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Chinese Teachers' Perceptions on the Use of AI-based Education Platform

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ABSTRACT

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In recent years, the introduction of artificial intelligence (AI) in education has attracted widespread attention. In particular, the AI-based education platform based on the combination of AI technology and learning analysis brings new light to the long-standing difficulties in personalized learning and adaptive learning. The AI-based education platform analyzes learners' characteristics by collecting their data and tracking their learning behavior. It then generates cognitive diagnosis for learners and provides them with personalized learning resources and adaptive feedback that match their cognitive level based on systematic analysis. With the help of the AI-based education platform, teachers and students can get real-time educational data and analysis result, as well as the feedback and treatment corresponding to the results. Previous studies have already demonstrated and proved its positive significance to personalized learning. However, these studies mostly start from a model development perspective or in a rigorous laboratory environment. There has been little research on teachers' perceptions of AI-based education platform. As a direct user of AI educational technologies, teachers' perceptions and suggestions are vital for introducing AIEd in education.

In this study, the researcher explored teachers' perceptions of using AI-based education platform in teaching.

The study conducted qualitative research to address the following research questions: 1) How do Chinese teachers perceive the advantages of AI-based education platforms for teaching and learning in secondary school? 2) How do Chinese teachers perceive the contradictions between AI-based education platforms and the secondary school system? 3) How do Chinese teachers suggest applying AI-based education platforms in secondary school? And it referred to the in-depth online interview with Chinese teachers who had experience with AI-based education platform.

Interview questions were constructed through literature review, and 14 secondary school teachers were selected by the snowball sampling method. The interviews lasted for an average of one hour per teacher and were transcribed from the audio recordings to text documents when finished. Afterward, the data were analyzed using thematic analysis, including generating initial codes, searching and reviewing the categories, and deriving the themes finally. Notably, for research question two, the researcher used the activity theory framework to analyze the contradictions among the use of the AI-based education platform and the various elements of the teaching and learning activities. Finally, four themes for research question 1, six themes for research question 2, and four themes for research question 3 were derived.

As for the advantages, teachers believe that AI-based education platforms can provide instant feedback, targeted and systematic teaching support, and reduce teachers' workload. At the same time, AI-based education platforms can also integrate teaching resources in different areas. Teachers also recognized that AI-based education platform might trigger contradictions in existing teaching activities. They are aware of the situation that the recommended model of the AI-based education platform is not suitable for all levels of students; that a large number of learning resources are not classified properly enough to meet the needs of teachers, and that there lack clear rules and regulations to protect teachers' intellectual property rights when using the platform. Besides, parents are also concerned about the potential risk of internet addiction and vision problems using AI-based

education platforms. Moreover, the use of the AI-based education platform may also affect students' ability to write Chinese characters due to the socio-historical background and educational characteristics in China. Furthermore, the restricted use of electronic devices on campus may also impact the consistent and effective education data collection. Teachers believe that these problems can be solved by improving rules and AI technology. Moreover, to make the platform more in line with the actual teaching requirements, teachers and education experts can also be involved in the development process of AI-based education platform.

This study explored how Chinese teachers perceive the AI-based education platform and found that the AI-based education platform was conducive to personalized teaching and learning. At the same time, this study put forward some suggestions from the perspective of rules, AI technology, and educational technology, hoping to provide a good value for the future large-scale introduction of AI-based education platform in education.

Keywords: AI-based education platform, activity theory, AIEd, teachers' perceptions

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Chapter 1. Introduction

1.1. Problem Statement

Widespread interest in Artificial Intelligent in Education (AIEd) has increased astonishingly as the fourth industrial revolution (Annoni et al., 2018). The field of AIEd brings together interdisciplinary Artificial Intelligent (AI) and the learning sciences to promote the development of adaptive learning environments and other AI Educational Technology (EdTech) (Luckin & Cukurova, 2019). It can also help supporting formal learning wherever it occurs in the traditional classroom or the workplace (Luckin & Holmes, 2016).

Many countries have accelerated the application and research of AIEd from the perspectives of educational policy and technology. The United States has emphasized AI's critical role in advancing personalized learning and lifelong learning because AI can customize learning plans or material based on learners' interests, abilities, and educational needs (National Science and Technology Council, 2016). Korea announced that it would accelerate the transition from software education to AI education, devoting to driving all learners to access the primary AI content in stages and developing competence about applying it (Korean Ministry of Education, 2020). In China, AI education has been gradually introduced in the formal curriculum and vigorously promoted AI EdTech in teaching and affairs management (China Ministry of Education, 2018). Thus, it can be predicted that the application and research of AIEd are significantly growing in the future (Alexander et al., 2019).

In China, some schools are using Automated Writing Evaluation (AWE) system to improve English as a foreign language (ELF) learners' grammatical performance (Liao, 2016; Chen & Cheng, 2008). Combining the corpus library and Natural Language Processing (NLP), such a writing evaluation system can generate scores for essays and generally provides writing feedback to learners (Warschauer & Grimes, 2008). Raczynski and Cohen (2018) also showed that active use of the

Automated Essay Scoring (AES) in teaching helps cultivate students' interest and enthusiasm for writing. Also, by increasing the frequency of essay revision, students' writing achievements can be improved (Wu & Wang, 2018). Deep learning and domain-specific knowledge graph can also use to promote personalized learning and precision teaching. Chen et al. (2018) developed the KnowEdu system, which can construct a mathematic knowledge graph to derive instructional concepts from curriculum standards. A study of the effectiveness of using AI in mathematics curriculum education also found that AI positively impacts increasing learners' motivation and attitudes towards mathematics (Pai, Kuo, Liao, & Liu., 2020). AI Educator, an Intelligent Tutoring System (ITS), can recommend supplementary learning material like micro lessons or exercises for learners based on their learning behavior. Teachers can also teach or arrange targeted learning tasks for learners. In this process, the teacher can save time from routine work and focus more on the instructions. Although there are cases of applying AI EdTech in China education, it is still challenging to clarify what role these AI educational tools play. One reason for that is the number of commercial AI developers who know little about learning science, resulting in products that could not meet teachers and students (Luckin & Cukurova, 2019).

Before dashing toward new educational technology, for example, AIEd, it is necessary to understand what it can provide for educators (Johnson, 2003). Unlike traditional education, as the interdisciplinary characteristics of AI technology, its introduction in education helps cultivate learners' higher-order thinking skills and creative ability (Lim, 2019). For instance, educational robotics is feasible for increasing academic achievement in Science, Technology, Engineering, and Mathematics (STEM) concept learning, as these disciplines are closely related to the field of robotics (Baker, Nugent & Grandgenett., 2008; Barker & Ansorge, 2007; Bers, Flannery, Anissa & Sullivan, 2014). As one of the adaptive learning systems, ITS can support learners' personalized learning by applying suitable learner models (Cavus, 2010; Santos & Boticario, 2016). It provides appropriate learning material by Recommended Learner Path (RLP) based on

learner characteristics or behavior (Janning, Schatten & Schmidt, 2016; Luckin & Cukurova, 2019). ITS can also connect learners' extracurricular interests with learning elements to effectively promote mathematics problem solving and second language learning (Walkington, 2013; Walkington & Bernacki, 2019; Heilman et al., 2010; Huang et al., 2018). Remarkably, the adaptive learning system is many used in e-learning and mobile learning. The researchers in this field tried to develop model like swarm intelligence, which can analyze learners' interest by Educational Data Mining (EDM) to match learners' characteristics with learning content (Henze, 2006; Wong & Looi, 2012; Kinshuk, 2012; Huang et al., 2018).

As the useful perception of learners' learning status can enhance the interaction between stakeholders (Garzon, Ankaraju, Drumwright & Kozma, 2002; Morishima, 2000), another hot issue of AIEd in the last few years is computer vision-based technology. Techniques like affective recognition, eye tracking, and other movement recognition can help Learning Analytics (LA) by providing physiological data, giving educators a deeper understanding of how learning happens (Luckin & Holmes, 2016; Luckin, 2017; Cukurova et al., 2016; Kiefer, Giannopoulos, Raubal & Duchowski, 2017). While the effectiveness of computer vision-based technology in physical learning environments has not been empirically proven, its application in distance education has shown that facial expressions are valuable and helpful for teachers to attain and understand the learners' emotional state (Sun et al., 2018). Facial expression data can help teachers reflect on their teaching practices, increase learner engagement in the course and reduce dropout rates (Whitehill et al., 2014; Ashwin, 2020). In general, it seems that AI can improve teaching and learning from a new perspective.

However, in some specific situations, there are indeed cases in which AI application has not shown learners' significant learning improvement. In some quantitative research using Lego robots as learning material for pupils, there are no different academic achievements between pretest and posttest groups (Hussain, Lindh & Shukur, 2006; Lindh & Holgersson, 2007; Baker & Ansorge, 2007).

Similarly, in a study to verify the effectiveness of using AI in the mathematics curriculum, no significant effect was found on academic performance (Pai et al., 2020; Steenbergen-Hu & Cooper, 2013). Walkington and Bernacki (2019) also concluded that the reasons for students' advanced performance and efficiency in an interest-oriented adaptive learning system might be for the reason of how much they tend to engage with their interests frequently in daily lives. Thus, the effectiveness and usability of applying AIEd in schools still need more evidence from the users, that is, teachers, students, and other stakeholders. At present, there is limited direct evidence on the application of AIEd to prove its pedagogical advantage and impact on a broader scale (William et al., 2007; Zawacki et al., 2019). One reason for this is that AI depends on both models and algorithms to process the knowledge intelligently. The existing research mainly focuses on algorithm development and modeling. For example, user modeling can provide interesting learning experiences and support personalization approaches in realistic learning environments (Santos et al., 2016). Multimodal affect detection systems can more accurately recognize emotions (D'Mello & Kory, 2015; Happy, Dasgupta, Patnaik & Routrary, 2013), and automatic frame-level puzzlement detection can help raise the recognition rate in affect detecting (Wang et al., 2014; Savelyeva, 2015). The developed AI tools or systems are mainly testing in a laboratory or a strictly controlled environment (Koedinger & Aleven, 2016). For example, to ensure the validity of collected data, the participants need to wear the detecting equipment in a quiet laboratory (Shen, Wang & Shen, 2009). When the participant made non-learning behaviors, he needs to remove the equipment in advance. Although data capture devices such as wearable devices, voice recognition, and eye tracking can collect learners' physiological and behavioral data, the devices are difficult to be promoted in actual teaching due to economic and ethical reasons (Kiefer et al., 2017; Welham, 2008).

As the user of AIEd, the role of teachers in such a learning environment using new technologies is still not exact. Through reviewing previous research, it seems that the cases like applying educational robotics in curricular and extracurricular activity always

involved human tutors to handle the material (Sullivan, 2008), providing technical assistance (Owens et al., 2008), and answer detailed questions (Toh et al., 2016; Zhong & Xia, 2020). Other research suggested that students' emotional and social interactions and inducing students' learning motivation are unique domains of teachers (Manyika et al., 2017; Kim, Park, Jeong, & Ko., 2018). As more and more intelligent technologies emerge, the education community has different answers to the question that whether AI teachers in the future will replace human teachers.

How to embed AI into school is one of the critical challenges. Koedinger and Anderson (1990) had tried to integrate ITS into the existing social context of school by replacing textbooks with ITS and adopting a collaborative learning method. The application of AI may bring convenience to teachers, but it may also bring some unprecedented challenges. New technologies should be designed based on an authentic environment, and these designs must consider various factors, which may determine the effectiveness, availability, and acceptability of the technology (Serholt et al., 2014; Mancini et al., 2010). To make AI educational products meet teachers' needs, stakeholders, including designers and educators, must be closely connected during the design and development process (Corbalan et al., 2008, 2009; Meabon, 2014).

At present, the study of teachers' and students' understanding of AI found that college students have a positive attitude towards introducing AI in university and believe it can help learners conduct learning analysis (Kwon, Yang & Jung., 2018). Although K-12 students have different views on the image of AI, they all agree that it can support personalized learning and provide structured learning content (Park & Shin, 2017; Shin, Ha & Lee, 2017, 2018). Besides, research indicates that teachers' teaching experience and teaching subjects also affect their attitudes towards introducing AI technology (Ryu & Han, 2018). Specifically, teachers in broadcasting and communications universities have more acceptance of AI techniques than those in comprehensive universities (Kwon et al., 2018). However, existing research on teachers' perceptions of AIEd involves the limited

investigation of secondary schools, and teachers have also rarely used AI educational tools in teaching and learning activities.

In order to systematically analyze teachers' perceptions about AIEd, this study will adopt activity theory as an analysis framework (Engeström, 1987, 2001). In a learning activity, solving the contradictions among the elements can smoothly promote the whole system and improve technology's effectiveness when introducing it (Cho, Kim & Hwang, 2014). Due to the intelligent and adaptive characteristics of AI educational tools, their application at school may impact the 'instructor-learner' community. For example, there is a new 'double-teacher classroom' instruction mode in China that AI educational robots used as teaching assistants to assist human teachers (Wang et al., 2019). In such a learning environment, the community has changed from the 'teacher-student' to 'teacher-educational robot-student.' The positive effects and risks in this new type of community relations can clarify through activity theory. Although AI has a positive effect on teaching, its application in human-centered activities inevitably brings about ethical problems. Just as the learning analytics system provides students with personalized learning support, they have to access learners' data, such as their learning styles and learning abilities. However, at the same time, such behavior data collection also exists the ethical concerns like personal information leakage and incorrect analysis (Li, 2007; Lee et al., 2020). Therefore, in the new learning environment mentioned above, solving or preventing the contradictions among teachers and intelligent systems or tools can be achieved by setting data collection and analysis rules, encouraging education stakeholders' participation to promote AI application in education (Lee et al., 2020).

This study would focus on the AI-based education platform. China is trying to introduce the AI-based education platform combining learning science and Convolutional Neural Networks (CNN) to provide students with personalized learning content to realized personalized learning (Luckin & Cukurova, 2019).

1.2. Purpose of Research

In recent years, some Chinese schools have introduced AIEd tools for teaching and management. Thus, there are some teachers and students who have experience in applying AIEd tools. For example, in language learning, some secondary schools use automatic scoring, a technique based on NLP and big data, to score students' writing intelligently. Besides this, speech recognition uses to conduct conversation exercises and evaluations with students in spoken English exams. More and more AI-based education platforms use in practical teaching and learning. Although these platforms' data collection methods are diverse, the students' academic achievement and prediction of learning effect can analyze according to the students' learning path, reflective log, and completion of the assessment. Furthermore, most platforms provide personal analysis reports and recommend learning content for learners. Therefore, this study focuses on Chinese secondary teachers and conduct in-depth research on their perceptions on AI-based education platform. The research questions are as follows:

1) How do Chinese teachers perceive the advantages of AI-based education platforms for teaching and learning in secondary school?

2) How do Chinese teachers perceive the contradictions between AI-based education platforms and the secondary school system?

3) How do Chinese teachers suggest on applying AI-based education platforms in secondary school?

