Data-Driven Precision Teaching Practice in Blended Learning

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Abstract. The development of new-generation information technology and the gradual promotion of digital education have facilitated the application of precision teaching. Given the widespread promotion of blended learning in institutions of higher learning, this paper explores how professional subject teachers can use information technology teaching platforms to carry out precision teaching practice based on blended learning data. A diagram of the transmission of precision teaching learning data is also provided, which shows a precision teaching process and teaching assessment plan consisting of five stages: pre-course assessment, teaching design, classroom teaching, personalized guidance, and post-course evaluation. Data-driven precision teaching in blended learning can improve learning effectiveness, satisfaction, efficiency, and autonomous learning ability. The conclusion is supported by student survey data and exam results, demonstrating the effectiveness of data-driven precision teaching in blended learning.

Keywords: blended learning · precision teaching · teaching process · teaching practice

1 Introduction

At the beginning of 2022, the Ministry of Education proposed to launch the national education digitalization strategy at the National Education Work Conference. Obviously, the digital transformation of education has become an important strategic theme of China's education reform and development [1]. In recent years, information technology and education have been deeply integrated, and various information-based teaching modes such as experimental classes and micro-courses have become increasingly diverse. In particular, the large-scale online teaching practice since the outbreak of the COVID-19 pandemic has systematically promoted the transformation of teaching modes. The development of new-generation information technology and the gradual implementation of education digitalization have given new vitality to precision teaching and promoted its practical application. However, existing precision teaching educational practices are mainly carried out in some primary and secondary schools [2], and there is little exploration in professional subject teaching. Most of the existing precision teaching research starts from a theoretical perspective to provide support frameworks or teaching modes

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for teachers to carry out precision teaching [3], and there is little research from the perspective of teachers to explore the implementation of data-driven precision teaching. In order to promote the sustained and healthy development of higher education, this paper explores how professional subject teachers in institutions of higher learning can use information-based teaching platforms and blended learning data to implement precision teaching from the perspective of frontline teachers, providing a reference for relevant subject teachers.

Blending teaching combines traditional face-to-face teaching with online teaching and has been widely used in many institutions of higher learning. Compared with traditional face-to-face teaching and pure online teaching, blending teaching can fully utilize the advantages of online learning flexibility and autonomy, and provide more interaction and personalized teaching in face-to-face teaching. Blended learning is the most similar expression to blending teaching, and many researchers directly equate the concepts of blended learning and blending teaching when using the term blended learning. The focus of blended learning is on the subject of learning - students, while blending teaching starts from the teacher's dominant position and focuses on how to help students achieve optimal learning results [4]. Bloom's mastery learning theory believes that almost all students can achieve mastery of nearly all content if given enough time and appropriate teaching. Today, the advantages of information technology for meeting students' learning needs have been demonstrated, and digital teaching enables teachers to further refine the teaching process. The mastery learning theory provides a solid theoretical foundation for blending teaching. Through the assistance and guidance of teachers, blending teaching allows students to participate in practical activities of problem-solving through self-learning and cooperative exploration, and to collaborate with peers to complete the practical activities. In this process, students obtain knowledge and skills through observation and introspection, master the thinking and methods of problem-solving, and continuously enrich and improve their emotions, attitudes, and values, achieving self-transcendence. To address the issue of how to implement blending teaching, Fengqing Li [4] proposed a three-stage implementation process of blending teaching: "pre-class", "in-class", and "post-class", which has been widely applied in blended teaching in institutions of higher learning.

Precision teaching was initiated by Ogden Lindsley in the 1960s, based on Skinner's behavioral learning theory, with the aim of tracking students' learning performance. It later rapidly developed into a framework for evaluating the effectiveness of teaching methods [5]. With the gradual popularity of mobile internet, big data, and cloud computing, precision teaching has provided the possibility for teachers to transform their teaching methods and optimize their teaching strategies. Based on comprehensive, rapid, and accurate recording of learners' learning processes, precision teaching accurately identifies learners' current and potential problems that arise in a split second. By analyzing learning behavior data, it gains insight into students' learning styles and status, generates targeted, personalized learning goals, and applies data decision-making technology to provide precise interventions and optimizations to teaching. The connotation of precision teaching is highlighted in three aspects: precise goals, precise problems, and precise interventions. Literature [6] summarizes precision teaching as follows: measuring to support teaching - precision teaching goals; seeking opportunities to intervene

- precision teaching process; and teaching according to students' abilities - precision teaching interventions.

