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From data to insights: the role of learning analytics in enhancing the teaching skills of teacher educators

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Abstract: In the process of professional development of teacher trainees, the cultivation of teaching skills is particularly important, which is not only related to the future improvement of teacher trainees' personal professionalism, but also directly affects the quality of education and the development of students. The article will explore the development path of the combination of learning analytics and data visualization by analyzing the possibilities of learning analytics and data visualization in the evaluation of teaching skills of pre-service teacher trainees.

1. Introduction

In the field of education, teachers' professional development and teaching skills are crucial for improving the quality of teaching and student learning outcomes. With the development of educational technology, learning analytics and data visualization, as two important technological tools, provide new perspectives and tools for evaluating and enhancing the teaching skills of teacher educators. Learning analytics reveals the association between teaching behaviors and learning outcomes by collecting and analyzing data from the teaching process; while data visualization presents these complex data in an intuitive and easy-to-understand way, helping educators identify problems and discover patterns more quickly. However, how to effectively integrate and apply these two techniques to the evaluation of teacher trainees' teaching skills is still a topic worthy of in-depth exploration.

2. The Possibility of Learning Analytics to Catalyze Professional Development for Teacher Educators

2.1. Teaching skills as core skills for professional development of teacher educators

In the process of teacher trainees' professional development, the cultivation of teaching skills is particularly important, which is not only related to the improvement of teacher trainees' future personal professionalism, but also directly affects the quality of education and the development of students. With the gradual reform and deepening of the basic education curriculum, the training and

cultivation of teaching skills of teacher trainees oriented to the new curriculum reform has become an important guarantee for the quality education and the high-quality development of basic education in China.

Schools at all levels have increasingly high requirements for the basic quality of teachers, especially many new requirements for teachers' teaching skills. For teacher trainees, teaching skills are the core professional skills and professional qualities necessary to become excellent teachers, and the cultivation of teaching skills is also directly related to the quality of teaching in schools.On October 26, 2017, the Ministry of Education issued the Implementation Measures for the Certification of Teacher Training Programs in Ordinary Institutions of Higher Learning (Provisional), which points out that in order to comprehensively safeguard and enhance the quality of personnel training for teacher training, teacher trainees, in addition to mastering relevant professional knowledge, they must also have the ability to practice in society and continuously improve their teaching skills [1].In January 2018, the CPC Central Committee and State Council issued the document "Opinions on Comprehensively Deepening the Reform of Teacher Team Construction in the New Era", which clearly states that it is necessary to optimize the curriculum system of teacher education according to the needs of the reform and development of basic education and optimize the curriculum system of teacher education with a practice orientation, and to strengthen the teachers' basic teaching skills and Teaching skills training [2].

As future prospective teachers, whether teacher trainees have the appropriate teaching skills to implement the concepts of curriculum reform is also one of the important factors for the success or failure of the reform. The development and utilization of these skills will help teacher trainees to better adapt to the educational environment in their future teaching practice, improve the effectiveness of teaching, and promote the overall development of students. Therefore, the development of teaching skills of teacher trainees has always been a hotspot of concern in teacher education research, and the enhancement of teacher trainees' teaching skills is very important for their professional development as well as for the development of the country's educational endeavors.

2.2. The digital transformation of education has given rise to digital evaluation

Entering the new era, high-quality development has become the theme of the times, the rapid development of information technology, and the field of education has ushered in a wave of digital transformation [3]. Zhang Qiuzi mentioned that colleges and universities should break through the traditional teaching mindset, jump out of the comfort zone, recognize that technological development is the general trend of future educational development, and grasp the opportunity of digital transformation to increase the training of teachers' (teacher trainees') informatization literacy [4]. The application of digital technology can continuously improve the skills assessment and evaluation system [5]. In the context of the digital transformation of education, digital evaluation is gaining great opportunities for development.