1.3. Definition of Terms

Artificial Intelligence in Education (AIEd)

In this study, AI is defined as a computer system that simulates human intellectual capabilities and behavior to perform cognitive tasks, particularly learning and problem-solving. AI divides into general AI and narrow AI (Baker, Smith & Anissa, 2019). The former refers to an AI system that could successfully perform any intellectual task that a human being could. Simultaneously, the latter means an AI system that could replace humans to perform specific tasks. The AI involved in this study refers to narrow AI.

Artificial intelligence in education (AIED) refers to integrating AI with learning science (including education, psychology, neuroscience, linguistics, sociology, and anthropology) to promote the development of adaptive learning environments and other AIEd tools (Luckin & Holmes, 2016). AIEd supports intelligent learning and teaching by providing educational data and helps demystify the learning process. Thus, the design and development of AIEd systems usually involve the pedagogical model, the domain model, and the learner model.

AI-based Education Platform

In this study, AI-based education platform refers to education platform integrated AIEd technology. AIEd technology brings together the interdisciplinary AI and the learning science, including education, psychology, neuroscience, linguistics, sociology, and anthropology (Luckin & Holmes, 2016). Based on analyzing learning behavior and learning data, AI-based education platform can recommend learners with personalized learning materials by recommending learner paths or providing adaptive feedback to realize personalized learning.

Activity Theory

Activity theory is a framework for exploring the relationships among various elements in the activity system. It is a research field initiated in the 1920s and 1930s by Russian psychologists, mainly Vygotsky and Leont'ev (Engeström, 1987). It is commonly used to explore human practice and development processes and the relationships among various elements. The activity system contains six elements. Subjects, objects, and community are the core elements, while the tools, rules, and division of labor are intermediaries for completing activities. The description of the activity system elements is equivalent to describing how people interact with the outside world (Kaptelinin & Nardi, 2009).

In this study, activity theory is applied as an analysis framework to explore secondary school teachers' perception of AI-based education platform. In the learning activity, due to the AIEd system's intervention, the subject (teachers and students) and object (educational task) affect by rules and division of labor. By clarifying the connection among these elements, this study would finally derive the practical suggestions of introducing the AIEd system into education.

Chapter 2. Literature Review

2.1. AI in Education

2.1.1 AI for Learning and Teaching

According to AIEd tools' characteristics, it can group from learner-facing, teacher-facing, and system-facing AIEd (Baker, Smith & Anissa, 2019; Holmes, 2019). By combining the actual educational scenarios that involve in the school, this study will review the literature from two aspects: AI for learning and AI for teaching.

Adaptive systems, learning management systems (LMS), and ITS are relatively mature areas in AIEd (Shute & Zapata-Rivera, 2012; Baker, Smith & Anissa, 2019). Every learner has different learning needs. In traditional teaching, teachers cannot meet all learners' needs simultaneously. With the development of information technology, AI has made a breakthrough. Researchers in related fields have focused on developing adaptive learning systems (Shute, Hansen & Almond, 2008). The adaptive learning system originated from the early LMS. LMS usually provides learners with the same learning content, lacking consideration of learner characteristics and actual needs, inevitably leading to high dropout rates (Dagger, Wade & Conlan, 2005; Karampiperis & Sampson, 2005). The adaptive learning system can help learners learn and understand complex concepts, recommend learning material that matches their interests and abilities or provide feedback automatically based on their learning achievements. It solved the limitations of the early LMS. Therefore, the adaptive learning system has been used in some disciplines like STEM (Schofield, Evans-Rhodes & Huber, 1990).

The core of the adaptive learning system is learner modeling. The learner model can divide into static and dynamic models. Static modeling is modeled based on learners' characteristics in EDM, such as learning style, motivation, and cognitive characteristics. When the learner engages the learning environment, the system can automatically adjust according to the pre-set learning path and provides learning material or methods (Vandewaetere, Desmet &

Clarebout, 2011). Such type of model obtains a large amount of learner information from previous learning tasks, categorizing different learners' characteristics in advance and selecting different teaching strategies according to each group's characteristics (Cronbach, 1957; Rich, 1979; Triantafillou et al., 2004). However, the static model's limitation is that it is easy to ignore the changed learner characteristics. The learner may change the learning characteristics due to the shifting learning scenario so that the adaptive learning system cannot make appropriate judgments. For solving the deficiencies of the static model, the concept of the dynamic model is introduced. Dynamic modeling is feature-based modeling. It means that after learners engage the learning environment, the system dynamically tracks the learner's learning trajectory and provides corresponding feedback based on their characteristics and interaction with the learning environment (Brusilovsky & Millan, 2007). Both static modeling and dynamic modeling need a large amount of educational data, and the most important thing is that such modeling can only achieve by machine learning (He, 2017). Machine learning is one of the techniques in AI, and it can recognize learner's characteristics and behaviors pattern and integrate these characteristics and patterns into the learner model.

The application of AI in promoting personalized learning is also reflecting in the ITS based on affective recognition. Since emotion plays a monitoring role in human cognitive activity, the affective recognition model becomes critical in the intelligent learning system (Picard, 1997). Generally, traditional affective computing methods include self-reporting and manual observation, but such approaches demanded learners recall memory, which would have individual subjective consciousness. Besides that, it cannot be fed back into the teaching scenario in real-time, leading to deviations in the final diagnosis results. (Mauss & Robinson, 2009; Lee, Cho & Hong, 2015). In affective recognition-based ITS, the learner model's core objective is to adjust formative feedback to detect learners' physiological data and affective states (Grawemeyer et al., 2017). At present, there are some measurement tools used to detect biological data. For example, electroencephalograph signals (EEG) can measure brain activity

(Blanchard, Chalfoun & Frasson, 2007), and the Electromyogram (EMG) can capture facial muscle activity (Liu, Rani & Sarkar, 2005). Biofeedback sensors can measure learners' stress and excitement (Blanchard et al., 2007; Liu et al., 2005). The face tracker can analyze their physical activity through snapshots (Sebe, Cohen, Gevers & Huang, 2005; Whitehill et al., 2014). The facial expression recognizer (Arroyo et al., 2009) can be used in computational models to infer learners' mental status. Although there is no significant difference between learner's academic achievement in affective recognition-based ITS, learners show noticeable advancement in motivation, self-efficacy, interest, and perceived control. The research focuses on ITS has gradually shifted from modeling to machine learning, self-training algorithms based on educational data, and neural networks. A modeling-based system can decide what learning content to provide to learners, but why it provides in such a way cannot be entirely explained.

AIEd tools for teaching generally use to support educators and reduce their workload from administration (Kim, Park, Hong & Park., 2020), assessment (Heffernan et al., 2014), feedback, and plagiarism detection (Holmes, Bialik & Fadel, 2019). Personalized teaching refers to the ability to tailor learning contents, learning methods, and plans according to the students' characteristics such as experience, interests, learning styles, and cultural background. Research in recent years has also developed ITS pedagogy models to help teachers make educational decisions, providing learners with suitable learning material. In the adaptive system mentioned above, the adaptive teaching system based on the dynamic modeling can grasp learners' dynamic characteristics in different learning scenarios, helping teachers identify students' learning status (Brusilovsky & Millan, 2007). Besides that, AIEd tools for teaching is more concentrated in the field of LA. Teachers use LA techniques to effectively conduct teaching and track learning activities, including intelligent decision-making and implementation. For example, teachers can check the number of students' questions on the platform, class participation, and participate in courses. Based on these data, the teacher can

proactively offer teaching support and learning guidance, and instructional adjustment. With LA, massive structured and unstructured data scattered in different fields such as teaching, learning, and research, can be converted into various information and knowledge through data measurement, collection, analysis, and finally apply to decision-making and teaching management. A large amount of data will generate in the teaching process. For achieving that providing intelligent decision-making for teachers' teaching process, the urgent matter is to understand how to most effectively collect, measure, analyze, and report the data and behavior information on the teaching process, and extract confidential information, knowledge, and patterns (He, 2016). In-depth teaching behavior analysis research on various behaviors in the teaching process (mainly teacher behavior and student behavior) should conduct in-depth teaching behavior analysis research.

LA can also help teachers make objective, comprehensive, and authentic evaluations of students. With the complete information obtained by EDM, and then analysis and reason by LA system, the assessment of students' learning behavior and performance can be objectively, comprehensively derived, thereby realizing intelligent evaluation. On this basis, teachers can effectively intervene in the student's learning process or provide necessary learning support.

Accurate prediction of learners' academic performance is another technique in AIEd. AI can help develop more effective models to predict students' academic performance more accurately than before. Various data mining techniques are used in this field, such as neural network (Romero & Ventura. 2007) and decision tree (Chen & Do. 2014). Among them, the most widely used is Artificial Neural Network (ANN). Previous research shows that the model based on ANN can accurately predict students' academic achievements and admission results (Asogwa & Oladugba, 2015). The results obtained from academic performance predictions can classify students, allowing educators to provide them with additional support in advances, such as customized learning content and tutoring and collaborative learning. Teachers can also use the predicted results to specify the most

appropriate teaching method for each group of students and provide them with further assistance based on their needs. One common feature of widely used AIEd tools for teaching is to predict students' academic achievements and behavior performance in advance to give teachers enough time to prepare related teaching material and educational methods.

Besides that, in teaching management, AIEd can provide administrators and managers information in schools or education system. Based on user's educational management data, behavior data, and related industry data for analysis and modeling, to achieve data support for management decision-making and provide functions such as monitoring, simulation, and behavior prediction. For example, a prediction system can monitor attrition patterns across faculties or colleges (Zawacki-Richter et al., 2019). Based on face recognition technology, AI systems can help stakeholders maintaining campus security and regional education management.

2.1.2 AI-based Education Platform

1) Cases of AI-based Education Platform

There is a growing number of AI-based education platforms, and many studies have attempted to support teachers and students by combining AI and education for teaching and learning in different areas. Lee et al. (2020) developed a deep learning-based art learning support tool to support students' art education activities. After the practical trial, it was found that learners were generally satisfied with it. Sohn (2020) developed a Software (SW) education lesson plan using a framework-based AI education platform to activate AI-based SW education. Applying the dialogue-based tutoring system in computer literacy, physics, and critical thinking also helps in in-depth concept learning (Nye, Graesser, & Hu, 2014). The use of AI in language learning, such as chatbots, has implications for children's language acquisition (Chen, Park, & Breazeal, 2020). It seems that AI-based

education platforms and AIEd systems are getting more and more attention from educators. Based on previous research, AI-based education platforms can divide into two categories according to their functionality: 1) recommendation based on learning analytics, and 2) providing adaptive feedback. AI-based education platforms can take learners' needs and levels into account (Lim, 2019) and use cognitive diagnostic models and neural networks to identify students' cognitive levels (Wang et al., 2019). Then provides students with learning material at their level by RLP (Lee & Moon, 2016).

AI-based education platform mainly collects learners' learning data, analyzes their behavioral characteristics and cognitive level, and then provides learning content to help realize personalized learning. CENTURY Tech in the UK is one of these types of AI-based education platforms. It supports students' customized learning in English, math, and science subjects from elementary school to university. It provides a report of learning outcomes for teachers, students, parents, and school administrators to help reflect their decision making (Kim, Park, Hong, & Park, 2020). Its algorithms combine cognitive science and neuroscience to recommend personalized learning content and provide real-time data for teachers and learners, ultimately closing the achievement gap between high and low achievers (Luckin & Cukurova, 2019).

Another education platform providing recommendation based on learning analytics is ALEKS. ALEKS is a web-based mathematic learning system. It includes an AI component based on the framework of Knowledge Space Theory (KST), which can help accurately describes a student's cognitive status and then recommends problem sets that match their cognitive level as the learning content (Sullins et al., 2013). The experiment also verified that students using ALEKS required significantly less teacher assistance in completing daily assignments (Craig et al., 2013). Similarly, in mathematics learning, the previous research used the cognitive tutoring system. The system used personalized learning and blended learning approach to experimentally verify that it positively affects high school mathematics learning (Pane, Griffin, McCaffrey & Karam, 2016).

In the case of Branching Minds in the United States, it is a platform that diagnoses students' problems in the areas of reading and mathematics, supporting teachers by providing appropriate educational interventions (Kim et al., 2020). Another AI-based education platform, Teacher Advisor With Watson, is designed to provide achievement standards, instructional content, and strategies to support teachers' instruction in the mathematics curriculum for students in grades K-8. Both education platforms have in common the ability to provide teachers with teaching interventions and pedagogical advice (Kim et al., 2020).

Another type of AI-based education platform focuses on showing teachers and students different educational data and feedback through dashboards. Hence, teachers and students know the current learning status and the parts that need to strengthen. ASSISTments is an educational platform that provides adaptive feedback for teachers and learners. It performs both assessment and coaching in an online environment. Automated assessments reduce teachers' correction tasks and provide timely feedback on student and the whole class deficiencies so that teachers can take appropriate interventions. Furthermore, students can also receive immediate corrective feedback on scaffolding questions or prompts provided by the platform (Heffernan et al., 2014). Koedinger et al. (2010) also found that teachers would adjust instruction based on student performance in ASSISTments, illustrating that AI-based education platforms can guide students and direction for teachers to adjust instruction. CENTURY also provides an optimized learning path for learners based on their educational data, allowing teachers to check students' progress through a dashboard, and finally reduce teachers' workload by an average of 6 hours in a week (UNESCO, 2019. 3; Kim et al., 2020). It can be seen that many countries are trying to integrate AI into education to support teachers' teaching and students' learning.

2) TALA Framework

The Teaching And Learning Acts (TALA) framework is developed to assess AI educational technology. The framework identifies the basic education activities that need to be performed by AI, human educators, and learners (Luckin & Cukurova, 2019). A particular AI educational technology can be indexed according to the TALA framework. Table 2.1 shows the TALA framework, which specifies the roles and learner responsibilities that human teachers and students need to accomplish in teaching and learning activities. When evaluating AI-based education platforms, the TALA framework can be used to determine which instructional activities the AI-based education platform can help teachers and students.

