibility.

## 5 The Implementation Strategy of Precision Teaching in the Teaching of Professional Basic Courses in Engineering

Based on the concept of precision teaching, the design and implementation of professional basic courses in engineering should focus on the following aspects.

### 5.1 Constructing a Precision Teaching Model Framework Based on Teaching Behavior Analysis

In the context of digitalization in education, modern information technology is deeply integrated with curriculum teaching. Teaching teams can use data collection platforms and big data analysis technologies to start with analyzing curriculum teaching behavior, and digitize classroom actions, extracurricular activities, online and offline interactions between teachers and students, in order to facilitate qualitative and quantitative analysis. The precise teaching model framework constructed by the author is shown in the Fig.1, which is mainly divided into three dimensions: teaching preparation, teaching implementation, and teaching evaluation.

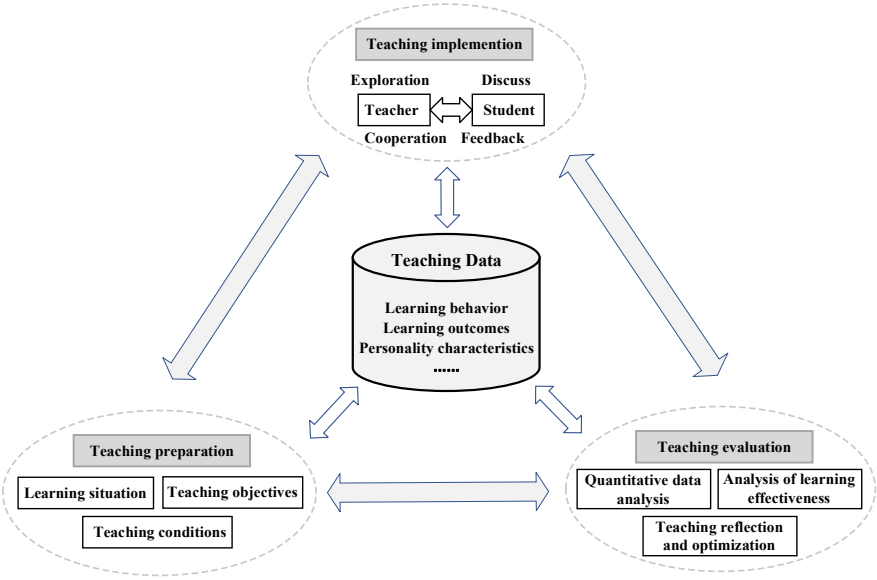


**Fig. 1.** Precision teaching model

In the preparation stage of teaching, with the help of information platforms and technological means, on the one hand, it is to conduct a survey and analysis of the learning situation, collect information on students' knowledge starting points, ability foundations, personality characteristics, etc., and try to understand the comprehensive situation of learners as much as possible, laying a foundation for the precise implementation of teaching; On the other hand, based on the characteristics of the course, teaching situation analysis can be carried out to establish teaching objectives, clarify teaching methods and means, and finely formulate evaluation standards to prepare for teaching implementation.

In the implementation stage of teaching, based on precise analysis of pre class learning and teaching situations, clear planning and design are carried out for each link and activity in actual course teaching. The core of the teaching organization form is student-centered, guided by teachers, and the comprehensive use of various learning methods

such as inquiry, collaboration, and discussion. In the dynamic interaction between teaching and learning, knowledge, abilities, and literacy are cultivated. Throughout the implementation process, fully utilize digital information technology, comprehensively record the teaching process, grasp real-time teaching dynamics and personalized differences of students, and adjust teaching strategies in a timely manner.

In the teaching evaluation stage, relying on big data analysis technology, teaching evaluation is dynamically embedded into the teaching process. By utilizing various data generated by teachers and students during the teaching process, quantitative analysis and accurate profiling of teaching effectiveness and learning performance are achieved, promoting the evaluation focus to focus on the learning performance of learners. Evaluation should include both teacher and student evaluations of teaching activities, fully leveraging the comprehensive role of evaluation, and conducting teaching reflection based on the evaluation situation to promote the healthy development of teaching and learning.