The digital transformation of education promotes the application of digital devices and digital resources, and new background data are constantly generated in the process. Integrating data resources and promoting data sharing and application can provide teachers and students with new pathways to improve education [6]. According to the EU, there are more complex issues involved, including how the data of various groups are managed, how the data can serve institutions, digital teaching and learning of teachers and students, and how data privacy and security can be safeguarded [7]. Thinking about how to better utilize these data and serve them in the teaching and training of teacher trainees can not only reflect the teaching effect of teacher trainees more comprehensively and objectively, but also provide data support for their professional development and promote the continuous improvement of education quality.

2.3. Learning analytics has advantages in data processing

Learning analytics and data visualization have significant advantages in data processing in education, and they play a crucial role in improving the efficiency and quality of data processing.

Learning analytics allows for rapid processing and analysis of large amounts of educational data through automated tools and algorithms [8]. This approach not only saves labor, but also increases the speed of data processing, enabling teachers and teacher trainees to get timely feedback and make adjustments accordingly during the training process. Data visualization techniques transform complex data sets into graphs and charts, making the data more intuitive and understandable. This visual representation helps teacher trainees identify their behavioral patterns, teaching efficiency, or teaching anomalies more quickly, which improves the readability and comprehension of the data and facilitates the improvement of teacher trainees' teaching skills.

In summary, being evaluated is the best way for individual progress. Through evaluation, teachers or classmates are able to point out the gap between the evaluated subject and the target, make it clear the direction and way of improvement in the next step, and urge the evaluated subject to move forward towards the corresponding evaluation target [9]. Therefore, under the premise that the teaching skills of teacher trainees are the core skills for their professional development as teachers, and under the background of the digital transformation of education that promotes digital evaluation, we should make good use of the convenience brought about by learning analytics and data visualization technology to update the evaluation of teacher trainees' teaching change skills, and make full use of the advantages of technology to evaluate the teaching skills of teacher trainees, so as to improve the level of teacher trainees' teaching skills.

3. Ways of applying learning analytics in teaching skills training for teacher trainees

3.1. Advantages of learning analytics

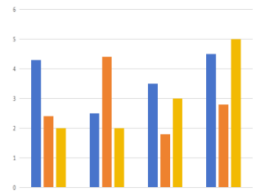
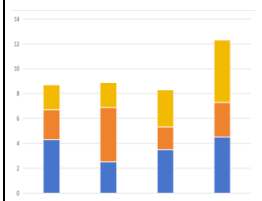
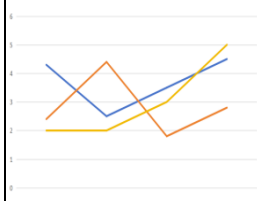
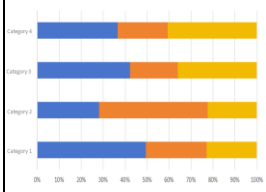
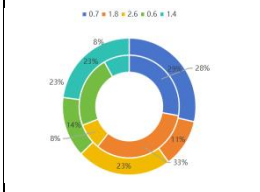
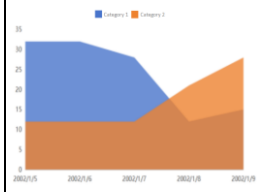
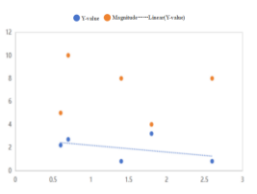
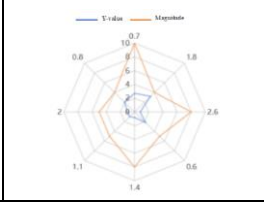
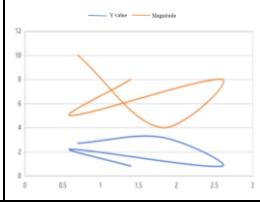
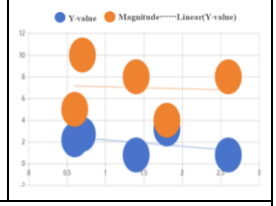
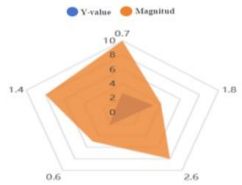
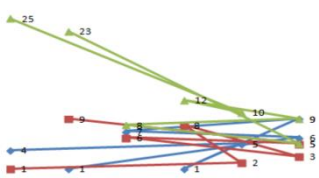
Learning analysis is in the study of the learning situation of the learner, the learner in the process of carrying out learning, will produce a variety of behavioral activities, these external behavioral activities often reflect the learner's will to learn, enthusiasm for learning, learning attitudes, and other internal psychology, the study of the learner's learning behavior can help to better grasp the general characteristics of the student's learning, according to these educational characteristics can be targeted to guide the learner's learning, can help to effectively improve the quality of learning. Learning analytics can provide a guarantee for learners to learn efficiently and to a high standard [10].

