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A Study of Precise Instructional Intervention Strategies Based on Learner Portraits

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Abstract: Personalized education is a key trend in educational innovation, but traditional teaching often fails to meet individual student needs. The development of big data and artificial intelligence has enabled learner profiling, which can support precise teaching. This study explores precise teaching interventions based on learner profiles to improve teaching quality and learning effectiveness. It provides new ideas for personalized teaching and is significant for enhancing educational outcomes.

Keywords: Precision teaching, Instructional interventions, Intervention strategies, Learner profiles

1. Introduction

With the advancement of information technology, education has transformed profoundly, and society's expectations for education have evolved. The information age and national development demand a new talent cultivation model. China's "Core Literacies for Student Development" has outlined six major literacies that students should possess, guiding talent cultivation. The innovative power of digital technology is deeply integrating information technology with learning and teaching, giving rise to a new data- and technology-driven model. In 2023, the U.S. Department of Education's Office of Educational Technology released its policy report, "Artificial Intelligence and the Future of Teaching and Learning" (2023), emphasizing AI's role in education and its potential to address student learning variability. In 2025, the Outline of the Plan for the Construction of a Stronger Education Nation (2024–2035) proposed using AI to drive educational change and establish a big data- and AI-supported evaluation and decision-making system. In the Intelligent Era, education now focuses on personalized learner growth, with data analysis technology becoming crucial for implementing precise teaching. By deeply analyzing group and individual student data to build learner portraits, we can reveal inherent group learning rules and accurately grasp each student's personalized needs.

This study uses intelligent learning technology to create precise teaching interventions based on learner profiles in an English course. By collecting and analyzing student data (basic info, progress, and behavior) in a smart learning environment, we build detailed group and individual learner portraits. These portraits help identify learning issues, support precise teaching strategies, and guide targeted interventions to improve teaching quality and meet individual student needs.

2. Definition of relevant concepts

2. 1 Learner Profile

Portraits were initially used to describe appearance, and later evolved into user portraits in the business field, proposed by Cooper(Cooper A,2004), which analyze user behavior through big data for product positioning and personalized recommendation. With the penetration of information technology in the field of education, learner profiling came into being, which is an expansion of user profiling in the field of education, and analyzes learner characteristics through visualization. In the era of big data, learner profiling technology mines learners' learning needs, motivations and preferences, and shows learning behaviors in a visual way, helping learners master their own learning conditions, providing a basis for personalized learning recommendations, and providing teachers with personalized teaching guidance.

Currently, academia lacks a unified definition of "learner portrait." From a teaching service perspective, some researchers view it as evaluating or characterizing learners. For example, Cui Jiafeng sees it as an intelligent learning evaluation system, Zhao Linglang et al. consider it a method for analyzing learners' big data using machine learning, and Dinh et al. define it as depicting the behavior of virtual learning communities. In essence, a learner portrait describes the learner's current state and summarizes their characteristics. In this study, the learner portrait is based on the learning analytics framework, aiming to provide personalized learning support by collecting, analyzing, and presenting learner behavior patterns through labels.

2.2 Precision teaching

In the 1960s, American education pioneer Ogden Lindsley first introduced "precision teaching," which uses standard variable speed charts to make educational decisions based on observed changes in student behavior frequency (Binder C, 1998). In China, Prof. Zhu Zhiting's team emphasizes combining precision teaching with information technology to enhance efficiency through human-machine collaboration. Others like Hao Jianjiang and Guo Jiong focus on precision teaching supported by intelligent technology, highlighting the importance of precise design and implementation of teaching objectives, evaluation, and activities.

In summary, precision teaching leverages intelligent technology, big data, and information technology to set precise teaching goals, conduct intelligent evaluations, and design personalized activities. Despite different definitions, the common goal is to improve teaching efficiency and quality through technology while emphasizing the role of teachers and teaching innovation. This approach integrates educational concepts and practices, offering a new direction for modern education.

3. Constructing and Analyzing Learner Profiles

Smart classrooms integrate advanced technologies to enhance teaching and learning, enabling instant communication and real-time data storage and retrieval. These classrooms collect data via digital tools like interactive whiteboards, tablets, and learning management systems. The collected data is used to create comprehensive learner portraits, which help diagnose learning issues and design targeted interventions. This supports individual learning needs and promotes a more effective, interactive educational experience.

The learner portrait modeling system proposed in this study is one of the constituent elements in the field of educational data mining. At the practical level, the construction and application of learner portraits need to follow a systematic process framework as support. According to the principles of pedagogy and data science methodology, this study designs a complete set of construction process system, whose technical route contains three core links of feature extraction, model validation and dynamic optimization, and the specific implementation steps are detailed in Figure1.