Table 2.1 TALA Framework

Teachers	Learners
Plan knowledge domain	Attend school
Collect resources	Organize themselves and their equipment
Define/modify learning activities	Exhibit appropriate behavior for learning
Define/modify assessment and tracking activities	Memorize knowledge
Assess before and after learning activities	Recognize knowledge
Assess during the lesson to decide what to do next	Recall knowledge
Marking	Evaluate information
Written feedback	Answer written questions
Tracking	Answer verbal questions
Differentiation	Ask questions
Reporting	Assess their own work
Verbal feedback	Assess others work
Behavior management	Assess their own emotions
Pastoral care	Record their own learning
Monitor attendance	Work collaboratively
Communicate with parents	Research
CPD	Reflection
Performance management	Learn, exhibit and practice domain-specific skills, e.g., writing, drawing, dancing

2.1.3 Teachers' Perception on AI-based Education Platform

Research targeting teachers to support and promote AIEd system by teachers is still insufficient (Lee & Kim, 2014). As the users of AIEd, teachers' perceptions of AI-based educational systems influence the development of AI in education (Luckin & Holmes, 2016; Kim et al., 2020). It is because factors such as the teacher's perception of the effectiveness and necessity of a particular technology, the teachers' education level, and prior experience and motivation can influence their willingness to adopt new educational technology (Rogers, 2003; Kim, 2011; Hong, 2009). Teachers' perceptions of AIEd systems may vary depending on their experience or the socio-cultural context in which they live. In the previous research about the teachers' perceptions of the AIEd system, teachers commonly recognized that AI can help them reduce the workload from administration (Kim et al., 2020), assessment (Heffernan et al., 2014), and feedback (Holmes et al., 2019). Teachers believe that AIED systems can solve the problem of timely response, which is difficult to achieve in large-scale teaching (i.e., when one teacher faces many students, it is challenging to take care of all students' learning requirements in the limited course time). Moreover, it can help free teachers from repetitive tasks because students can use AIED systems for multiple iterations of deliberate practice to improve their learning achievement (Qin et al., 2020). The prospective mathematics teachers recognized that AI provides personalized learning and helps teachers play supplementary assistant (Shin, 2020). In language learning, English teachers recognized that the AIEd system and AI-based chatbot could significantly improve learners' listening and speaking skills by providing plenty of practice opportunities (Kim, Lim & Chang, 2019; Yang, Kim, Shin & Lee, 2019). As for the relationship between the human teachers and AI in education, teachers believe that the relationship between AI and teachers is closer to assisting and collaborating with teachers by providing service such as learning management, assessment, and personalized learning than replacing human teachers (Roll & Wylie, 2016; Kim et al.,

2019; Ma, Adesope, Nesbit & Liu, 2014). Although teachers have certain expectations of AIEd systems, they are also aware of the risk issues that come with them.

There are some voices about the negative comments about AIEd. For example, some teachers responded that AI-based education systems might lead to the school's loss of socialization function, lack of interaction between teacher and student, and even the teacher being overly dependent on AI (Kim et al., 2020). As for the potential risks in using the AI-based education platform, Shin (2020) also found that teachers are concerned about the inability of AI to interact emotionally with students. Also, they believe that learning through AI may undermine students' ability to think on their own. Some teachers believe that even the AIEd system with better performance will not solve low learning motivation because the low motivation to learn can be caused by environmental and psychological or other factors (Qin et al., 2020).

In addition to the issues that may arise in teaching and learning, many researchers are mindful of the ethical and moral issues of AIEd. Teachers who were having the experience of using the learning analytics system perceived problems including privacy violation, incorrect analysis and intervention, excessive competition, discrimination against low achievers, and inappropriate rules of teachers' responsibility (Lee et al., 2020). They also proposed data privacy and the importance of developing legal and institutional measures, which help prevent the misuse of data produced in private and public institutions and enhance teachers' AI literacy when introducing AI-based education platforms in education. Using AI-based education platforms should also consider the educational system, educational environment, and instructional methods (Heo et al., 2013; Kim et al., 2019). Therefore, it can be seen that teachers have different concerns about the use of AI education systems.

2.2. Activity Theory

Activity theory, also named cultural-historical activity theory (CHAT), was initiated in the 1920s by Russian psychologists Vygotsky. Activity theory focuses on the process of human activities, such as the interaction between humans and the environment, individual and social groups, and the practice process and results of activities (Engeström, 2001). Activity theory is concerned with the nature of the tools people used in the human development process, different environments, social relationships, purpose, and the significance of activities (Kuutti, 1996). Activity theory has been an increasingly popular theoretical framework in human-computer interaction (Spinuzzi, 1997) because it is useful in applying technology by providing a systematic way to describe the artefact-based interactions (Stevenson, 2008). The activity system contains three core components: subject, object and community, and three secondary components, including tools, rules, and division of labor. Their relationship refers to Figure 2.1.

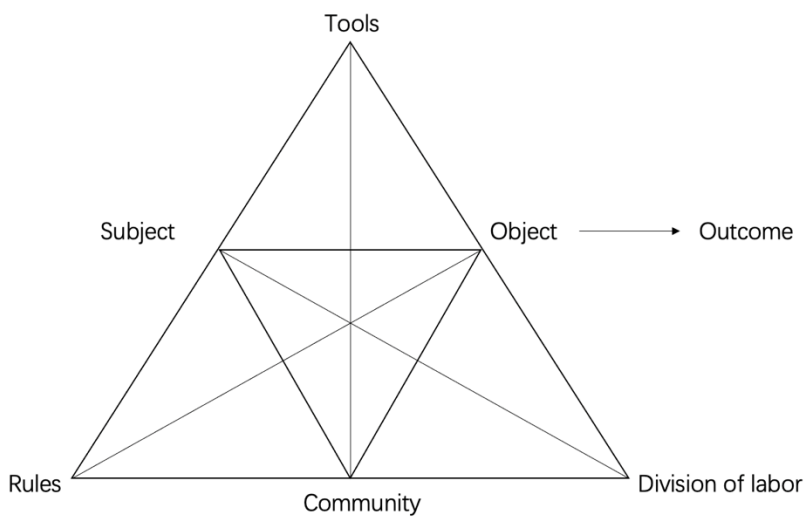


Figure 2.1 Activity Theory Framework of Engeström (2001)

In learning activities, the subject is teachers and students. Through learner analysis, learner characteristics such as cognitive level, affective, and ability can be obtained. It is conducive to the

teacher's further development of reasonable teaching goals. The object refers to the teaching goal or learning purpose achieved by the subject through using the tool. The community refers to participants who complete the learning activity with the subject, such as teachers, other students, and technicians. The community plays a role in the whole system, just as guidance or participation. In the learning activity, the community continuously affects the subject and provides learning support for the subject. Therefore, subject, object, and community are the core elements of activity theory.

The rules mean the policy, such as norms and guidelines of school or education department. The application of education technology, for example, a learning analytics system, requires a lot of educational data, and the access authority of data inevitably involves personal privacy issues, so the rules here can also refer to social, moral constraints, and ethical norms (Lee et al., 2020). Teachers' decision of when or how to use technology depends on the curriculum, education policies, and other constraints existing in the activity system (Preston, 2004).

Activity theory focuses on human beings using tools for the specific purpose to complete interaction with the outside world in a specific social and cultural context. It emphasizes the practical process rather than the knowledge itself (Kuutti, 1996). In educational technology mainly involves how to improve the teaching and learning quality by using techniques. Therefore, the activity theory is beneficial for exploring and understanding the significance of educational activities. Activity theory can provide a theoretical framework for introducing new teaching technology and helpful to learn about how new technologies interact with the existing social and cultural context. Scanlon and Issroff (2005) used activity theory to assess the interaction among teachers, students, and learning technology when college students applied Information and Communication Technology (ICT). Activity theory can also be used to assess the impact of digital technology on Australian elementary schools (Romeo & Walker, 2002), the impact of ICT on British higher education (Issroff & Scanlon, 2002), as well as the impact of using mobile devices in education (Scanlon, Jones & Waycott, 2005). Cho et al. (2015) employed activity theory to

explore the effects and limitations of role-playing in the 3D virtual world in pre-service education and analyzed the contradictions between such teaching activities and the existing education system.

The development dynamism comes from resolving the tensions and contradictions that exist within and between these six elements. These elements restrict each other, and the result acts back on the system to change the relationship between the elements.

In the activity system, there are contradictory relations among the elements. The effective strategy for carrying out the activity can be generated by resolving the conflict or contradiction and ultimately promoting the activity development. Therefore, the activity system's conflict is the principal analysis subject (Engeström, 2001; Youn & Park, 2012). When a teaching technology is not mature enough and ensures it can be used for teaching, appropriate manual intervention is necessary (Stevenson, 2008). Take ICT as an example, the impact of ICT on education is mostly analyzed by analyzing teachers and their ideology (Stevenson & Hassell, 1994). Therefore, integrating new technologies into teaching reflects teachers' attitudes, beliefs, and experimental processes about new technologies.

Chapter 3. Research Method

3.1. Research Design

This study aims to obtain an in-depth understanding of secondary school teachers' perception on using AI-based education platforms and the suggestion of applying it. In order to achieve the research purpose, this study adopted in-depth interviews, which is one of the qualitative research methods to collect data, and thematic analysis is used for data analysis. The contradictions of AI educational tools in teaching activities were analyzed within the activity theory framework.

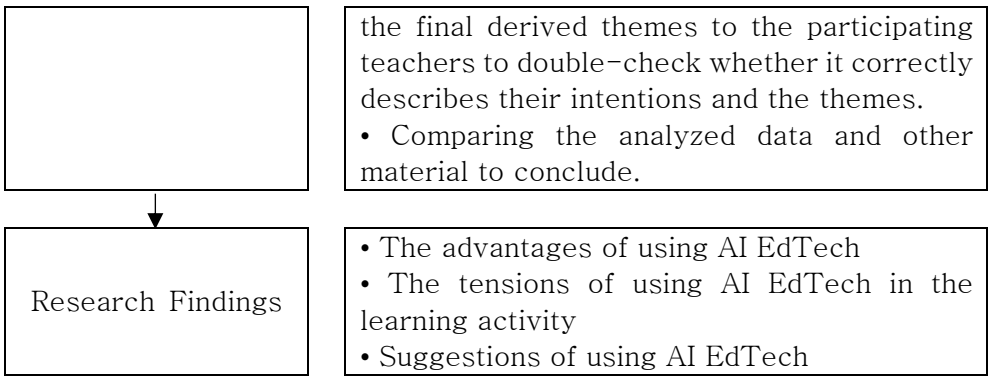
Qualitative research refers to the method that obtains qualitative information around a specific subject and investigates somethings based on social phenomena or the essence of things and the contradictory changes in activity (Creswell, 2012). Through extensive and meticulous research on the research objects, qualitative research can help deeply comprehend the social phenomena and further state the problems to serve as a reference for educational activities in similar situations. It can also be used in areas with no theoretical basis when the appropriate concepts of phenomena that researchers are interested in are not identified or lacking (Strauss & Corbin, 1998). The qualitative research method's advantage is that open-ended questions can be used to obtain participants' responses in their own words, which is more open than the quantitative research. Obtained data is also more affluent and more explanatory and can even get surprising answers. Among qualitative research methods, in-depth interviewing is the most commonly known and widely used in qualitative research (Liamputtong, 2013). It is an effective way to collect empirical data of individuals' interaction with the outside world.

In this study, 14 secondary school teachers participated in the study by semi-structured interview. The semi-structured interview can provide space for reciprocity and reflexivity between the researcher and the participants in dilemmas encountered within the project (Galletta, 2013). Through in-depth interviews, it can unearth

the interviewee's non-superficial opinions, such as the motivation, attitude about AIEd. The interviews included teachers' perceptions of AI-based education platform, the problems they encountered in using them, and the corresponding suggestions. The interviews were recorded and then transcribed for subsequent analysis. The initial coding was then done through a thematic analysis to identify the codes relevant to the research questions and the relationships between the subcategories and finally set the themes. The overall sequence of this study shows in Table 3.1.

Table 3.1 Research Procedure and Content

Research Procedures	Content
Literature Review	• Lack of research on AI applications corresponding to the physical learning environment. • AI With the introduction of AI into schools as teaching tools, the relationships of the elements in such a learning-teaching system will change, but the perception of such change is still vague.
Data Collection	• Collect cases in that schools use AI for educational purposes. • According to the research questions, compose the interview outline. • Formulate selection criteria of research participants and confirm secondary school teachers as research objects. • Obtain the teacher's permission to interview and conduct the online interview with them. • Collect other data resources such as the interviewed teachers' lesson plan or other AI application material for further objective analysis.
Data Analysis	• The researcher transcribed the interview content into document format. • Adopting thematic analysis method and activity theory framework to analyze data. • Send the transcribed interview content and



3.2. Participants

The purpose of this study is to perceive the advantages, contradictions, and corresponding suggestions of AI-based education platforms through interviewing secondary school teachers who have experience using the learning platform. In the actual survey, it was found that the number of teachers using the platform was limited, so the snowball sampling method was used to select the participants. Specifically, first of all, randomly find a teacher on the education forum who has published articles on the use of AI-based education platform, and then contact the teacher and conduct an interview with his consent. After interviewing this teacher, another teacher who also had experience using the platform was contacted through this teacher's referral. Finally, in this way, interviews were completed with 14 secondary school teachers.

In order to diversify the data and reflect as much as possible teachers' perceptions of the platform in different regions, teachers in Beijing, Hunan, and Guangdong were interviewing. Schools in these regions have different attitudes towards platforms. Teachers in Beijing generally have a positive attitude towards platforms, while schools in Hunan and Guangdong have a neutral attitude. Besides, Beijing and Guangdong regions use the same version of the textbook, while Hunan uses another version of the textbook, and they all under the same curriculum standard. Finally, 14 secondary school teachers (3 males and 11 females) with experience in using the AI-based education platform were interviewing, and they have 3-10 years of teaching

experience. Thirteen teachers were from non-Bring Your Own Devices (BYOD) schools, and only one teacher from Guangdong was in BYOD school (Teacher G). Also, considering the varied needs of different subjects, these teachers are from Chinese, mathematics, English, physics, geography, biology, and chemistry. All teachers interviewed used the platform at least once a month during the regular semester (see Table 3.2).

Table 3.2 The Information of Participating Teachers

Teachers	Gender	Subject	Years of Teaching	School Area	Frequency of applying AI-based education platform (times per month)
A	F	Math	5	Hunan	2
B	F	English	3	Hunan	1
C	M	Physics	4	Hunan	3
D	M	Geography	7	Hunan	2
E	F	Math	6	Hunan	2
F	F	English	4	Guangdong	1
G	F	Geography	7	Guangdong	≥ 5
H	F	Chinese	4	Guangdong	1
I	F	Geography	3	Guangdong	1
J	F	Biology	4	Guangdong	2
K	M	Chinese	10	Beijing	3
L	M	Chemicals	5	Beijing	2
M	F	Chinese	4	Beijing	4
N	F	Physics	3	Beijing	1

3.3. Instrumentation

3.3.1 Potential Value of AI System in Education

This study used an AI platform called ZHIXUE in iFlytek as the education platform, and all 14 participating teachers commonly have experience in using it. ZHIXUE education platform has been applied in more than 16,000 schools in 28 provinces, covering nearly 7 million students in China (China Daily, 2020). It is a commercial AI platform that aims to improve learners' academic achievement and narrow the achievement gap between high and low achievers by providing personalized learning and real-time data for learners and teachers.

The platform applies EDM, cognitive diagnostic models, and Question Difficulty Prediction models (QDP) to solve learners' cognitive level diagnosis and Recommended Learner Path (RLP). Specifically, the Test-Aware Attention-Based Convolutional Neural Network (TACNN) learns to represent text material of questions as predicted difficulties and set up question sets with similar difficulty for different levels learners (Huang et al., 2017). This model consists of four parts: the input layer, sentence CNN layer, attention layer, and prediction layer (Figure 3.1). The sentence CNN layer learns the input text material of each question from the sentence semantic perspective, while the attention layer learns attentional representations of each question by qualifying its contribution to the text material. The TACNN framework is used to predict questions' difficulty.

