Research on the Construction of Mathematical Precision Teaching Model Based on Knowledge Graph

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Abstract. The development of information technology has injected vitality into precision teaching, and mathematics, as an important subject in the basic education stage, has strong logic and abstraction. The knowledge graph integrates the mathematical subject knowledge graph, corresponding question banks and resources based on the knowledge points in the knowledge graph, learner analysis models, etc., which can provide strong support for the entire precision teaching process. Therefore, how to construct a precise teaching model based on knowledge graph and verify its effectiveness in junior high school mathematics teaching is an important research content of this study.

Keywords: Knowledge graph; Accurate teaching; Junior high school mathematics; Analysis of academic situation

1 Introduction

The development of intelligent technology has injected vitality into classroom teaching and achieved personalized growth of students, becoming the focus of educational researchers. The precise teaching centered on "test assisted learning" is the key to personalized talent cultivation[1]. Linsley believes that precision teaching is based on the continuous frequency changes of students' performance on a standard speedometer, and educational decisions are made based on students' changes[2].Lee&Fink believes that the core function of knowledge graphs is to discover knowledge, track its source through the relationships between knowledge, map the existence and changes of knowledge, and help people identify the most needed areas[3].Balaid et al. also pointed out that knowledge graphs can facilitate prediction and correction, as knowledge graphs can provide detailed interpretation of fragmented knowledge in subject knowledge[4].Precision teaching to promote personalized growth of students is an ideal demand of education and also a practical requirement of national education[5]. Knowledge graph is a representative technology of knowledge engineering in the era of big data, and is currently the fastest developing and most widely used tool for knowledge expression and processing[6]. Liang Meifeng[7]and Wang Yong gu[8]respectively defined precision teaching as a teaching mode in their research and

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believed that information technology can play a role in every aspect of precision teaching. Therefore, the research questions of this study are as follows:

(1) What support can knowledge graphs provide for precise teaching of mathematics?

(2) How to construct a precise teaching model based on knowledge graph?

(3) Verify whether the precise teaching model based on knowledge graph is effective?

2 Construction of Accurate Teaching Mode Based on Knowledge Graph

2.1 Analysis of the Advantages of Knowledge Graph in Accurate Teaching of Mathematics

A mathematical subject knowledge graph has been established, The mathematical knowledge graph refines and divides the knowledge points in mathematics according to the curriculum standards and textbooks, and then correlates them. At the same time, a question bank and resources based on a knowledge graph have been established. **The goal of supporting precise teaching is precise,** providing appropriate analytical models for various application scenarios of students. Based on students' learning data and paths, accurate diagnosis of students' learning level is achieved, tracing back to the source, and clarifying students' fundamental problems, as shown in Figure 1. **Supporting precise teaching with precise problems,** through knowledge graphs and learner analysis models, efficiently and accurately diagnose students' knowledge loopholes, trace the root cause, identify the root causes of students' problems, provide comprehensive learning situation diagnosis reports, and clarify the mastery of specific knowledge points by class students, as shown in Figure 2. **Interventions that support precision teaching are precise.** Through visual graphs, teachers can obtain the mastery of students' personal and class dimensions related knowledge points, as well as diagnose students' problems. Based on the presentation of student diagnostic reports and visual knowledge graphs, teachers develop teaching intervention strategies based on the proportion of class students' scores on knowledge point attributes, and carry out teaching interventions to achieve precise teaching.