2 Blended Learning Data-Driven Precision Teaching

Precision teaching adheres to the teaching concept of "student-centered," emphasizing personalized, customized, and refined teaching processes. Personalization is also a prominent feature of blended learning, which is consistent with the concept of precision teaching. Blended learning can collect data on student learning, such as learning progress, doubts, preferences, and grades, during online learning. Precision teaching then uses this data to provide personalized learning support and guidance to each student accurately. In practice, learning data is obtained from the following three sources: MOOC learning platform, information collection form such as Tencent Docs or Kingsoft Docs, and Mu Class or Rain Class. The learning data of each student's from three pathways is aggregated in an Excel sheet to form a student's learning footprint. Figure 1 shows the data transfer diagram of data-driven precision teaching in blended learning adopted by the author. Before class, students study on the MOOC platform. Teachers can view students' account information, video and file numbers, etc. In the meantime, they can collect the information they need to explain their questions and key concepts through distributed editable documents. Then, based on the MOOC platform data and document data, teachers set precision teaching objectives and classroom teaching designs for students at different levels. During class, a pre-test is first conducted, and based on the results of the pre-test, the teacher adjusts the teaching content, team learning content, and teaching methods, conducts a mid-test, and assigns homework to students for the practice of solving complex problems. After class, the teacher uses the homework function of the QQ group to correct the homework and communicate with students one-on-one. Teachers provide answers and guidance to students based on the analysis of pre-test and mid-test data. As shown in the data transfer diagram of precision teaching in Fig. 1, precision teaching focuses on how to use pre-class and in-class data. If the theoretical basis of blended teaching is to master learning theory, then data-driven precision teaching in blended teaching is to use the data advantages of blended teaching to strengthen the teaching role of teachers. Implementing precision teaching based on blended teaching data has practical significance for optimizing teaching models and improving students' learning effectiveness.

The data-driven precision teaching of blended teaching includes five stages: pre-assessment, instructional design, classroom teaching, personalized tutoring, and post-assessment, with specific workflows outlined in Table 1.

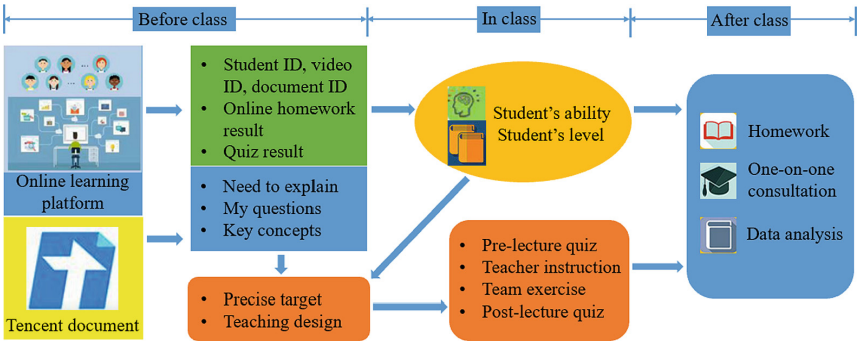

Fig. 1. Information Flowchart of Precision Teaching Data in Blended Teaching

2.1 Pre-assessment

Pre-assessment consists of two levels. The first level is a survey of the overall learning situation at the beginning of the semester. Through Rain Classroom voting, students' previous course grades are obtained to roughly classify students into three levels: good, average, and poor foundation. This classification is dynamic and will be adjusted timely according to learning data during the subsequent teaching process. Students with a good foundation usually have good learning habits and can follow the teaching plan step by step. For students with an average foundation, they need more motivation. Students with poor foundations require special attention and frequent reminders. At the same time, understanding students' acceptance of blended learning methods, the teacher will pay attention to students with low acceptance and gradually improve their adaptability in subsequent classes. The second level is a survey of learning situations before the start of each new class. The teacher first publishes a learning task book on Rain Classroom, collects students' learning needs and doubts through a Tencent document that is editable by multiple people in a QQ group, in order to better design the instruction.