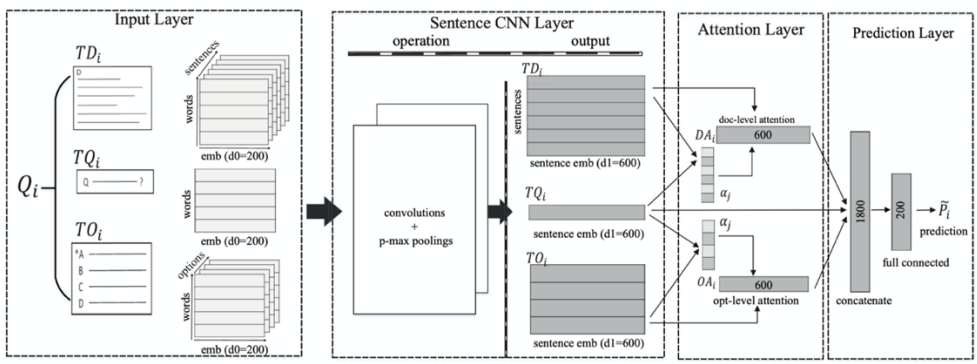


Figure 3.1 TACNN Framework (Huang et al., 2017)

As for learner cognitive diagnosis, another fuzzy logic model is applied to do so. Four-tier fuzzy cognitive diagnosis (FuzzyCDF) combined fuzzy logic with cognitive diagnosis to make the fuzzy cognitive diagnosis for learners and diagnose their cognitive level (Liu et al., 2018) (Figure 3.2). Most Cognitive Diagnosis Models (CDM) have the limitation that they can only analyze learners based on the objective problems the learners have done (Liu & Jansen 2015). Combining fuzzy logic, the FuzzyCDF model can model cognitive framework for objective problems and subjective ones.

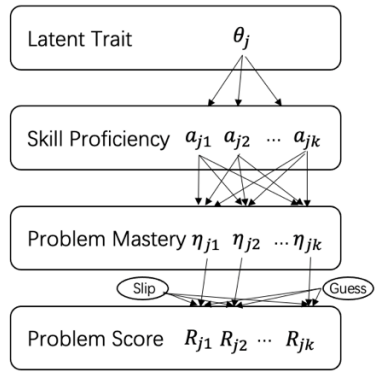


Figure 3.2 Fuzzy CDF Model (Liu et al., 2018)

Finally, in obtaining the learner's knowledge mastery, the learner's actual mastery of each test question is calculated by matching their answering situation with the knowledge corresponding to the topic. After that, it can predict the learners' answers and recommend personalized material equivalent to their cognitive level.

The Teaching And Learning Acts (TALA) framework is developed to evaluate AI education technology (Luckin & Cukurova, 2019). It determines the basic teaching and learning activities that AI, human educators, and learners need to undertake. According to the TALA framework, it is possible to index the work that a specific AI education technology can help educators and learners. Table 3.3 and Table 3.4 are the educational support provided by the ZIHXUE platform for teachers and students in primary teaching and learning activities. ZIHXUE provides cognitive diagnostic analysis and material recommendations for students and real-time data on students' learning status in the classroom and automatically generates exam papers for teachers.

Table 3.3 ZHIXUE Using the TALA Framework (1)

Teachers	ZHIXUE in iFlytek
Plan knowledge domain	√Teachers can assign specific learning tasks for learners.
Collect resources	√Teachers can upload or collect their resources and even automatically generate test papers.
Define/modify learning activities	√Teachers can modify existing auto-tagged learning material, such as the difficulty of the questions.
Define/modify assessment and tracking activities	√Teachers can assign learner-specific assessment and adjust the assessments, which are auto marked by the platform.
Assess before and after learning activities	√Teachers can evaluate learners' knowledge before or after completing learning activities. The platform's assessment exercises are provided randomly or uploaded directly by the teacher and generally take students 5-10 minutes to finish. The data will be displayed on the teacher's data dashboard.
Assess during the lesson to decide what to do next	×
Marking	√ZHIXUE can reduce teacher workload by auto marking the objective problems. However, the description problems still need teachers to mark.
Written feedback	×
Tracking	√Using data collected automatically by the platform, teachers can understand how many tasks the learners have completed, their performance, and their effort.
Differentiation	√ZHIXUE supports and extends learners' learning by recommending personalized learning material for each learner. Teachers can use the platform's question bank to assign different practices to students at different levels.
Reporting	√Auto-generated reports detail students' overall performance or the whole class, including their strengths and areas that need to develop, even the extent to which they complete the tasks and their level in the entire group. Learner's guardian can also keep track of the learner's learning through the guardian portal application.
Verbal feedback	×
Behavior management	×
Pastoral care	×

Monitor attendance	×
Communicate with parents	×
Performance management	×

Table 3.4 ZHIXUE Using the TALA Framework (2)

Learners	ZHIXUE in iFlytek
Attend school	×
Organize themselves and their equipment	×
Exhibit appropriate behavior for learning	√Monitor learner's efforts and provide reports to teachers, learners, and their guardians.
Memorize knowledge	×
Recognize knowledge	√Learners can immediately confirm the knowledge by instant feedback after answering questions. They can also access a comprehensive learning dashboard for individual performance and areas for development.
Recall knowledge	√Learners recall and apply knowledge by answering a series of questions of a similar test type or the platform's same knowledge.
Evaluate information	×
Answer written questions	×
Answer verbal questions	×
Ask questions	×
Assess their own work	√The learner can review past answers and redo the wrong exercises. The platform will save all past test paper records uploaded by learners, equivalent to establishing a learning tracking profile for learners.
Assess others work	×
Assess their own emotions	×
Record their own learning	√ see above
Work collaboratively	√Teachers can group students for collaborative learning based on their level of knowledge.
Research	×
Reflection	×
Learn, exhibit and practice domain-specific skills, e.g., writing, drawing, dancing	×

As shown in Figure 3.3, it is the analysis interface for a particular exam in the teacher version. From top to bottom, the following implemented:

1) Teachers can know at a glance the difficulty of the exam. The different colors represent the difficulty level of the questions,

with red for difficult, yellow for hard, blue for general, and green for easy.

2) Teachers can know that how many students scores for this question in the whole class. The histogram is divided into three stages: full score, half score, and failure to score. By clicking on the histogram, the teacher will know in detail which students failed to score on this question and can also send feedback to students individually in the form of a notification.

3) The knowledge covered in the question. Students' failure to score on this question may be related to the fact that they have not yet mastered the covered knowledge.

4) The radar diagram of knowledge distribution allows the teacher to have an overall picture of how well students have mastered the knowledge covered in this exam.

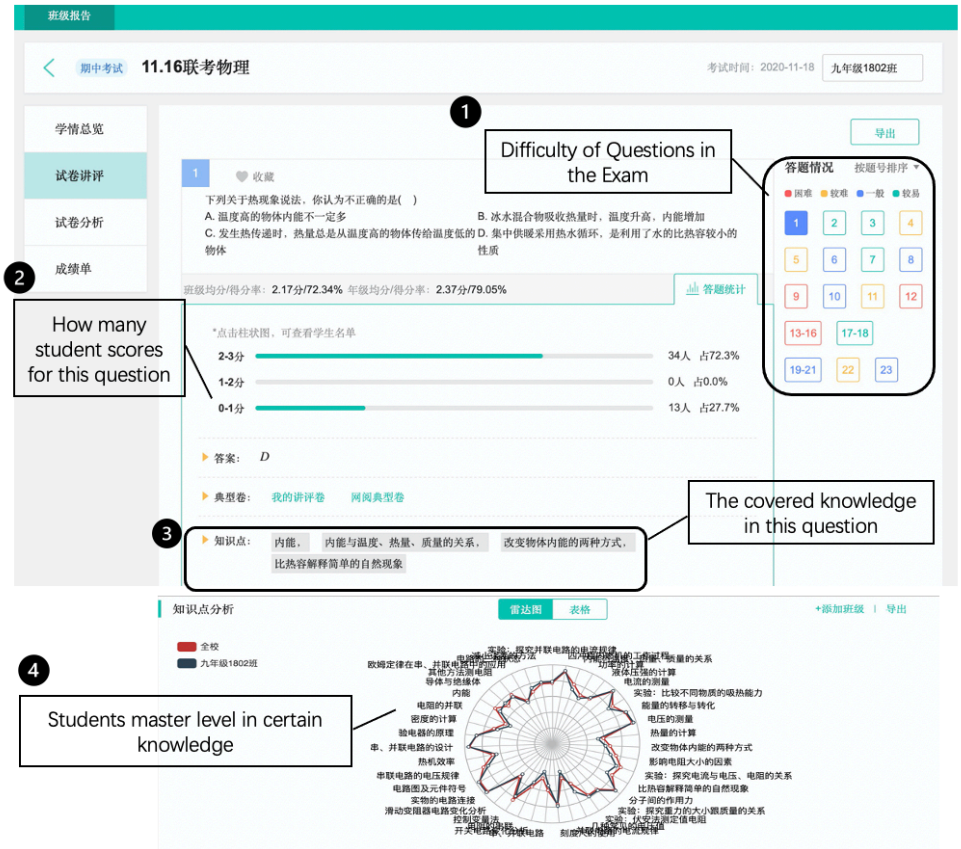


Figure 3.3 Teacher Interfaces of Education Platform

Figure 3.4 is the student interface of the education platform. From top to bottom, the following implemented:

1) Students can review their analysis reports for each previous exam. The Fuzzy CDF model is used to calculate the student's level of master a specific knowledge. The bar marked in red alerts the student should focus more on the corresponding knowledge.
2) Recommendations are provided to students through a diagnosis of their cognition and the master level of covered knowledge in this exam.
3) Students can see how they have progressed or regressed with each previous test.

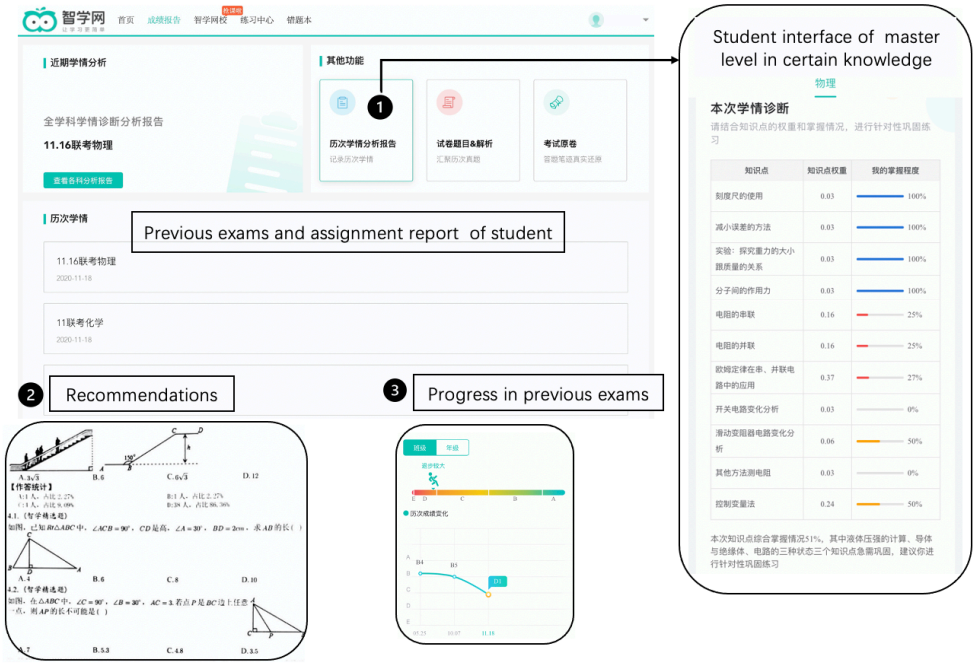


Figure 3.4 Student Interfaces of Education Platform

3.4. Data Collection

Data were collected primarily through the in-depth interview method of the qualitative research. From September to November 2020, 14 secondary school teachers who had experience using the AI-based education platform were interviewing with semi-structured interviews. Due to social environment factors, semi-structured interviews were conducted online video with an average of one hour per teacher. The interview questions mainly focus on teachers' experience of applying AI-based education platform, the effectiveness, concerns, and suggestions for applying such AI products (refer to Appendix 1 for more details). The interviews were recorded with the interviewed teachers' permission and finally transcribed by Microsoft Word software, totaling 178 pages.

Before the interview, there was a consideration that teachers may not understand the concepts of AIEDs or may not be aware of whether the AI-based education platform they used incorporates AIEDs. The researcher explained the concept of AIEDs to teachers and prepared some relevant examples to explain, trying to help the interviewed teachers recall their memories and experiences. Semi-structured interviews were conducted through an interview outline prepared in advance, addressing the advantages of AI-based education platform in teaching, the contradictions, and corresponding solutions. The semi-structured interview's advantage is that the interviewees can express their thoughts more profoundly and obtain more information by open-ended questions. The interview's leading questions were based on the research questions and activity theory components in teaching activity. During the interview preparation, additional questions were continuously added or modified by checking the relevance of the research direction. Initially, teachers were allowed to freely talk about which AI-based education platform they had used and how to use them, so the researcher can better understand participants' background and whether the platforms used by teachers are consistent with the research direction. Then, based on the platform teachers described, they were asked about the purpose of using these platforms and how

it can help them in their work, also the disadvantages and the reasons why they think so. Besides, they were also asked to talk about the solutions or suggestions about the problems they had encountered. If they had relevant information, such as screenshots of the platform, photos of personalized material, they are also asked to provide them as much as possible.

3.5. Data Analysis

The transcribed interview content was analyzed based on the thematic analysis method (Braun & Clarke, 2006). Thematic analysis has five steps to guide the researcher in analyzing the collected qualitative data, including familiarizing the data, generating initial codes, searching themes, reviewing themes, and defining and naming themes.

First, the researcher recorded the conversation during the interview and then transcribed the interview by software Microsoft Word. In this process, the researcher was allowed to repeatedly listen to the interview and become familiar with the data. During the transcription, inspirations from the content were memo to help the researcher better understand and analyze the next step. In this section, 178 pages of interview content transcribed eventually.

Second, initial codes were done based on the research question, i.e., the advantages, disadvantages, and suggestions of applying AI technology in teaching. The researcher extracted the data involved or implied to these parts of the content and split them into units of words or phrases. For example, "It gives me immediate feedback on my students' practice, such as what they have done incorrectly, and it immediately auto marks the practice and gives me the result, so I know which parts need to explain in more detail." This sentence can initially code as 'timely feedback,' 'automark,' and 'giving teacher guidance.' preserve as much of the data's richness as possible, data that were initially difficult to distinguish based on the research questions were grouped into 'other.' Then, initial coding was performed again based on the second research question with the activity theory framework.