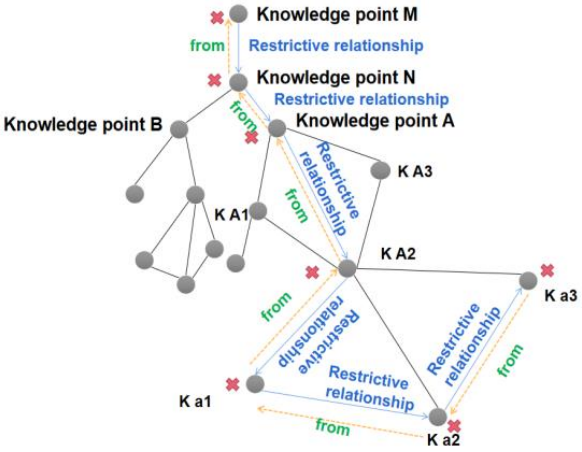

Fig. 1. Accurate Diagnosis of Knowledge Points

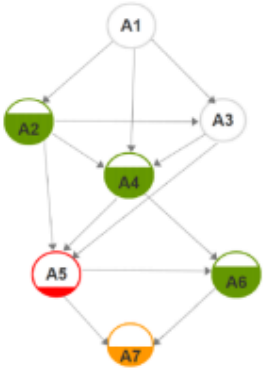

Fig. 2. Visualization Knowledge Graph Supported by Knowledge Graph

2.2 Construction of Accurate Teaching Mode Based on Knowledge Graph

This study is based on the core of precision teaching, achieving precise goals, problems, and interventions. As shown in Figure 3, the precise teaching model based on knowledge graph is divided into three stages: the stage of precise determination of teaching objectives, the stage of precise implementation of teaching processes, and the stage of summary and reflection.

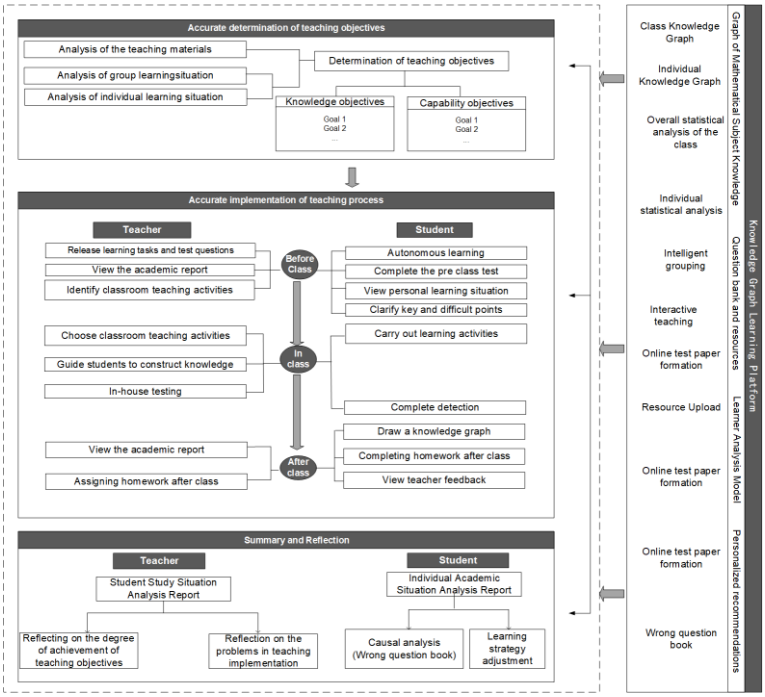

Fig. 3. Precision teaching mode diagram based on knowledge graph

2.2.1 Accurate determination of teaching objectives

The determination of teaching objectives is the first stage of precise teaching based on the knowledge graph. Based on the analysis of students' group learning situation and individual learning situation, the learning level of students is determined, the nearest development area of students is accurately positioned, and the knowledge and ability goals that students will achieve are accurately determined.

2.2.2 Accurate implementation of teaching process

The precise implementation of the teaching process is the second stage of knowledge graph based precise teaching, and it is also the core of the knowledge graph based precise teaching model. Teaching implementation is divided into three stages according to the teaching process: pre-class, during class, and after class, with corresponding teacher activities and student activities. Determine teaching activities based on the scoring rate of students' knowledge points.

2.2.3 Summary and Reflection

Summary and reflection are the final stage, divided into teacher reflection and student reflection. Teachers reflect on the entire teaching process based on students' class and individual learning situation analysis reports, Students analyze the causes of their

own problems based on individual academic reports and feedback from teachers, trace the root cause, and establish their own problem book.

3 The Application of Accurate Teaching Mode Based on Knowledge Graph

3.1 Experimental tools

This experiment has developed two test papers, one for the pre test and the other for the post test to assess students' mastery of the teaching content during the experiment. The difficulty level of the two test papers is consistent.

3.2 Experimental design

This experiment was conducted in a middle school in G city, S province. The selected subjects were students from two classes in eighth grade, and the grades of the two classes were not significantly different in eighth grade. The original teaching mode was also basically the same. On this basis, one of the classes was established as an experimental class with a population of 48, while the other class was a control class with a population of 52. The experimental class implemented a precise teaching model based on knowledge graph support, while the control class taught according to the original teaching model. The two classes of students had similar levels of mathematical learning before the experiment.