2.2 Instructional Design

Instructional design also consists of two levels. The first level is the instructional design for multiple weeks in the semester. The content of the first class is a survey of the learning situation. Then, according to the relevance of the content of each class, all the content is divided into several large units. After learning each large unit, there is a review. To cultivate students' innovative thinking or critical thinking, and improve their learning ability and language expression ability, learning group activities are arranged for professional knowledge or humanities knowledge, such as writing PPT and speeches, recording videos to share in class. The second level is the instructional design for each class. Based on the pre-class survey, the teacher formulates a precise teaching plan, including teaching content, teaching methods, teaching resources, etc., to meet the learning needs of different students.

Table 1. Phases and Contents of Precision Teaching

Time	Precision Phase	Teaching Process	Specific Contents	Information Channel
Pre-class	Pre-class assessment	Task distribution	Present questions and tasks related to learning content	Rain Class
		Video learning	Study the video with questions according to the learning task book	MOOC
		Collect information	Collect questions and understanding during learning through QQ online multi-person collaborative documents	QQ group
	Teaching design	Setting goals	Semester design and class design: Based on the results of pre-class assessment, set precise teaching goals	Null
		Semester design	Organize the first class well, review the big unit, and organize small group activities	
		Class design	Determine the teaching content, methods, and resources for each class based on pre-class surveys	
In-class	Classroom instruction	Pre-class quiz	Conduct a pre-class quiz in the form of multiple choice and fill-in-the-blank questions for simple problems	Rain Class
		Teacher instruction	Determine the teaching content and methods based on the pre-class assessment and pre-class test data	Physical classroom

(*continued*)

Table 1. (*continued*)

Time	Precision Phase	Teaching Process	Specific Contents	Information Channel
		Teacher-assisted learning	Students engage in small group discussions or complete tasks and communicate with teachers	Physical classroom
		Peer assistance	Peer mutual influence and exchange during small group discussions to improve learning	Physical classroom
		In-class quiz	Students solve simple problems released by the teacher	Rain Class
Post-class	Personalized coaching	Class assignments	Students independently complete the solution to complex problems and submit them via QQ	QQ group
		Offline Q&A	Face-to-face Q&A before and after class	null
		Online Q&A	Provide guidance on students' questions after they complete exercises during and after class	QQ group
	Post-class assessment	Data analysis	Analyze, reflect upon, and summarize the data collected from the Rain Class backend	Rain Class

2.3 Classroom Teaching

Before each class, the teacher announces the teaching objectives for the class to let students compare their pre-class learning status with what they need to learn in class. At the beginning of class, a pre-test consisting of simple questions in the form of multiple-choice or fill-in-the-blank is conducted. Based on the results of the student tests, the teacher dynamically adjusts the explanation content and depth, and decides whether to discuss a specific question or arrange corresponding group activities to improve students' learning outcomes. After the explanation and discussion, a mid-class test on the same

knowledge point is conducted. Homework on solving complex problems is assigned in the form of subjective questions.

2.4 Personalized Tutoring

After class, the teacher provides one-on-one guidance based on student's learning footprint excel sheet, or through online methods such as the MOOC platform and QQ for answering questions, to help students solve learning problems. This process is also an opportunity for comprehensive communication between teachers and students. In addition to solving academic problems, students are guided to reflect on their gains in knowledge and skills, learning processes, attitudes, experiences, and methods, and conduct self-evaluations, constructing self-awareness, thereby improving their learning effectiveness and internal drive.