Specifically, the school education system elements related to AI-based education platforms are defined as subjects, tools, objects, rules, communities, division of labor, and outcome. Based on the previous step's data, the problems arising from using AI-based education platforms are marked with the activity theory elements to clarify the conflict between the elements. In this phase, a total of 106 codes were generated.

Then, in the phase of searching and reviewing themes, finding themes that match with the codes by repeatedly comparing and looking for relationships between the initial codes and merging some similar codes. For example, initial codes such as 'saving time searching for material,' 'reducing repetitive work,' and 'automatic statistics' are all related to reducing teacher workload, so they are grouped under the theme of 'reduce workload.' Besides, to ensure the extracted data's reliability, final derived themes and interview contents were sent to the interviewed teachers to ensure that the interpreted data matched with their intentions. The themes were also sent to a teacher in the doctoral course of educational technology to ensure the derived themes' validity. In this way, a total of 14 themes were eventually derived at this stage.

In the final stage, 14 themes were finally derived, including four themes for the advantages of using the AI-based education platform, six themes for the tensions, and four themes for the suggestions.

Chapter 4. Findings

4.1. Advantages of Using AI-based Education Platform

As shown in Figure 4.1, four themes and nine subcategories were eventually generated about the advantages of using AI-based education platform, including instant feedback, targeted and systematic teaching supporting, educational resources sharing, and reduce workload for teachers.

Table 4.1 Coding Results for Advantages of Using AI-based Education Platform

Themes	Categories	Number of teachers mentioning the contents
Instant Feedback	Formative assessment	6
	Instant cognitive diagnosis	6
Targeted and Systematic Teaching Support	Personalized learning resources	8
	Instructional adjustment	7
Educational Resources Sharing	Teaching resource integration	6
	Creating learning opportunity	6
Reduce Workload	Reduce repetitive and mechanical work for statistics	9
	Times-saving for materials searching	8
	Automark for exam and exercise	14

4.1.1 Instant Feedback

1) Formative Assessment

AI-based education platform combines learning science and AI technology to collect a large amount of real-time data and generate evaluation reports through the interaction between students and the platform. It can help teachers instantly know the learning status of students and predict their performance. Teachers mentioned that by having students complete the exercises related to the class, the platform could automatically mark students' works according to the content inputting in advance. Then, through the teacher dashboard, the teacher can know the whole class's mastery level, time on task, and average number of attempts per task. The platform also records students' past learning results, which provides a good summary of what students have learned in previous semesters. These data can help teachers predict academic performance for the entire class and individual students to provide advice or intervention.

> With his records' help, I found he had not done well in the previous semester, which may have contributed to his poor foundation, so I suggested that he could relearn some basic concepts. (teacher H)

> There are some questions, like the student chooses the wrong answer without even thinking about it. In this case, you can see that he is choosing randomly (teacher G).

> If he gets it (in-class testing) wrong the first time, it's probably because of his careless or he didn't know about it. But if he gets it wrong again, it just means he hasn't mastered it yet (teacher I).

In other words, with data such as education outcome, time on task, and the number of attempts per task, teachers can infer students' mastery level, learning emotions, and engagement. Then, by combining

their observations of students' actual performance in class, they can predict the course's teaching effects.

Another piece of lateral evidence that data about the platform contributes to formative assessment is provided by Teacher D. After completing the learning process, and the teacher expects students to demonstrate mastery of the subject. As a result, there is often a short diagnosis test for students in the class. Figure 4.1 shows the data provided by the teacher for a student's in-class exercises. It can be seen that the exercises with low accuracy (30%, 60%) just only be completed with 2 minutes and 43 seconds, respectively. Therefore, it can be assumed that the student completed the practice in a low engagement. The most recent exercises have a high accuracy, which shows an increase in student engagement in learning, and helps the teacher predict the student's academic performance.

Figure 4.1 In-class Exercise List of Student

Appropriate use of AI-based education platform can automatically generate personalized evaluation data for teachers and students, providing them with instant information, including learning results, mastery level, and learning progress, which helps identify students' weaknesses and predictions of their learning and promoting

personalized learning. Teachers can also combine their observations of student performance with real-time educational data to objectively understand students' individual cognitive development so that timely formative assessment can be applied to actual teaching, ultimately improving teaching quality.

2) Instant Cognitive Diagnosis

Teachers pointed out that using the AI-based education platform can help them keep track of students' cognitive levels. As shown in Table 3.3 of the previous chapter, the AI-based education platform predicts test questions' difficulty by data mining and building a text semantic-based CNN model. By a fuzzy logic cognitive model, the platform determines the students' cognitive level based on their initial interaction on the platform and then recommends the extended practice or online courses. The interviewed teachers suggested that many students have ambiguous diagnoses of self-perception in their daily instruction.

> If you ask students what they still do not understand, they may not be able to tell you explicitly because sometimes they may not know it themselves, so I would also refer to the platform to get a rough idea (teacher A).

> If you ask students to do paper-based exercises in class and require them 'raising your hand if you chose C' to check their answer, maybe only some of them would have done so, and you would only be able to know about the situation in this way (teacher H).

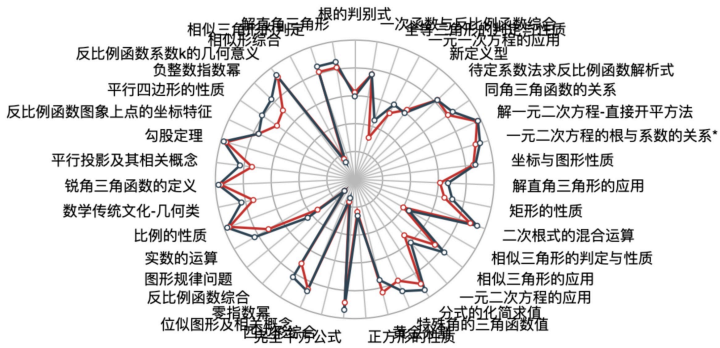


Figure 4.2 Radar Diagram of Math Knowledge Distribution

Figure 4.2 provided by teacher A is a radar diagram showing a class student's mastery of particular mathematics knowledge in a test, with the red line for the school average level and the black line for the class's average level. The dot distributing in the figure represents the knowledge covered in this exam. The dots near the center of the circle indicate that students still do not have a good mastery of this knowledge, while the dots far from the center indicate that students have a good grasp of that knowledge. The radar analysis provided by the AI-based education platform shows that the students still have not mastered the content of the exam on shapes such as similar triangles and squares. Thus, platform data such as a radar chart give the teacher a rough idea about students' mastery level. It provides the students with personalized learning diagnosis reports to understand their learning status and promote teachers' accurate teaching and reasonable evaluation.

> It can correct it (assignments) immediately and give results and generate reports immediately, so students can also know their shortcomings without having to wait a few days for manual correction (teacher G).

Automated evaluation enables immediate feedback because it can quickly confirm the students' concepts and confirm the results. Traditional assignments require students to complete exercises and submit them to the teacher, who reviews and corrects them. Although

this method can ensure that the teacher understands all students' learning situations, this method has a time lag problem. For example, as shown in Figure 4.3, students can receive immediate feedback on their answers after submitting the assignment, including the knowledge covered in this topic (left) and the mastery level and the parts recommended for strengthening (right), such as calculation of pressure.

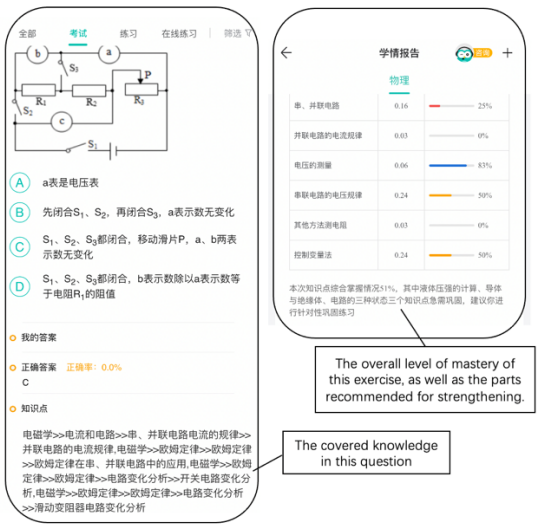


Figure 4.3 Analysis Report of a Student

I still have reservations about it (diagnosis result) because you don't know how the student completes the task in what circumstances. For example, some students work very hard under parental supervision, while others may finish it while surfing the Internet (teacher M).

Although student learning analysis was not detailed enough for other reasons, the general direction was accurate (teacher K).

The cognitive diagnostics results can be used in subsequent education activities such as recommending educational resources, predicting student performance, and grouping students into study groups. However, since many other factors influence cognitive

diagnosis, such as the ability to understand the contents or scenario in which the problem arises, teachers also believe that the platform's data is only informative in the process of students' cognitive diagnosis.

4.1.2 Targeted and Systematic Teaching Support

1) Personalized Learning Resources

The teachers interviewed noted that students could strengthen their weakness after the exam with personalized learning material, which had a positive effect on their academic performance to some extent. Students can see their test results in their accounts, including how they performed comparing with previous exams and what they need to develop. As seen in the previous section, the AI-based education platform can help diagnose students' cognitive levels based on their interactions with the platform, such as time on task, score, and practice time. Based on these data and analysis, the platform searches the question bank for relevant content that the student needs to strengthen and gives the student personalized recommendations. Especially for students who are in intermediate academic performance, such recommended practice model can significantly improve their performance.

> Because the recommendations were based on the questions they had wrong on the test, and it does help them by practicing a lot of similar type questions (teacher C).

> For each incorrect question, it would have three or four questions of the same type recommended for students or a more specific supplement of the wrong question (teacher D).

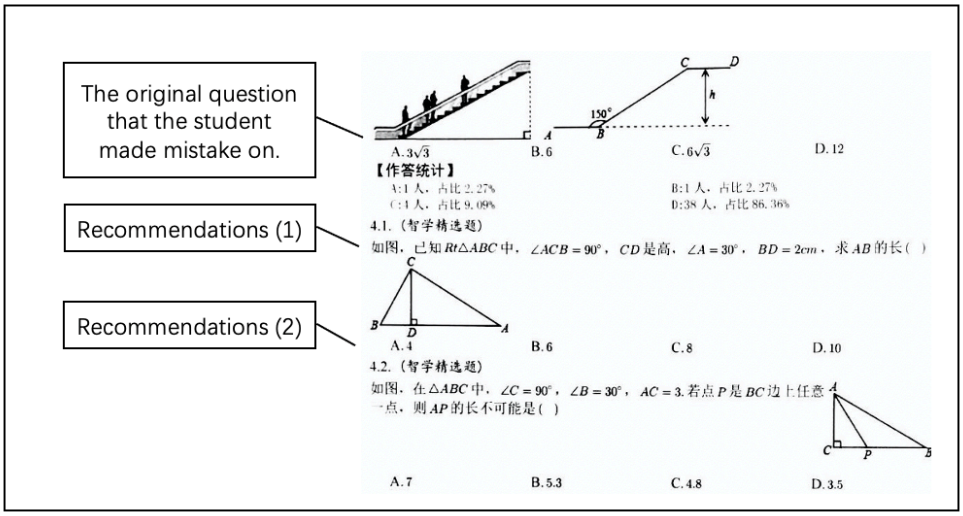


Figure 4.4 Student Personalized Workbook

Figure 4.4 shows a scanned copy of the math personalized workbook provided by Teacher A. The picture shows that the student failed to score on questions about triangles on the exam. Hence, the platform inferred that the student needed to reinforce the triangulation problem and finally recommended two questions. By completing the personalized workbook, the student can improve their academic achievement to a certain extent.

Besides, some platforms support personalized learning by providing reading material, micro-lessons, and other resources. It shows the possibility that such education platforms attempt to realize personalized learning by collecting a large amount of learning material through their question banks, generating analysis reports based on students' educational data, and finally providing recommended material.

2) Instructional Adjustment

The interviewed teacher from BYOD school pointed out that using the AI-based education platform in the classroom allows for timely confirmation of teacher's teaching, improving teaching quality and students' academic achievement. Suppose the teacher finds that the

majority of students are making too many mistakes in specific knowledge. In that case, she will combine the students' performance in the class and the practice data to determine if necessary to re-explain the section or make instructional adjustments in the next class. Simultaneously, these data are also provided as evidence for teachers to reflect on their teaching.

> If I found most students make mistakes in a particular question, maybe I didn't explain it enough, or students have not understood it clearly, so I would think about how to teach it well (teacher G).

> When I encounter this situation, I would think about whether I have neglected the basic concepts or whether I have not allowed all students, particularly the low achievement students, to keep up with the classroom (teacher F).

Feedback plays a vital role to assist regulating learning processes. When the teachers found most students have misunderstood the same content, they can consider whether instructional adjustments are needed based on the situation. In BYOD school, teachers can instantly get the students' answers by the tablet, so classroom feedback becomes more efficient and helps them learn about the lesson's effectiveness.

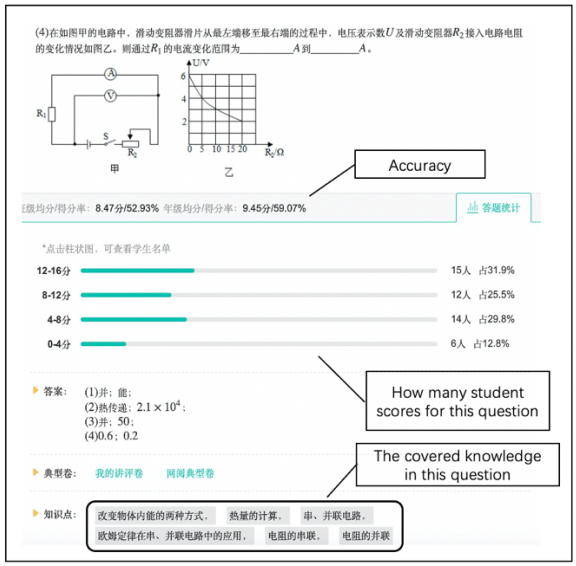


Figure 4.5 Analysis of a Physics Question

On the other hand, the interviewed teachers from non-BYOD schools also pointed out that AI-based education platform can provide direction for the next phase of their instruction. Specifically, these schools have a test at least once a month. After scanning the student's answer sheet to the AI-based education platform, the platform can auto mark and generate detailed learning reports for teachers. Figure 4.5 shows an analysis of a physics question in a particular examination. With the statistics and analysis of the platform, the teacher can see in the histogram that nearly half of the students were unable to score high on this question, and the accuracy of the class is lower than the entire grade. Besides, the graph's bottom shows the physics knowledge involved in this question, such as circuits and Ohm's law. Therefore, the teacher can consider how to teach better the content involving these parts or make instructional adjustments in the next phase of instruction.

> After a final exam, it (platform) gives me immediate results and all kinds of analytics to see the data at a glance and give targeted feedback to students (teacher F).

For each question, it (analysis reports) has a specific analysis, such as what the student should focus on. And then, I would help the student strengthen these parts as they needed (teacher C).

Teachers who have access to tablets in the classroom prefer the platform's interactive data to provide timely insight into their teaching. In contrast, teachers who do not have access to electronic devices in the classroom prefer the platform's analytics to identify their teaching problems.