## 5.2 Improve the Teaching Data Environment that Supports Precision Teaching Models

One of the key points for the implementation of precision teaching mode is to have relevant supporting data that can accurately reflect teaching activities and teaching effects, focusing on forming effective teaching data. Therefore, building and improving a good data collection environment is of great practical significance.

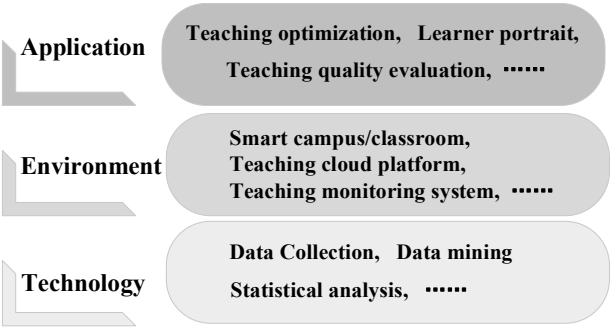


**Fig. 2.** Architecture of teaching data application system

The architecture of the teaching data application system proposed in the article is shown in Fig.2. In recent years, the construction of teaching environments represented by smart campuses and smart classrooms in various universities has developed rapidly, providing a good method for teaching data collection and effectively solving the problem of difficult teaching data collection. By relying on various environments and methods such as the smart classroom management system, teaching monitoring system, smart teaching platform, and personal wearable devices, detailed information about students' classroom performance, learning behavior, learning interests, learning focus, and even emotional attitudes can be obtained through various perception methods and

technologies. This can achieve multi-dimensional data information about teaching activities, learning behavior, learning characteristics, interests, and physical and mental states without interfering with normal teaching work and campus life, and achieve multi-dimensional tracking and recording of the entire teaching process and teaching subjects and objects. The generated teaching big data will provide strong support and assistance for optimizing teaching decisions, improving teaching activities, and enhancing learning effectiveness.

### 5.3 Enhancing the Ability to Carry out Precise Teaching in Professional Basic Courses

To promote the teaching of professional basic courses in engineering based on precision teaching, firstly, the teaching subject, namely teachers and students, should form a positive and consistent recognition of precision teaching. Teachers should dare to break through past thinking and practices, think about teaching work in a new way, especially by leveraging the advantages of information and data to empower teaching work, target and accurately solve teaching problems, and improve teaching effectiveness with precise goals; For students, the core goal of teaching work is to enhance their comprehensive abilities and help them become useful talents. The current generation of young people has grown up with the rapid development of the information age. They have strong personalized designs and diversified pursuits for personal growth and career pursuits. At the same time, they are also the most active group in using digital information technology on campus. Therefore, students maintaining an open, pragmatic, and actively participating attitude and action towards precision teaching based on digital information support is also one of the key factors supporting teaching reform. Secondly, it is necessary to enhance the relevant abilities of teachers to carry out precise teaching. The awareness of data feedback, data interpretation ability, and data analysis thinking that teachers possess in teaching and research activities are one of the important factors that affect the quality and efficiency of precision teaching. This requires teachers to actively carry out various teaching data collection and integration, use data mining and processing techniques to screen and analyze teaching data, and from the perspective of scientific, targeted, and personalized teaching needs, scientifically carry out teaching analysis, accurately design teaching strategies, dynamically adjust teaching organizational forms, effectively evaluate teaching quality, and continuously improve the teaching quality and efficiency of professional basic courses. Thirdly, we should actively create a research atmosphere for teaching innovation. Schools should strengthen their design and investment in incentive measures, fault tolerance mechanisms, and resource guarantees, strongly support collaborative teaching reforms between teachers and students, and encourage more teachers and students to participate in innovation; Establish and improve corresponding quantitative evaluation mechanisms, recognize the workload and physical and mental efforts of teachers in carrying out precision teaching, give certain rewards to students who actively cooperate with teaching reform, and create a beneficial environment and atmosphere for promoting education digitization and conducting precision teaching.