2.5 Post-assessment

The teacher uses the homework function of the QQ group to grade each student's homework online, provide timely feedback on the results of the revisions, and request corrections for errors. Students with low scores need to supplement their knowledge and skills in a targeted manner. At the end of each semester, a comprehensive assessment is conducted to evaluate students' learning outcomes and the effectiveness of the teaching model.

In summary, precision teaching requires teachers to assess students before class and develop personalized teaching plans based on the assessment results. They also need to use different teaching strategies during class, prepare questions for students, decide on class content based on the accuracy of the questions. Moreover, teachers should provide personalized tutoring after class, analyze learning data, reflect and summarize to improve student learning effectiveness and satisfaction.

3 Process and Assessment Plan for Precision Teaching

The teaching assessment plan involves the vital interests of students, schools, and teachers, and all three parties are concerned. According to relevant documents formulated by the school's academic affairs office and teaching actual situations, and referring to the assessment methods of other universities, the total score is divided into two major parts: regular scores and final scores, but the composition of regular scores has many items [7]. In order to make students pay attention to various aspects of regular learning and fully mobilize their enthusiasm, the whole process of blended learning is integrated into the assessment. Regular scores account for 50% of the total score, and eight aspects are assessed: offline homework recorded in QQ, attendance performance recorded in Rain Classroom, classroom test results, unit quizzes recorded on the Chinese University MOOC platform, online assignments, online final exams, online interactions, and group report scores. Only whether the QQ homework is submitted within the specified time is assessed, and all the scores recorded on the platform can be downloaded with data and have a basis. To reflect the value-added evaluation and increase the coefficient of

in-class test scores, the student equivalent scores of in-class tests are significantly higher than those of pre-class tests. The final exam uses traditional paper tests and accounts for 50% of the total score.

4 Implementation Effect of Precision Teaching

Precision teaching can provide personalized learning support and guidance for each student based on their learning data, helping students better understand and master knowledge and improve learning outcomes. Students can choose learning methods and resources that suit their interests and abilities and can also interact with teachers and other classmates through online discussions and platform communication, which can better meet their learning needs and provide them with better learning experiences and satisfaction. Teachers can collect student learning data through online learning platforms, and precision teaching can adjust course content based on this data, providing personalized learning support and guidance for each student, thereby improving teaching efficiency. By providing personalized learning resources and tasks, encouraging students to actively explore and learn, and providing online assessment and feedback, students can understand their own learning outcomes and progress, and develop their self-directed learning skills and abilities.

In theory, implementing precision teaching in blended learning can have the positive effects described above. In practice, we conducted a QQ survey with 27 students in the precision teaching experimental class and received a 100% response rate. We surveyed the degree to which students agreed with the implementation effect, using a 5-point scale for each item, where 5 indicated "strongly agree" and 1 indicated "strongly disagree." The results are shown in Table 2.

From Table 2, it can be seen that the students have a relatively high overall agreement on the implementation results of precision teaching in terms of learning effectiveness, learning satisfaction, learning efficiency, and self-directed learning ability. Among them, the highest agreement was for the active participation in video learning and providing feedback, indicating that teachers have improved students' self-directed learning ability through reasonable process arrangements. The lowest agreement was for the active use of the learning data on Rain Classroom for self-reflection and summary after class, which suggests that students have relatively little habit of reflection and summary in their usual study, and also because the implementation process and assessment scheme lack measurement in this aspect. Overall, students are satisfied with the precision teaching of the teacher and their own self-directed learning.

During the final exam, the precision teaching class and other classes used the same test paper and were graded through the same method of blind grading. By comparing the final exam scores of different classes, the teaching implementation effects of different teaching methods can be evaluated. Table 3 shows the statistical results of the final exams for two semesters of precision teaching implementation, compared with the classes of the same major.