Also, as the AI-based education platform can provide teachers with students' knowledge levels, teachers can use them to group students for collaborative learning or apply individualized quality education for students in different levels.

4.1.3 Educational Resources Sharing

1) Teaching Resources Integration

The AI-based education platform helps integrate teaching resources from all over the country, which is conducive to the sharing of educational resources among regions. Take the ZHIXUE platform that the teachers interviewed commonly used as an example. As schools in different regions of the country use the platform, teachers in these different areas can freely upload their questions, practices, or online courses and download the material for free. It breaks the problem of data isolation among schools or regions.

Students can practice on the platform. We don't have to look for additional material like reading or listening practices because it has many resources on it, even covering the areas that I may not know about (teacher F).

It collects many teaching resources from all over the country. For example, some test papers from essential schools in other

provinces can also be found on it, which is a very high-quality resource (teacher G).

For students, teachers pointed out that the platform will broaden their horizons by giving them access to more learning resources from different regions. For example, in language learning, students can access a wide range of up-to-date reading and listening material. For teachers, they can easily find learning material from critical institutions on the platform. Teachers from Hunan said that the high-quality teaching resources and excellent teaching and research teams in Beijing and Shanghai could provide more teaching resources for students in remote areas, promoting education equity.

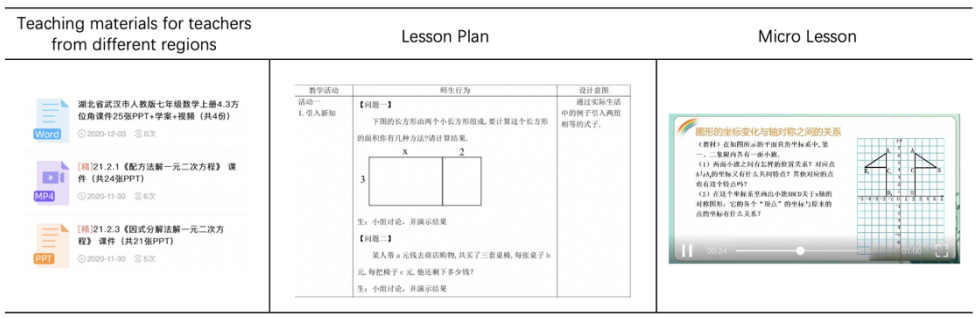


Figure 4.6 Different Material in Platform

I can upload and share my courseware on the platform. Other teachers can also use it if they need it (Teacher H).

Some interviewed teachers also mentioned that other AI-based education platforms provide teachers with the opportunity to share courseware. Figure 4.6 shows different materials in the platform, including lesson plan, micro lesson, and courseware. The AI-based education platform has a vast resources library that teachers can freely upload and download the resources. By integrating different types of material from different regions, the platform can provide different resources for teachers.

2) Creating Learning Opportunity

From teachers' perspective, the AI-based education platform, which integrates resources from all over the country, can provide teachers with references and new ideas for lesson planning and creating learning material and help stimulate teachers' capacity for innovation. It provides teachers with courses and teaching research results from other teachers and can also prepare lessons collaboratively across regions, providing teachers with an opportunity to learn from each other.

> Of course, I can also refer to other teachers' courseware or use it directly when I prepare lessons (teacher H).

> I can see how other teachers come up with the questions, prepare for the lesson, and explain the content. It helps update my knowledge base (teacher G).

> Sometimes, I also prefer to learn from other teachers if I had to generate an exam paper, particularly the experienced teachers (teacher C).

The platform provides opportunities for teachers to learn from each other. Teaching material for different scenarios, such as lesson planning and generating test papers, can be found on the platform. Teachers especially appreciate material from experienced teachers or schools.

From students' perspective, AI-based education platform having different material can provide students with additional learning support and improve their academic achievement. Therefore, AI-based education platforms can provide opportunities to learn from each other and learn in-depth.

4.1.4 Reducing Workload

1) Reduce Repetitive and Mechanical Work for Statistics

Interviewed teachers generally noted that the use of AI-based education platform could significantly reduce their workload. Because it can relieve teachers of repetitive and mechanical daily tasks, such as marking a large number of assignments and post-test statistical analysis and is more efficient than traditional manual methods of data entry and statistical analysis.

> It is more convenient than manual analysis as it can automatically mark papers and give systematic analysis reports after each exam (teacher G).

> After each test, the scores and pass rates need to be tallied, and it would take at least a few days to do this manually (teacher K).

> It's very detailed, even down to the school-wide score for each exam's subtopic (teacher N).

Automated assessment reduces teacher administrative work such as grading. It can provide instant results on student and class deficiencies. The platform's statistical analysis is more detailed, thus freeing teachers for other activities such as supporting struggling students.

2) Times-saving for Material Searching

The AI-based education platform used by the interviewed teachers is equipped with a question bank, the content of which is provided by the teaching and research team of the platform company or other schools teachers using the platform. Therefore, teachers can save much time in generating exercises by using the resources of the

platform.

> It generates exam papers much faster than me because I used to take dozens of reference books to find the appropriate contents. It has many topics for me to choose (teacher D).

> I wouldn't need to find him more additional material because my knowledge base is limited compared to the internet. The website indeed has more information than I can gather (teacher J).

Teachers may need to refer to other material when generating exercises and to prepare for class. As the platform integrates many other teacher users' materials, it can save teachers much time in searching.

3) Automark for Exam and Exercise

Teachers interviewed unanimously noted that automated assessment significantly reduced their workload. As shown in Table 3.3 in the previous chapter, the platform can reduce teacher workload by auto marking the objective problems, although subjective questions still need to be scored by the teacher.

> All we need to do is enter the answers in advance into the platform, and it can automatically mark more than 400 papers, even on the same day (teacher C).

> Because English exams have many objective questions, and we have to grade papers for the weekly quizzes and monthly tests, it saves me a lot from repetitive work (teacher F).

Automated marking allows many corrections to be made quickly, which improves teacher productivity and reduces the time it takes for students to wait for feedback.

4.2. Tensions of Using AI-based Education Platform

Based on the activity theory framework of Engeström (2001), this section analyzes the contradictions teachers encountered when using the AI-based education platform. A learning activity system based on the AI-based education platform was obtained through interviews with secondary school teachers, as shown in Figure 4.7. Teachers perceive that although AI-based education platforms can help provide cognitive diagnostics and personalized recommended paths for learners, there are also problems in their actual application. Thus, this section analyzes the conflicts between the AI-based education platform as a tool and other elements of the learning activity.

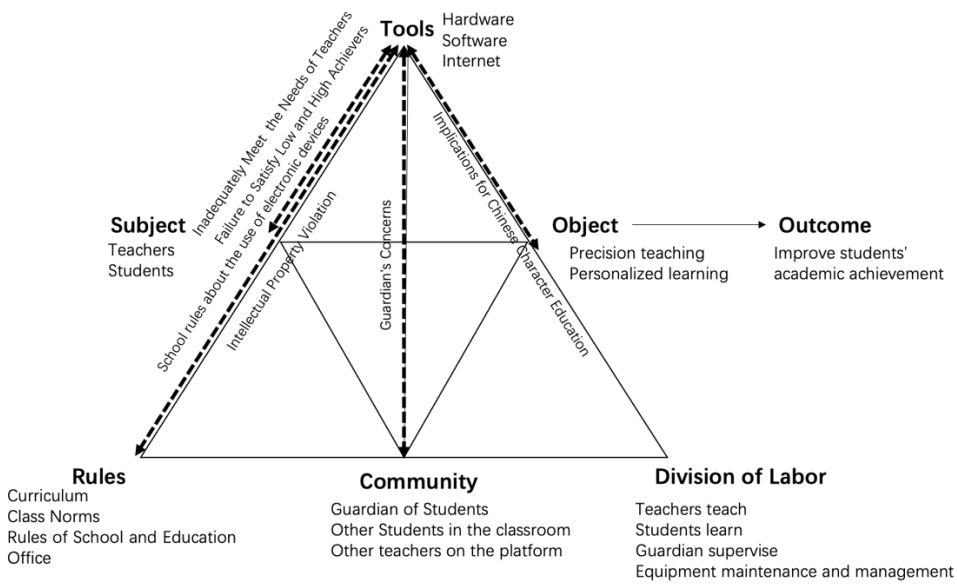


Figure 4.7 Activity Theory Model Adapted from Engeström (2001)

In the learning activity, the participating teachers perceive teachers and students as the subjects of the activity. Teachers use the AI-based education platform to reduce their workload, access students' educational data and other resources. In contrast, students use the platform to access extended learning material that matches their cognitive levels, so students' personalized learning and teachers' precision instruction are the activity objects. Ultimately, students and

teachers can achieve the outcome of this activity by using the platform to improve students' academic achievement.

Tools in this activity refer to hardware devices, the Internet, and AI-based education platform as software. As the AI-based education platform requires hardware devices, such as smartphones, iPads, and computers as technology carriers and the collection and analysis of educational data require the network as a transmission media, the tool elements include hardware, software, and the Internet.

Rules refer to the class norms and standards of the school and Education Office. Although all secondary schools in China are in the same curriculum standards, different versions of textbooks are used in different districts, leading to differences in content and instructional sequence. The resulting issues will be discussed as curriculum in the rules.

The community of the system refers to other students and teachers using the platform. Besides that, students' guardians are also included in the teaching community as they also play an essential role in applying AI-based education platform.

The division of labor includes teachers to teach, students to learn, guardian supervises, and equipment maintenance and management. In the activity system, teachers use the platform to obtain more detailed educational data to guide their instruction; students use the platform to reinforce their weaknesses, and guardians are responsible for supervising students' use of electronic devices. Also, the AI-based education platform, electronic equipment, and network environment require specialized maintenance personnel to manage.

4.2.1 Inadequately Meet the Needs of Teachers

The first tension is that the platform cannot meet teachers' needs (i.e., the tension between the tools and subject).

Under the same curriculum standard, different textbook versions are used in different regions of China. Different versions of textbooks lead to different teaching sequences and contents. The teachers

interviewed in this study came from three districts: Beijing, Hunan, and Guangdong. Beijing and Guangdong use the same version of the textbook, and the version they used is the most widely used in China; Hunan, on the other hand, uses the version with fewer users. Most of the question bank material is uploaded directly by the teachers, so the versions with the largest number of users and their associated resources will be more popular than other versions. It is because the proportion of teachers who also use these versions and resources will be relatively larger. For example, when the platform randomly recommends learning resources for Hunan students based on a particular chapter's content, it may recommend the content from Beijing to Hunan students without giving sufficient consideration to whether the recommended content is within the students' comprehension.

> Since most of the material on it is from the PED Edition and few are from our area, I can't fully trust what it recommends for my students (teacher D).

> There is often recommended content out of the teaching syllabus because of the versions (teacher A).

Since there is no proper classification technique to sort through the large amounts of material on the platform, teachers reported that these recommendations might not meet students' requirements in various districts. The issue of recommendations being out of the syllabus often arises. Teachers indicated that if the content outside of students' scope of the study, their confidence in learning may be affected by frustration.

> The student himself doesn't know whether the content is out of the syllabus or not. He only realizes that I can't do this question (teacher A).

> In last semester, 2 out of 5 questions were out of the syllabus in

the personalized workbook, and it is a bit serious (teacher C).

Teachers noted that it could be confusing for students as they cannot tell if the content is out of the syllabus or just really something they do not understand. This phenomenon was most evident among the teachers interviewed from Hunan. Compared with Beijing and Guangdong, the versions used in Hunan have fewer users, there is not much more content on the platform that meets the needs of teachers in Hunan. When teachers want to use the resources of AI-based education platforms to prepare for their lessons, it can be challenging to find the proper ones. Ultimately, the platforms still fail to support teachers from districts with different versions of the material.

4.2.2 Failure to Satisfy Low and High Achievers

The second tension is related to the platform's recommendations failure to meet different level students (i.e., the tension between the tools and subject).

Participating teachers generally pointed out that the personalized recommendations technology could not satisfy low and high achievers when using it. For high achievers, little additional material provided to high achievers, because the current limited cognitive diagnosis cannot diagnose their cognitive level without the test results.

> Even these students want to do more exercises to deepen their understanding. There are not many proper exercises available to them (teacher D).

> What they need is in addition to content for expansion, not consolidation exercises (teacher L).

The pattern of diagnosing students' weaknesses through their test result is not suitable for high achievers. Because these students make fewer mistakes on exams, the platform cannot diagnose their

weaknesses based on their test scores. Furthermore, the platform's recommendations tend to be reinforcement exercises. Even though the students have higher learning expectations, it cannot meet these students' demands, such as providing more challenging learning content.

> They generally have a good foundation and may just lack skills or have some weaknesses, so they were productive with the personalized workbook. (teacher D).

> They already understand basic concepts and practice more content that they are still deficient in is helpful. (teacher C).

For intermediate academic performance students, have a good mastery of basic concepts and can improve their academic performance by completing the same types of questions or other exercises on the same knowledge. Especially in platforms like ZHIXUE that recommend learning resources based on the students' incorrect answer record, there are many questions with moderate difficulty in the question bank.

> Students with a poor foundation do not even understand the basic concepts, so they are not suitable to do as many exercises (teacher N).

> They need to relearn the primary content. Otherwise, no practice will be useful because they don't have a good grasp of the basics (E).

For low achievers, they need to relearn the basic concepts but not do more reinforcement exercises. If low achievers are not addressed the fundamental cause and continually do reinforcement exercises, they will only enter a vicious cycle. AI-based education platform still struggles to reach a level where they can accurately diagnose the cause of students' mistakes. In other words, the current

recommendation mode is more suitable for students with intermediate academic achievement, and it is not suitable for high and low achievers. The recommendation effect is not entirely satisfactory. Also, lacking high-quality learning material in the question bank is also one reason for this result.

4.2.3 Intellectual Property Violation

The third tension was associated with lacking rules about teachers' intellectual property (i.e., the tension between the tools and rules).

AI educational platforms are generally equipped with a question bank to provide learning material for learners. Generally, the questions in such a question bank are provided by the platform's teaching and research team or directly uploaded by the user, teacher. However, interviewed teachers pointed out that out of concerns that others misuse their uploaded materials, teachers show no inclination to share online, resulting in unsatisfactory quality of recommended contents.

> I would consider the issue that if I upload some excellent teaching material to the platform, but other companies take advantage of the opportunity to make money from it, that's not what I'm trying to do (teacher D).

> I would worry about other teachers using the paper or courseware I've shared, but it doesn't work as expected. So I think it's better to save trouble (teacher C).

On the one hand, teachers are reluctant to upload their material on platforms because they concern that their ideas will be taken for profit by others. Some teachers do not prefer this sharing model due to teaching responsibility issues. There is a lack of clear regulations or standards to protect intellectual property rights and clarify teachers' responsibilities in using these AI-based education platforms.

Thus, the concerns about misusing the resources they provided lead teachers to be cautious about it.