Learning analytics can process large amounts of data on teaching interactions to reveal patterns and effects of teacher educators' instructional behaviors, providing a deeper understanding of teacher educators' teaching behaviors and learners' responses. Based on the results of learning analytics, customized recommendations for instructional improvement can be provided to each teacher educator, which can help predict the development of teaching skills and potential teaching problems, leading to early intervention.

3.2. Application of data visualization

Generally speaking, data visualization is divided into two forms: one is exploratory visualization and the other is comprehension visualization. Hai Yujiao [10]summarizes the data visualization as follows based on the different forms of output and different ways of processing data, as shown in Table 1:

Table 1: Data analysis types and their corresponding visualization output types [10-11]

Types of Data Analysis		Types of Visual Output			
Trend Analysis		Bar Chart 	Stacked Bar Chart 	Dot Plot 	Line Graph 
Proportional Analysis		Proportional Chart 	Pie Chart 	Doughnut Chart 	Stacked Area Chart 
elational Analysis	Logical Relationships	Scatter Plot 	Spider Chart 	Curve Graph 	Bubble Chart 
	Spatial Relationships	Radar Chart 		3D Animation 	

In teacher education research on teaching skills of teacher educators, a lot of complex data is generated(As shown in Table 2), and data visualization is a powerful tool to help researchers and educators understand complex data in a more intuitive way.

Table 2: Visualization data generated during teacher trainees' training in teaching skills

Type of content	data type	Route of use
Teaching performance data	Text, audio data	Demonstrate the performance of teacher trainees in different teaching sessions (e.g., introduction, explanation, interaction, summarization)
Frequency of use of teaching methods	text data	Demonstrate the frequency and effectiveness of different teaching methods (e.g., lecture, discussion, group work, experimentation)
Analysis of classroom interactions	Video data	Demonstrate the frequency, type and quality of interaction between teacher educators and students
Allocation of teaching time	Time series data	Demonstrate the allocation of time by teacher trainees on different teaching activities such as lectures, exercises, discussions

Sentiment analysis results	Video, audio data	Demonstrate changes in teacher educators' emotions during the teaching process, such as the distribution of positive and negative emotions
Instructional Improvement Process	text data	Demonstrate the process and effects of teacher educators' improvements in teaching practice, such as instructional design, implementation, and reflection on teaching
Multimodal data integration	multimodal	Integrate multimodal data such as video, audio, and text to show the full picture of teacher educators' teaching
Factors in the teaching environment	spatial data	Demonstrate the impact of teaching and learning environmental factors (e.g., classroom layout, instructional equipment) on teaching and learning effectiveness
Teaching evaluation indicators	text data	Demonstrate various indicators of teaching evaluation, such as achievement of teaching objectives, content coverage, student engagement
Teaching skills development trajectory	Text, video, audio, space, etc.	Demonstrate the growth trajectory of teacher educators in teaching skills, such as the transition from practicum to formal teaching

Through the visualization of these data, teachers can have a more intuitive understanding of the teaching skills and teaching effectiveness of their teacher trainees, thus providing strong support for teaching improvement. Choosing appropriate visualization tools and chart types (e.g., bar charts, line charts, scatter plots, heat maps, pie charts, etc. [12]) can further enhance the presentation and interpretation of the data.