3.3 Experimental result

3.3.1 Analysis of pre-test and post test scores in the experimental class

3.3.1.1 Significant difference analysis

Table 1. Analysis of pre and post test scores in experimental classes

	Average value	Paired sample correlation		Paired Sample T test		
		Correlation	significance	t	Freedom	Sig.(two-tailed)
Pre-test results	101.58	.905	.000	-8.201	47	.000
Post-test results	110.88					

As shown in Table 1. This study tests the mathematical scores of the experimental class students in the pre and post tests. The average score of the post test in the experimental class is higher than the average score of the pre test. At the same time,

P=0.000<0.05, there is a significant difference between the pre test and post test scores of the experimental class students, indicating that the precise teaching model based on knowledge graph has a significant impact on students' mathematical performance.

3.3.1.2 Statistical analysis of data for each score segment in pre and post tests

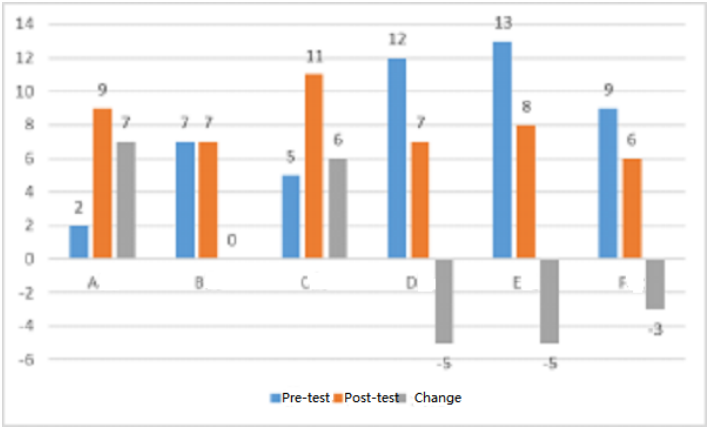

Fig. 4. Distribution of Test Results before and after the Experimental Class

In Figure 4, it can be seen that the pre-test scores of the experimental class students are more distributed in the D, E, and F segments. After the implementation of the knowledge graph based precise teaching model, the post test scores are more distributed in the A, B, and C segments. After comparing the results of the pre-test and post-test, it was found that the number of people in the D, E, and F segments was decreasing, while the number of people in the A and C segments was increasing, especially with an increase of 7 people in the A segment, the most significant change. This indicates that after the implementation of the precise teaching model based on knowledge graph, the number of students with learning difficulties is decreasing, while the number of students with learning disabilities is increasing.

3.3.2 Analysis of Post-test Scores in Experimental and Control Classes

Table 2. Post-test scores of students in the experimental and control classes

Independent-sample T test						
		Levin's variance equivalence test		Mean equivalence t-test		
		F	Significance	t	Freedom	Sig.(two-tailed)
Post-test results	Assuming equal variance	1.728	.192	2.576	98	.011
	Not assuming equal variance			2.559	92.385	.012

As shown in Table 2. F=1.728, P=0.192>0.05, the difference is not significant, indicating that the variance of post test scores between the experimental class and the control class is equal. Therefore, t-test P=0.011<0.05, indicating a significant difference in post test scores between the experimental class and the control class. In these two months of teaching experiments, there was a significant difference in math scores between the experimental class and the control class. This indicates that the implementation of precise teaching mode based on knowledge graph has a positive and significant impact on mathematics learning performance, which can significantly improve students' mathematics learning performance.

4 Conclusions

This study is based on the core and key links of precision teaching, transferring the functional role of knowledge graph appropriately, and constructing a precision teaching model based on knowledge graph. The effectiveness of the precise teaching model based on knowledge graph has been verified through conducting quasi experimental research in experimental schools. The math scores of the experimental class students have significantly improved and are higher than those of the control class students, and the progress in academic performance of the experimental class students is higher than that of the control class students. The precise teaching model based on knowledge graph has a higher impact on students' academic performance than the original teaching model. At the same time, the implementation of precise teaching mode based on knowledge graph has increased the number of students with excellent academic performance and decreased the number of students with learning difficulties, which has strong pertinence and achieved precise teaching.

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