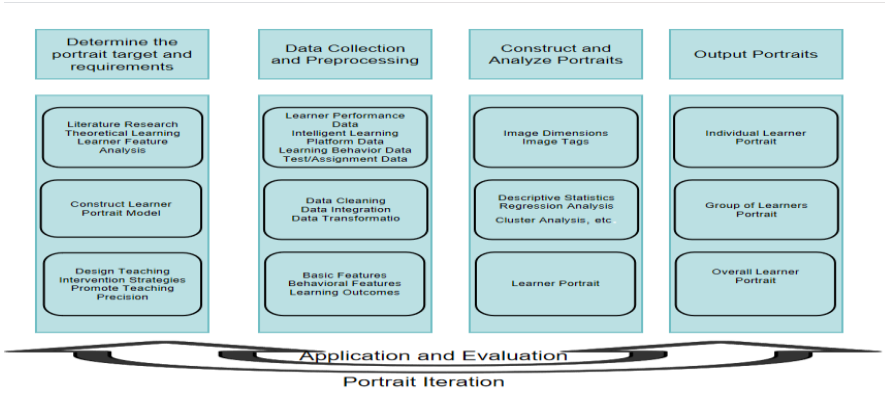

Figure. 1 Learner Profile Construction Process

In this study, we applied K-means clustering to categorize learners across four dimensions: engagement, interaction, learning, and knowledge acquisition. Three distinct learner types emerged:

1.Excellent Learners: These students excel in learning and knowledge acquisition but show limited participation and interaction. To enhance their engagement, strategies should focus on integrating them into classroom interactions and collaborative learning.

2. Diligent Learners: Despite positive behaviors, these students often struggle with competence and participation, leading to lower accuracy in assignments and exercises. Providing them with more challenging tasks and targeted learning strategies can improve their efficiency and quality.

3. Marginal Learners: Low performance and engagement; they need personalized support to boost motivation and improve participation and competence.

These findings are consistent with broader research showing that K-means clustering effectively identifies distinct performance levels and informs targeted interventions.

4.1 Types of interventions

Instructional interventions, categorized by the Response to Intervention (RTI) framework, include three tiers: universal, targeted, and personalized. Universal interventions address common issues for all students through adjusted teaching strategies and optimized resources, focusing on basic knowledge reinforcement and general learning difficulties. Targeted interventions focus on specific groups, addressing common problems through collaborative learning and group discussions to promote communication and problem-solving. Personalized interventions provide tailored support for individual students to meet unique learning needs and solve specific problems. Additionally, interventions can target cognitive skills, enhancing thinking and problem-solving abilities; behavioral habits, improving active learning attitudes; and competencies, boosting overall learning and communication skills.

4.2 Elements of intervention

During the practice of precision teaching, the classroom becomes the center point of attention for both teachers and students, and in doing so, it aims to promote the holistic development of learners. In order to effectively match instructional elements with students' individual characteristics, this study developed appropriate instructional interventions based on the findings. Incorporating elements of instructional design and classroom structure, instruction is designed around student characteristics with precise objectives, tasks and activities to motivate learning. Resources and tools need to accurately match students' needs, and evaluation methods should integrate process and summation, and clarify multiple evaluation subjects. This study clearly defines the core elements of precise instructional interventions, as shown in Table 1.

Table 1. *Elements of Precision Instructional Interventions*

Elements of intervention	concrete content
goal	Identify students' learning goals and assist them in developing individualized independent learning progress plans.
mandates	Based on the results of learner profiling, differentiated learning tasks and requirements are assigned to groups of learners with similarities and groups of learners with differences.
maneuver	Teachers focus on teaching, group cooperative inquiry, individual independent training, individualized tutoring and guidance, learning tips and information, supervision and assessment feedback.
resource (such as manpower or tourism)	Produce resources for students' varied learning preferences and push relevant resources based on learning.
estimation	Students are assessed based on the accuracy of their answers, presentation and communication of their reports, and their behavior and conduct.

In precision teaching, intervention elements are interrelated and mutually reinforcing. Learning objectives must be personalized, considering individual learner characteristics, serving as both the starting and end point of learning. These objectives significantly influence task difficulty and guide resource and evaluation system construction. Learning tasks should closely align with activities to promote learner participation and ability enhancement. Precise matching of resources and tools is crucial. Each intervention element requires tailored strategies to ensure learning continuity and integrity, optimizing teaching and learning outcomes.

4.3 Framework for intervention

Accurate teaching is based on in-depth analysis of learner characteristics, and learner profile is the key element, the construction of which covers the collection and analysis of multi-dimensional data, including basic information, behavior, knowledge mastery and ability level. These data are presented through the visualization technology to visualize the learning situation, identify problems, and provide a basis for teaching. This data-driven accurate teaching strategy can effectively improve teaching effectiveness and learner development.

Zhu Zhiting and Peng Hongchao constructed an information technology-enabled precision teaching model in a smart classroom environment, centered on the RTI instructional intervention model and implementing interventions in three progressive levels. The model screens and imposes interventions step by step in the teaching process to ensure accurate teaching (as shown in Figure 2.).