3.3. Integration of the two in educational evaluation

Learning analytics provides in-depth analysis of data, while data visualization provides an intuitive presentation, and the combination of the two can understand and convey information more comprehensively. And the intuitive nature of data visualization can stimulate teacher trainees' interest and engagement, making them more actively involved in the teaching skills training and evaluation process [13]. Combining the insights of learning analytics and the intuitive presentation of data visualization in the evaluation process can provide more comprehensive support for teaching skills evaluation and improvement.

Therefore, when designing a model for evaluating the teaching skills of teacher trainees, consideration should be given to using a combination of learning analytics and data visualization to leverage the strengths of each to provide more comprehensive, in-depth, and intuitive evaluation and feedback. This integrated approach can help teacher trainees better understand their teaching practices and guide them to make effective teaching improvements.

4. Implications of the value of learning analytics in the evaluation of teaching skills of teacher trainees

4.1. Improvement of classroom teaching skills of teacher trainees and enhancement of teaching effectiveness

Teaching skills are manifested in many ways in the teaching process. For example, classroom teaching cannot run smoothly without teacher-student interaction. Whether verbal or nonverbal, there

are significant differences in the time and content occupied by students and teachers in this process. Teachers tend to dominate the classroom, which makes it important to study and evaluate teacher educators' skills in changing teaching styles. It is important to train and polish the teaching skills of teacher trainees as much as possible before they enter the real teaching environment. The process of polishing requires careful evaluation, and the in-depth understanding of learning analytics as well as the intuitive convenience of data visualization can be effective in improving teacher trainees' teaching posture change skills.

4.2. Beneficial to the standardization of teacher trainees' pedagogical skills training

Accurate data are beneficial for establishing meticulous evaluation standards. By exploring the application of learning analytics and data visualization in the evaluation of teaching skills of teacher trainees, a more scientific and systematic evaluation method can be provided for teacher education and professional development. This not only helps to improve the teaching skills of teacher trainees and promote their professional growth, but also has an important guiding value for optimizing teaching strategies and improving teaching quality.

5. Practical Implications of Learning Analytics-Based Assessment of Teaching Posture Change Skills for Teacher Trainees

5.1. Visualization of the teaching process and more convincing evaluation

According to pedagogical research, the ten teaching skills that teacher trainees should master include: teaching language skills, teaching presentation skills. Questioning Skills, Explanation Skills, Board Writing Skills, Teaching Posture Change Skills, Introductory Skills, Feedback Reinforcement Skills, Organizational Teaching Skills, and Closing Skills [14]. As shown in Table 1, if the data generated in the teaching process of teacher education students are visualized and analyzed in depth, the evaluation process will be clear and more convincing, and students will be able to intuitively feel their own problems in the teaching process, which will make it easier for them to find ways to improve and enhance their teaching skills. Therefore, the combined use of learning analytics can provide more convincing evidence to help educators and policy makers understand the current status of teacher training students' teaching skills and the direction of improvement.

5.2. Emphasis on individualized needs and provision of exclusive assistants for teacher trainees

Learning analytics identifies the needs and preferences of different learners, and data visualization presents this information in a personalized way. Where available, teachers can provide teacher trainees with personalized lesson plans based on relevant data to meet the specific needs of each teacher trainee.

5.3. Pattern cycling to enhance the effectiveness of training

In the training of teaching skills for teacher trainees, in-depth analysis of teaching behaviors and learning outcomes can be carried out through learning analytics methods, and then the results of the analysis can be presented in an intuitive way using data visualization techniques, enabling teacher trainees to clearly see the strengths of their own teaching skills and the areas that need to be improved.

The combined use of learning analytics and data visualization can create an ongoing feedback loop, where teacher educators can continually adjust and optimize their teaching methods based on

feedback from visualizations, and learning analytics can continually track the effectiveness of those adjustments.

6. Concluding

In the combined use of learning analytics and data visualization, it is important to maximize the advantages of both. This integration not only enhances the accuracy and efficiency of teaching skills evaluation, but also strengthens the teacher trainees' ability for self-reflection and continuous improvement. By building a comprehensive and dynamic feedback system, teacher trainees are able to continuously optimize their practice methods and improve their teaching skills in teaching practice.

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