From Table 3, it can be seen that the experimental class achieved a score more than 10 points higher than the control class. The standard deviation value reflects that the scores of the experimental class are more concentrated than those of the control class,

Table 2. Survey Results of the Implementation Effectiveness of Precision Teaching in Blended Learning

Research Project	Specific Description of the Research Content	Mean
Learning effectiveness	Ability to better grasp the taught knowledge points in teaching	3.74
	Generated a stronger interest in studying this subject	3.53
Learning satisfaction	Experience a sense of achievement during the learning process	3.63
Learning efficiency	Received support and guidance during homework and classroom learning, which improved learning efficiency	3.58
Self-learning ability	Proactively engage in video learning and provide feedback before the start of new classes	4.26
Self-learning ability	Proactively use the learning materials provided by the teacher for review after class	3.58
Self-learning ability	Proactively use Rain Classroom learning data for self-reflection and summary after class	3.26
	Proactively complete exercises and seek help from teachers or classmates when encountering problems	3.63

Table 3. Statistical analysis of final exam scores for experimental and control classes with precision teaching

Round	Class Type	Highest Score	Lowest Score	Average Score	Standard Deviation
1	Experimental class	91	52	68.43	12.05
	Control class	84	4	51.07	24.90
2	Experimental class	100	52	84.21	16.64
	Control class	100	8	71.03	21.13

and the lowest score in the experimental class is much higher than that in the control class. This indicates that through one semester of precision teaching, students in the experimental class have achieved better learning outcomes. The experimental class used Rain Classroom for interactive learning more frequently, and through precision teaching, the teacher was able to grasp the daily learning situation of students and take certain measures, while the interaction in the control class was relatively low, and students mainly relied on self-discipline for learning, so the teacher had limited knowledge of students' learning situation and limited effectiveness, leading to a significant difference in learning outcomes.

5 Conclusion

Blended learning integrates traditional face-to-face and online learning modes, and by pre-learning knowledge, makes in-class learning more targeted. It is a rough form of precise learning, which requires strong self-discipline from students. Precision teaching utilizes the teacher's leading role in teaching activities, evaluates students' learning levels and needs, customizes learning content, and provides targeted learning strategies, thereby comprehensively improving students' learning mastery.

Implementing precision teaching based on blended learning data is a meaningful exploration. Currently, students' learning data comes from individual courses and teachers. Future developments could consider the following aspects: 1. Integration and construction of teaching management platforms: building more intelligent and integrated teaching management platforms to reduce the aggregate workload for teachers, integrating students' personalized information and teaching resources, and achieving more precision teaching. 2. Application of big data: using big data to analyze students' learning behaviors and outcomes, comprehensively and deeply evaluating students, and thus better formulating personalized teaching plans and providing personalized teaching assistance. 3. Application of artificial intelligence technology: using artificial intelligence technology for more precise evaluation and teaching of students, such as analyzing and predicting students' learning behaviors through machine learning algorithms to formulate more personalized teaching plans. In summary, in the future, precision teaching will pay more attention to the intelligence of teaching management and the application of technology to achieve more personalized, efficient, and comprehensive teaching results.

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References

1. Chaozi LEI. Taking advantage of digital transformation affordances to construct the new ecology of smart education[J]. Distance Education in China. 2022(11):1–5.
2. Liming GUO, Xianmin YANG, Yao ZHANG. Research on Design and Practice of A Data-driven Five-dimensional Support Service Framework for Precision Teaching[J]. E-education Research.2021 (4): 85–92.
3. Xuemei BAI, Xiaoqing GU, Huanhuan YIN etc. Data-driven Precision Instruction: Practice Paths, Perceptual Understanding and Realistic Dilemmas [J]. E-education Research. 2022(4): 77–84
4. Fengqing LI. The Theoretical Basis and Instructional Design of Blending Teaching [J]. Modern Educational Technology. 2016,26(09) 18–24
5. Hongchao PENG, Zhiting ZHU, Generative Design of Precision Instruction Activities in Smart Learning Context [J], E-education Research, 2016(8):53–62
6. Xiaocan JI, Jichun CHENG, Yuqiang ZHANG. Research on Precision Instruction in Technology Era [J]. E-education Research.2020(9):102–107
7. Peizhong XIE, Xin WEI, Teaching Reform and Practice of signal and system flipped classroom [J]. Journal of Electrical and Electronic Education.2022(2):78–81