Besides, teachers also expressed concern about whether the school had a negative attitude toward sharing resources on intelligent platforms, which led them to share resources rarely.

> There is also the question about sharing. In some cases, not only teachers but also schools have their consideration (teacher K).

On the other hand, teachers are also eager to access quality teaching resources from other teachers using the platform. However, such a resource library's learning material is of low quality and failure to meet teacher requirements. Therefore, this unequal relationship leads to a situation where it is difficult to improve the resource library's quality. Even AI-based education platform recommends students with personalized learning materials, and they can be affected by inadequate quality learning resources, making learning less effective than it should be.

4.2.4 Guardian's Concern

The fourth tension was associated with the guardian's concerns about using electronic devices (i.e., the tension between the tools and community).

The use of online AI-based education platform cannot separate from electronic devices and the Internet. Teachers pointed out that there are general concerns among parents about students' concentration and vision problems. Prolonged use of electronic devices would affect students' eyesight, and some students might addict to online games or other website-browsing with the excuse of online learning. Despite the potential value of AI-based education platforms combining EDM and AI technology helps improve students' academic achievement. Some parents consider that e-learning environments are seductive and AI-based education platforms are not

conducive to their children's learning.

> Parents generally have two main concerns: children use smartphones or iPad to play games and nearsightedness (teacher M).

> Some parents are concerned about the amount of time their child spends online (teacher A).

Therefore, teachers said that they would inform parents in advance if they needed students to complete learning tasks on the AI-based education platform, so parents can adequately guide students to use electronic devices and the Internet at home. However, the need for students' parental supervision using electronic devices leads to additional problems, such as parents being too busy to supervise and unavailability of electronic devices. It is not an issue that arises from learning activities. No more additional discussion is provided here.

4.2.5 School Rules about the Use of Electronic Devices

The fifth tension existed in school rules about using electronic devices (i.e., the tension between the tools and rule).

The AI-based education platform intends to seamlessly collect learners' educational data through students' interaction on the platform and then analyze them and provide personalized learning material by recommended paths. However, in China, K12 education is still mainly offline and does not allow students to use their electronic devices in schools. The data collection mainly relies on teachers uploading data after exams and assignments and lacks data on students' direct interaction with the platform and other learning behavior data.

> Since our school is a boarding school and students cannot bring their electronic devices, paper-based assignments are still the norm in class (teacher A).

Our school is quite strict in managing electronic devices, and most of the schools also have a ban on using smartphones (teacher K).

Data collection on these platforms currently relies on teachers uploading data after each exam or practice. The learner data collected by platforms is limited and only reflects the student's learning at a particular stage. Using this limited and discontinuous data to diagnose students and recommend learning paths is likely to lead to inaccurate and even erroneous diagnostic results. Thus, although a large amount of data collated from a data value perspective, it does not fully reflect its educational value because it was collected in a non-interactive way. Discontinuous and superficial data collection may lead to limited accuracy and low quality of the recommendation.

4.2.6 Implication for Chinese Character Education

The last tension was associated with the platform's influence on Chinese character education (i.e., the tension between the tools and object).

Chinese character education is an essential part of traditional Chinese education. In the background of the information society, electronic devices are popular in life. The age at which students are exposed to electronic devices is decreasing. In using the AI-based education platforms, students need to use keyboards, touch screens, and other typing means. The prolonged use of electronic devices can weaken students' ability to write Chinese characters.

As the entrance examination are paper-based exams, prolonged typing on the keyboard leads to miswriting in the formal exams. It is such a pity (teacher G).

Miswriting is deadly for language learning. Even if the students know the question's answer, they still can't score because of the

miswrite (teacher M).

AI-based education platform has a great potential value in education. However, the interviewed teachers mentioned that students are increasingly completing exercises through online platforms, affecting their ability to write Chinese characters. Particularly in Chinese K12 education, national standardized tests such as university entrance exams are still administered in a paper-based format. Teachers pointed out that prolonged use of electronic devices or learn on the AI-based education platform can lead to problems, such as the inability to write or miswrite words on formal exams. It was eventually resulting in situations that students fail to score even though they have mastered the knowledge.

4.3. Suggestion of Using AI-based Education Platform

4.3.1 Improving Rules of Using the AI-based Education Platform

1) Regulate the Time on Using Electronic Devices

In response to parents' common concerns about vision problems and addiction to the internet, teachers suggested that it could alleviate the problem by regulating the time to use electronic devices. China's Ministry of Education has developed guidance to address this issue. In 2018, China's Ministry of Education issued a plan to prevent severe vision problem among students:

> "The use of electronics for non-learning purposes, preferably no more than 15 minutes in a single session, or no more than 1 hour per day. In principle, the amount of time spent using electronic products for teaching purposes should not exceed 30% of the total teaching time."

Besides, teachers also mentioned that if students were required to use the platform to complete learning tasks, they would keep the completion time under 30 minutes.

> I would always tell the parents in advance on SNS how long the assignment would take to complete, and basically, it would only take the student 10 minutes to finish it (teacher A).

> During the COVID-19, students were only allowed to do the exercises online, and each exercise was limited in time, as well as fewer questions (teacher H).

> In-class assignments are only about five minutes (teacher G).

As for preventing students from becoming addicted to the Internet,

teachers noted that they rely heavily on parents. For example, they would notify parents in advance of how long the task would take. In addition to preventing students from vision problems, it is generally acceptable for parents to supervise their children for short periods.

> We had installed an application on students' tablets to prevent them from browsing non-study related web pages during class time (teacher G).

As for schools that have access to electronic devices in the classroom, teachers said they install the software in advance to prevent students from excessive web browsing.

4.3.2 Improving Rules of Protecting Teachers' Right

1) Develop Rules to Protect Teachers' Intellectual Property

Policy or regulation should develop to clarify the rights and responsibilities of teachers in using the platforms. When asked about the quality of the learning material in the resource library, most teachers agreed that the platform's current material was of low quality and lacked innovative content. The issue of the low quality of the resource library is related to the protection of teachers' intellectual property rights. As seen in the previous section, teachers have concerns about the misuse of their resources. At the same time, with the development of online education, there is much concern about protecting the rights of teachers in the online environment.

> I think the government can enact regulations to protect teachers' rights on these platforms, and it is important that how to prevent others from taking our ideas for profit (teacher E).

In addition to legislation regulating the misuse of teachers' ideas by others, some teachers also mentioned that the Ministry of Education

could raise the standard for these platforms to enter the education market.

> Some policies can be introduced to regulate the current education market, especially with the emergence of more and more of these platforms (teacher J).

> It is not easy to legislate in the education sector, but I think it could raise the standard for these platforms to enter the education market. There are too many education platforms now (teacher I).

In other words, in addition to legally protecting the rights of teachers, the rights of students and teachers can be protected by raising the standards of educational platforms to filter out risky ones.

2) Establish Incentive Mechanism

In addition to protecting teachers' rights from the perspective of legislation and regulation, most teachers suggested that platforms can establish incentive mechanisms to protect teachers' rights.

> I think it could recruit on-school teachers from all over the country to be part of their teaching and research team (teacher G).

> Alternatively, it can purchase to get the teacher's high-quality content. Some teachers may be able to get a small profit from their intellectual property, which will also stimulate teachers' originality (teacher D).

Interviewed teacher G said that she is one of the teaching and research team members of another platform. By uploading her high-quality resources to the platform, she can get free access to other material on the platform. Besides, the platform can also purchase material from teachers. In this way, it not only protects the rights and interests of teachers but also fundamentally improves the quality of

the platform's resource library.

> It can also try to work with schools, and for example, if they provide material to the platform, then the platform allows schools to use all the platform features for free (teacher H).

Another teacher mentioned that such a platform could strengthen the cooperation between the platform and schools by exchanging resources for access to the platform. The platform establishes incentives mechanism and partners with schools and teachers to improve their resource library quality and become more aware of teachers' requirements, ultimately better serve students and teachers.

4.3.3 Improving AI Technology

When asked about the confusion of resources on the platform, some teachers suggested that it be mitigated technically by importing suggested that it could be mitigated technically, such as by importing multi-label.[①] Different versions of the textbook can easily lead to confusion in the platform's teaching content. Multi-label learning allows for the systematic classification of large amounts of scattered content.

> The most effective way to introduce a topic is to label it with a multi-label. Tagging can also significantly increase the accuracy of searches (teacher K).

> Because many question banks have a single type of objective question, if it's a comprehensive subjective question, such recommend pattern may not work (teacher L).

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① Multi-label learning mainly focuses on the problem of multi-label text categorization (Zhang & Zhou, 2014). For example, to illustrate an instrument or emotion in a recording, it can be described from multiple perspectives, generating an appropriate set of tags to clearly express its semantic meaning (Tsoumakas & Katakis, 2007).

Teacher K is a teacher with a background in educational technology. He mentions that multi-label techniques can invoke to categorize the many resources in the platform. If the subject is tagged with as many tags as possible, teachers can be more accurate when conducting keyword searches. Likewise, the platform can recommend learning material to students more accurately based on these different tags. At the same time, introducing multi-label may play a useful role in subjective question analysis. Because subjective questions generally cover a wide range of knowledge, multi-label can help split the knowledge involved in the questions, which may be useful for learning analytics.

> One of the significant problems with these platforms is that they are still not accurate enough to sort out the reasons for students' error and self-analysis, and these problems still need a lot of tags (teacher K).

The teacher also mentioned that these platforms could apply multi-label techniques for analyzing the causes of the student making mistakes in the exam. Nevertheless, using such a technique to classify students' cognitive abilities requires spending a great deal of time doing self-analysis. For example, reflecting after the examination and analyzing the cause of the error requires students a great deal of time, so platform designers and developers can consider how to use existing data for modeling.

> The syllabus is changing, and if without a common disciplinary standard to govern the content, the question banks will be useless (teacher K).

Another approach to technology enhancement is to construct a knowledge graph of the discipline. Building a knowledge graph can also help in classifying a large number of resources on the platform. The teacher noted that although these platforms have their development models, it lacks standard discipline knowledge graph to classify the

whole subject systematically. As a result, each platform has a different classification of content for different disciplines, leading to confusion. Developers can work with education experts to design fixed discipline knowledge graphs, and collaboration among stakeholders can also solve the problem of over-exploitation.

4.3.4 Participatory Design

1) Co-design the AI Education Technology with Teachers

Teachers mentioned that the current platforms have little regard for teachers' needs. The development of AI education technology and related products that better meet teachers' practical needs can be facilitated by building partnerships between teachers, AI developers, and designers. As most commercial AI platforms' development may lack the participation of on-school teachers, the products developed cannot fully meet the practical needs of most teachers. For example, the platforms' learning analytics reports can be inconvenient for teachers because it contains too much detailed data.

> It is too much data for analysis reports. It would be more convenient if it could be converted into text form (teacher B).

> I cannot read all the data with that many students in the class, but it would be friendly if there were a more straightforward way to understand it (teacher I).

> Teachers noted that although the platform could generate detailed analytics reports, in reality, they had not even looked at the data in detail because it was complicated. They would only look at the class as a whole.

> It would be nice to have a feedback function when marking papers (M).

The grading mechanism is a little different from our school, but it would be nice to add custom service (teacher H).

Besides, teachers felt that these platforms could add custom service functions. Since not all schools use the same rubrics as the platform, adding a customer service function would allow teachers to be more flexible to use it. Also, teachers would like to add a feedback function to write feedback to specific students during the grading process. These design problems arise from the fact that the platform was not designed and developed with teachers' practical needs.

Chapter 5. Discussion and Conclusion

5.1. Discussion

The research purpose is to explore the Chinese secondary school teachers' perceptions of AI-based education platforms that combine learning science and AI technology in education. The reason for studying from teachers' perspective is that teachers, as users of AI educational technology, their attitudes and perceptions of the technology will influence new technologies in education (Meabon, 2014; Kim et al., 2020). Therefore, from the teachers' perspective, this study conducted in-depth interviews with 14 teachers to explore the impact of using the AI-based education platform on teaching and learning.

Firstly, from the results of the study, the teachers interviewed generally agreed that AI-based education platform could help them to reduce their workload from the administration, mechanical statistical tasks, and automatic marking, which is in line with the previous research (Zhu et al., 2017; UNESCO, 2019. 3; Kim et al., 2020). Other Chinese teachers also mentioned that the AIEd system could provide immediate feedback in large-scale teaching (Qin et al., 2020). In this research, the teachers interviewed also mentioned that AI-based education platforms could provide instant feedback for students to some extent, consistent with the previous research findings.

Second, it also found that AI educational technology contributes to personalized learning and precision teaching by providing instant feedback and targeted and systematic teaching support. The platform can provide various educational data for teachers and help them learn about the class's status. Park and Cho (2014) revealed that dashboards visualizing the collected student data based on learning analytics could provide effective teaching and learning support. In face-to-face instruction, instant feedback can provide teachers with evidence of instructional adjustments (Cho, Park & Kim, 2019; Han et al., 2020). It is consistent with the teachers' perceptions, as evidenced by the

content of their interviews and the materials they provided. Also, the automated assessments can quickly diagnose learners' conceptual levels (Beggrow et al., 2013) and provide formative assessments (Zhu, Liu & Lee, 2020), which also help teachers in their teaching. The teachers in this study mentioned that the learning materials shared on the AI-based education platform could provide learning opportunities for other teachers and students, distinct from the previous studies. Although teachers believe that AI technology can achieve personalized learning and precise teaching from these aspects, some problems also exist.

Concerning the practical use of the AI-based education platform, the results of the teachers' feedback revealed differences from those in the prior studies. Korean teachers in the previous studies were concerned that the AI-based education platform would cause a lack of interaction between teachers and students and that the AI would not interact emotionally with students as human teachers do (Kim et al., 2020; Shin, 2020). However, according to Chinese teachers' feedback, the interaction between teachers and students was rarely mentioned, which may be related to the development of technology and Chinese teachers' purpose using AI education systems. Despite the continuous development of AIEd technology, current AIEd systems still cannot and are unlikely to completely replace teachers' role in education (Roll & Wylie, 2016; Ma et al, 2014; Kim et al., 2019). The teachers were more inclined to use the AI-based education platform's data to make adjustments to their teaching.

Besides that, recommending learning resources in response to the students' test report's assessment was not practical for high and low achievers. In previous research, the Recommended Learner Path (RLP) model provided appropriate learning support based on learners' cognitive levels (Salehi et al., 2014; Liu et al., 2018). However, the recommendation model based on test result could not diagnose their higher cognition level through teachers' response because high achievers performed well on the test. Also, the recommendation model cannot address their problem for low achievers because it cannot further diagnose the reasons for students' errors, such as insufficient

basic knowledge or missing schemas (Roelle, Berthold & Fries, 2011). In the previous study, some teachers also proposed that AI-based education platforms had limitations in inducing learning motivation (Qin et al., 2020). It is more effective for students above the average than those with less basic academic proficiency (Choi, Park, Jeong & Eun, 2019; Steenbergen-Hu & Cooper, 2013). In this respect, the study's finding is also similar to the results in the previous study. The advice given by the teachers on this issue is to improve the technology, such as adding data tags or building a knowledge graph. In addition to this, the researcher argues from the perspective of educational technology, and the recommendation model should consider incorporating adaptive support and scaffolding for supporting learners learning. In an online learning environment, the instructor needs to provide appropriate assistance when they have difficulty performing the learning (Cho & Jonassen, 2002). In previous research, explanation scaffolding and cue scaffolding in the problem comprehension phase and the applying solution phase can be useful for low achievers (Jang, 2014). Kochmar et al. (2020) also verified that providing personalized hints and explanations improves student learning outcomes significantly. Therefore, introducing adaptive support and scaffolding from the existing RLP model may effectively solve the recommendation problem.