In the autumn semester of 2023, relying on the reform of the "Digital Electronic Technology" course, we conducted a preliminary test of the teaching effect after introducing the precision teaching model. In the teaching preparation stage, we fully utilized various channels to collect learning information, such as students' academic performance in leading courses such as "Advanced Mathematics", online questionnaire survey data, teacher-student symposium information, etc., to comprehensively grasp students' learning situation as much as possible. In the implementation stage of teaching, we adopt a graded and precise teaching strategy based on the obtained data, and develop differentiated teaching plans for students with different learning foundations. During the implementation process, we dynamically collect relevant teaching data, conduct data analysis, and use it as the basis for adjusting teaching strategies. In the teaching evaluation stage, we comprehensively sort out and analyze various teaching data, conduct comparative research, and summarize and reflect. By comparing the course assessment results of the same type of classes from 2021 to 2023, we found that the average grades of the classes conducting precision teaching pilot projects in 2023 increased by nearly 7 points compared to the average grades of the classes using traditional teaching methods before the reform, and the excellent rate increased by 13%. The effectiveness of the reform is quite significant.

## 6 Conclusion

Starting from the value and application perspective of the organic combination of professional basic course teaching and precision teaching philosophy, this article discusses the foundation and advantages of carrying out precision teaching in engineering professional basic courses. Strategies and suggestions are proposed from the aspects of constructing a precision teaching model framework, improving the precision teaching data environment, and enhancing the relevant capabilities of precision teaching implementation. This provides useful reform ideas and reference for the teaching of professional basic courses in engineering colleges.

## References

1. Zhang, S., Cui, Y.L., Zhang, B. (2024) Research on the implementation path of precision teaching model in higher vocational colleges under the background of big data. Journal of Chengdu Aeronautic Polytechnic., 40: 20-22. https://kns-cnki-net-s.libyc.nudt.edu.cn.
2. Wan, H.C., Qin, G.F., Yang, J.F., Wei, C.R., He, Y.L. (2024) Problems in precision teaching under perspective of education digitization and solutions. Journal of Hubei Open University., 44: 9-15. https://kns.cnki.net/kcms2/article/abstract.
3. Sun, L.N., Wang, J.S. (2024) Design and implementation of the precision teaching strategies in blended mode under the idea of OBE. Scientific Research Education., 29: 39-43. https://kns.cnki.net/kcms2/article/abstract.
4. Ye, X.D., Liu, Z.M. (2024) Research on the construction of precise instructional support system based on multimodal foundation models. Journal of Distance Education., 42: 84-93. https://kns.cnki.net/kcms2/article/abstract.

5. Tan, A.J.Y., Davies, J.L., Nicolson, R.I., Karaminis, T. (2023) Learning critical thinking skills online: can precision teaching help?., Educational technology research and development., 71(3): 21-22. https://doi.org/10.1007/S11423-023-10227-Y.
6. Luca, V., Vanessa, A., Federica, B. (2022) Using Precision Teaching to Train Motor Skills to Improve the Daily Living Skills of Adolescents with Intellectual Disabilities., Journal of Developmental and Physical Disabilities., 35(1): 1-16. https://doi.org/10.1007/S10882-022-09842-Z.
7. Tang, C.Y., Shi, Y.Z. (2023) Research on the dilemma and strategy of classroom precision teaching. Scientific Research Education., 28: 22-24. https://kns.cnki.net/kcms2/article/abstract.
8. Richard, M., Kubina. (2020) Precision Teaching and Behavior Dynamics. Behavior Analysis in Practice., 14(3): 1-5. https://doi.org/10.1007/s40617-020-00482-3.
9. Wang, A. (2023) An empirical study on effect of precision teaching based on massive data mining. Journal of Civil Aviation Flight University of China., 34: 36-40. https://kns-cnki-net-s.libyc.nudt.edu.cn.
10. Cui, Y.L., Zhang, Y.Y., Zhang, H. (2023) Research on the educational data maturity model under the digital transformation. Journal of Modern Educational Technology., 33: 19-28. https://doi.org/10.3969/j.issn.1009-8097.2023.11.002.
11. Wu, X.G., Li, Y.Q., Wang, S.P. (2023) Construction and application of a hybrid precision teaching model based on education big data. Computer Education., 11: 142-150. https://doi.org/ 10.16512/j.cnki.jsjjy.2022.11.003.
12. Liu, C.H., Tang, T.T., Yu, F.Q., Pan, X.L. (2020) Committed to precision teaching in the context of big data to achieve classroom efficiency. The Guide of Science & Education., 35: 39-85. https://doi.org/10.16400/j.cnki.kjdkz.2020.12.019.