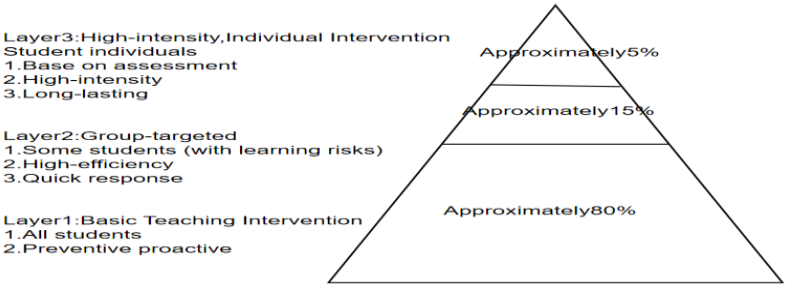

Figure 2. Intervention-Response Model

The ADDIE model is a classic instructional design model widely used in the field of teaching and learning, which, as a systematic instructional design framework, comprehensively integrates the major elements of instructional design, covering both the learning subject (teachers and students) and the learning object (instructional content, instructional methodology, instructional resources, and assessment of learning, etc.)(Liu Caiyan,2008). The ADDIE model is a student-centered holistic instructional design, which is in line with many theories of teaching and learning and achieves good The ADDIE model is a student-centered holistic instructional design that is compatible with many instructional theories and achieves good teaching results(Qi Huixuan,2016).

5. Basic Strategies for Precision Instructional Interventions

The Precision Teaching Model deeply integrates information technology with teaching practices. Initially, it constructs learner profiles to precisely grasp each student's learning situation. Subsequently, based on in-depth analysis of these profiles and precise problem diagnosis, cohort intervention strategies are designed and implemented. These strategies leverage artificial intelligence and technology to meet students' differentiated learning needs, reducing teachers' workload in large-scale classrooms. Precision teaching not only promotes students' overall development but also enhances teaching and learning efficiency and quality, advancing the modernization and innovation of education

5. 1 Cohort Intervention Strategies

5. 1. 1 Intervention strategies for exceptional learners

Based on the diagnostic analysis, outstanding learners tend to focus on results rather than the learning process, have limited self-concept, and lack self-awareness for in-depth and self-directed learning. To address these characteristics, we need to start with goal setting and carefully plan task and activity strategies to enhance commitment to learning behaviors. We also need to develop appropriate resource strategies based on learners' personality styles and cognitive development levels to stimulate their motivation and create an atmosphere of self-directed inquiry and collaborative learning. Ultimately, the learning process and outcomes are evaluated based on "excellence"

5. 1.2 Intervention Strategies for Diligent Learners

Diligent learners tend to exhibit a tendency to emphasize quantity over quality; they focus on the quantity of tasks accomplished during the learning process but may neglect the quality of their learning, and as a result, learning outcomes tend to remain at the level of literacy, and lack in-depth independent thinking, effective teaching and leadership. With this in mind, it is important that we focus on diligent learners and improve the quality of their behaviors.

5. 1.3 Intervention strategies for marginalized learners

As a result of the problem diagnosis, marginal learners were found to suffer from a lack of self-management, as evidenced by a lack of behavioral engagement, frequency of interaction and concentration, as well as a lack of solid mastery of basic knowledge. Given this situation, these students need to rely on teacher support and individual attention. The main thing they need to do is to complete learning tasks, submit assignments and tests in a timely manner in order to gradually improve their learning outcomes.

In this study, learning strategies were developed for different types of learners in terms of five dimensions: objectives, tasks, activities, resources, and evaluation (as shown in Table 2.).

Table 2. *Cohort intervention strategies*

Type of learner	Excellence in Learning	Diligent learner	Marginal learners
Target strategy	Enhance engagement and self-directed learning; develop self-motivation.	Improve behavior quality; increase interactions and task quality.	Boost engagement and competencies through personalized strategies.
Mission strategy	Progressive tasks; Deepen cognitive level.	Moderate difficulty tasks; teacher-monitored practice.	Basic learning activities; personalized instruction.
Campaign Strategy	Independent exploration; challenging tasks; peer feedback.	Collaborative learning; reinforce basic knowledge.	Scaffolded activities; effective questioning; group collaboration.
Resource strategy	Advanced exercises and resources; challenging test questions.	Video materials; practice exercises; supplementary guides.	Microteaching; easier test questions.
Evaluation strategy	Reflective and performance assessments based on "excellence".	Reflective assessment; focus on quality of outcomes.	Reflective assessment; targeted strategy guidance.

6. Conclusions of the study

From the systematic documentation, it is obtained that student data, as a direct source of information for teaching and instruction, is crucial for the implementation of precision learning. Precision teaching interventions based on learner profiles can rely on technology to gain insight into the characteristics and learning needs of each student and implement highly targeted personalized learning strategies. In view of this, this study reviewed relevant literature and combined with fieldwork data to scientifically categorize student profile parameters and propose a learner profile and its construction process. Based on the results of the profiling, an accurate teaching intervention framework was constructed and a multidimensional intervention strategy was formulated, which provides a practical solution for the current implementation of personalized learning.

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