As for the AI-based education platform that cannot meet teachers' needs, to address this issue, teachers suggest that developers collaborate with in-service teachers to understand their actual teaching needs. In previous research, there are many cases of participatory design among educational stakeholders. In educational technology development, educational stakeholders from different fields collaborate to bridge the gap between educational theory and practice (Cho et al., 2019). Likewise, Luckin and Cukurova (2019) propose a framework for developing AI educational technology that allows educators to understand AI and AI developers to understand the teaching and learning process. Therefore, the researcher argues that teachers and AI technology developers can refer to these cases to develop appropriate collaborative solutions and develop AI educational

technologies that meet teachers' needs. In addition to educators and AI developers, the researcher argues that parent education can also be received to increase parents' understanding of new technologies in education. This study found that there are concerns among parents about their children's use of the platform. Teachers were ultimately unable to provide an effective solution to this problem. In previous research, Lee and Choi (2019) verified that parent education could improve parents' attitudes toward the new educational technology and make them know its benefits. Likewise, parent education can educate parents about AIEd technology's role and its impact on education, helping address their concerns. At the same time, parent engagement in children's learning significantly impacts children's academic achievement (Seo, 2014). Receiving parent education allows parents to understand their child's learning better.

The participating teachers believed that the platform affects students' Chinese character writing skills. The platforms do not consider the problems that resource confusion caused by the diversity of textbook versions. These issues are related to the Chinese social context and the specificity of Chinese education. It can be seen from the teachers' suggestions that developing a series of standards and norms to regulate the use of AI-based education platforms can provide the right policy environment for the development of AI education technology. Correspondingly, the continually evolving AI education technology needs to be constrained by updated education policies to prevent problems caused by applying new technologies in education effectively.

5.2. Conclusion

The purpose of this study is to explore Chinese secondary school teachers' perceptions of AI-based education platforms that integrate AI educational technologies into education. It also analyzes the problems induced by using the platform in teaching and learning activities within the activity theory framework. The teachers were then asked for their opinions and suggestions to effectively address these issues, promoting platforms incorporating AI educational technology in personalized learning and precision teaching. The aim is to contribute to the research on the introduction of AI technologies in education. This study dedicates to contributing to research on the introduction of AI technology in education.

Fourteen teachers were interviewed in this study using the in-depth interview method. After analyzing the qualitative data, it was found that using AI-based education platforms can contribute to personalized learning. It provides teachers with 1) instant feedback to help them formative assessment and diagnosis of students' cognitive levels; 2) targeted and systematic instructional support for teachers, which helps them practice precision teaching by providing students with personalized learning materials and generating analytical reports; 3) the automatic assessment features to reduce teachers' workload and provide students with immediate confirmation of their conceptual levels; and 4) equipped resource library provides teachers with additional resources. All of these benefits commonly mentioned by teachers are similar to previous research related to AI educational technology.

However, there are identifying some problems during the use of the platform. The existing recommendation model of recommending learning resources based on students' test or practice results does not apply to students with different academic achievements, exceptionally high and low achievers. Moreover, the lack of suitable classification technique of resources leads to confusion and, therefore, cannot meet teachers' needs. Also, teachers' intellectual property rights are violated due to the lack of clear regulations and norms. Parents are

also worried about such educational platforms. There is also a general perception among teachers that platform's use will affect students' Chinese character writing skills due to the social and cultural context of China and the specificity of Chinese education.

Based on these concerns, the teachers suggested that the issues could be addressed by improving the rules of using the education platform and improving the technology. Also, teachers believe that participatory design will enable AI educational technology products to meet teachers' actual needs better. By improving the rules and refining the technology, the tension between the different teaching and learning activity elements can be resolved, ultimately favoring the application of AI educational technology in education.

This study was conducted with secondary school teachers in China and explored the use of AI-based education platform. This study's findings may not be the same as those in other countries due to the particular socio-cultural context and the specificity of education. Therefore, a study exploring AI-based education platforms in other countries is necessary as a follow-up research task.

Finally, this qualitative study conducted in-depth interviews with 14 teachers who used the AI-based education platform, and there are also some limitations in the study. Firstly, as this study used online interviews with teachers, it was impossible to visit the site to observe how teachers were using the AI-based education platform in their work. Therefore, no additional observational data could obtain. Teachers provided screenshots of the platform's interface and picture data such as students' personalized workbook as the supplementary data. Secondly, because the sample for this study included only one teacher from a BYOD school, it was challenging to explore in-depth teachers' perceptions of using an AI-based education platform in class. Moreover, the discussed educational platform is based on student performance to recommend learning materials. Thus, the findings of this study only apply to educational platforms that use the same model. Despite these limitations, it is possible to identify the positive role that AI technology can play in teaching and learning. Also, to understand the problems that may arise in its use and inform research that

attempts to introduce an educational platform that combines AI technology and learning analytics in teaching and learning. In future research, the researcher hopes to visit teaching sites to observe how teachers and students use these AI-based education platforms and can interview students to understand the impact AI-based education platforms have on teaching and learning.

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Appendix 1

Interview Outline about Teachers' Perception on Intelligent Education System

In recent years, with the rapid development of AI technology in China, more and more intelligent products have been applied to the education. These products are supported by a large amount of educational data in order to provide direction for teachers' precision teaching and students' personalized learning.

The purpose of this study is to explore about secondary school teachers' perception on Artificial Intelligence in Education (AIEd) tools and systems applying in education, as well as teachers' concerns and suggestion about applying it. The following questions are used as an interview outline, and the actual interview will be conducted in-depth interview based on your answers, hoping you can answer the questions based on your teaching experience.

Sincerely appreciating your precious time and effort for this study!

1. Personal basic information

Gender	Teaching Experience (Years)	Teaching Subject	Area

*We promise your personal information will be kept confidential.

2.Interview Questions

In this study, Artificial Intelligence in Education (AIEd) refers to AI tools or systems applying for educational purpose. The interview questions are as follow:

1) What kinds of intelligent education system or tools have you used?
   1-1) How often do you use it？
   1-2) What purpose promotes you to apply it?
   1-3) Are there any differences in using the platform among you and

your colleagues?

2) What do you think the change and advantages of using these products in education?

3) What difficulties or inconveniences have you encountered in the process of using intelligent education platform?

3-1) What do you think are the reasons for these problems?

3-2) What other problems do you think it may be caused?

3-3) Have you received training about using the intelligent education platform ? (eg. strategies about dealing with ethical issues, excessive competition or other problems)

4) How do you resolve or alleviate the difficulties? / What methods do you think can be used to prevent these problems from occurring?

5) Can you recommend other teachers who has used the intelligent education platform around you ?

6) Can you provide some material about the platform?

(eg. screenshot, pictures, documents or others)

Appendix 2

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Advantages of using AI-based education platform	Instant Feedback	Formative assessment	If he gets it (in-class testing) wrong the first time, it's probably because of his careless or he didn't know about it. But if he gets it wrong again, it just means he hasn't mastered it yet.	I
			There are some questions where the student chooses the wrong answer without even thinking about it. In this case, you can see that he was choosing randomly and assumed the student might participate in a low learning status.	G
		Instant cognitive diagnosis	It can correct the assignments immediately, give results, and generating reports immediately, so students can also know their shortcomings without having to wait few days for manual correction.	G

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Advantages of using AI-based education platform			After the student finishes the exercise and clicks submit, it automatically scores the student and provides an approximate analysis of how well he completed the exercise.	D
	Targeted and Systematic Teaching Support	Personalized learning resources	It will accumulate the questions that students have done wrong, which can help students generate a personalized workbook. Students can practice and reinforce their deficiencies.	G
			Because the recommendations are based on the questions they had wrong on the test, I think it helps them by practicing many similar type questions.	C
		Instructional adjustment	After a final exam, it (platform) gives me immediate results and all kinds of analytics to see the data at a glance and give targeted feedback to students.	F

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Advantages of using AI-based education platform			If I found most students make mistakes in a certain question, maybe I didn't explain it enough, or students have not understood it clearly, so I would think about how to teach it well.	G
			For each question, it (analysis reports) has a specific analysis, such as what the student should focus on more. And then, I would help the student to strengthen these parts as they needed.	C
	Educational Resources Sharing	Teaching resource integration	It has a part of the exam paper uploaded to the platform directly from many provinces and cities after the exams, and these parts of the resource are very high quality.	G
			I wouldn't need to find students more additional material because my knowledge base is limited comparing with the internet, and the website certainly has more information than you can gather.	J

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Advantages of using AI-based education platform		Creating learning opportunity	I can see how other teachers come up with the questions and how they prepare for the lesson and how they explain the content. It helps update my knowledge base.	G
			Sometimes, I also prefer to learn from other teachers, incredibly experienced teachers, if I had to generate an exam paper.	C
	Reducing Workload	Reducing repetitive and mechanical work for statistics	Apart from the automatic marking, it's also very convenient to analyze the test results, so I don't have to calculate the marks and pass rates and so on; it just exports the data for me.	D
			After each test, the scores and pass rates need to be tallied, and it would take at least a few days to do this manually before.	K

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Advantages of using AI-based education platform		Times-saving for materials searching	It would take the burden off us to come up with questions well, we wouldn't have to think about the topics as often by ourselves, or we would have to refine each exam topics. We can just use the questions on it, so it's less of a burden for us.	D
			It's all about convenience, i.e., it's easy to generate papers, it's easy to correct, and it's also easy to analyze students' overall performance after they've taken the test.	G
			Students can practice on the platform, and we don't have to look for additional material like reading or listening practices because it has a lot of resources on it, even covering the areas that I may not know about.	F
		Automark for exam and exercise	I mainly use it to correct exam papers, which is convenient for our teachers, and then after automated correction, a systematic analysis is generated.	D

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
			We usually use it mainly to correct papers, i.e., after each month's examination, we would correct it on mobile or computer. Then we can get a systematic analysis report, which is more convenient than the human to analyze.	A
			All we need to do is enter the answers in advance into the platform, and it can automatically mark more than 400 papers even in one day.	C
Tensions in using AI-based education platform	Inadequately Meet the Needs of Teachers	No rational classification of learning resources	Since most of the material on it is from the PED Edition and few are from our area, I can't fully trust what it recommends for my students.	D
			One of the disadvantages is that the personalized workbook often contains questions that are out of the teaching syllabus, and the materials are confused. It may be because the textbook versions used in our school differs from place to place.	A

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Tensions in using AI-based education platform	Failure to Satisfy Low and High Achievers	Limited recommendation model	The personal workbook is generated based on the questions that students made mistakes in their exam, so the questions are similar with their wrong questions. For intermediate level students, more practice is available; for high score students, they need to expand their thinking, so such type of practice is not suitable for them; for students with poorer foundation, they need to enhance their basic concept about the knowledge, so this recommendation is also not suitable for them.	D
		Poorly pertinence	Students with a poor foundation do not even understand the basic concepts, so they are not suitable to do as many exercises.	N
	Intellectual Property Violation	Misappropriation of labor	To be honest, the platform's questions are not of high quality because high-quality questions that teachers thought by themselves are involved in intellectual property rights. So, generally speaking, many teachers would not like to upload their high-quality questions.	D

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Tensions in using AI-based education platform		The willingness of teachers and schools	There is also the question about sharing, in some c ases, not only teachers but also schools have their consideration.	K
	Guardian's Concern	Internet addiction	Some parents are concerned about the amount of time their child spends online.	A
		Nearsightedness	Parents generally concern that children use the smartphone or iPad to play games and nearsightedness.	M
	School Rules about the Use of Electronic Devices	Non-BYOD	Because we are a residential school and students cannot have mobile phones in school, the problem is that they can only see their marks and reports when they go home.	D

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Tensions in using AI-based education platform		Restriction of using electronic devices	Our school is quite strict in managing electronic devices, and most of the schools also have a ban on cell phones.	K
	Implication for Chinese Character Education	Decline in students' hand-writing skills	Miswriting is deadly for language learning; even if you know the question, you still can't score because of the miswrite.	M
			As the entrance examination are paper-based exams, prolonged typing on the keyboard leads to a situation that miswriting in the formal exams; it is such a pity.	G
Suggestion of using AI-based education platform	Improving Rules of Using the AI-based Education Platform	Monitoring the online-learning environment	We had installed an application on students' tablets to prevent them from browsing non-study related web pages during class time.	G

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Suggestion of using AI-based education platform		Limited using time	If students were only allowed to do the exercises online, I would limit the time for it, such as finish it within 10 minutes and assign fewer questions.	H
	Improving Rules of Protecting Teacher's Right	Regulation	I think the government can enact regulations to protect the teachers' rights on these platforms, and it is important to prevent others from taking our ideas for profit.	E
		Reward mechanism	Suppose someone else takes our paper or exercise to makes a profit, that's definitelv an infringement of intellectual property rights, so I think the platform could collect the teacher's questions as a purchase way.	D
			It can try to work with schools. For example, if they provide high-quality material to the platform, then the platform allows schools to use all the platform features for free.	H

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Suggestion of using AI-based education platform			I think it could recruit on-school teachers from all over the country to be part of their teaching and research team.	G
	Improving AI Technology	Introducing multi-label technology	I think the most effective way to introduce a topic is to label it with a multi-label. Tagging can also greatly increase the accuracy when searching the keywords.	K
		Further analyzing the causes of students' mistake	One of the significant problems with these platforms is that they are still not accurate enough to sort out the reasons for students' mistakes or self-analysis, and these problems still need a lot of tags.	K
	Participatory Design	Not simple enough in data display	The current platform design is too much data for analysis reports; it would be more convenient if it could be converted into text form.	B

Coding results and category development of interview content

	Themes	Subcategories	Examples from Interview Contents	Teacher
Suggestion of using AI-based education platform			I can't read all the data with that many students in the class, so it would be friendly if there were a more straightforward way to understand it.	I
		Out of touch with the needs of teachers	It would be nice to have a feedback function when marking papers.	M
			The grading mechanism is a little different from schools; it would be nice to add more custom service.	H

국문초록

최근 교육 분야에서 인공지능(AI)의 도입이 큰 관심을 끌고 있다. 특히 AI 기술과 학습 분석이 결합한 인공지능 기반 교육 플랫폼은 지금껏 실현되기 어려웠던 맞춤형 학습(personalized learning)과 적응적 학습(adaptive learning)에 도움이 될 수 있도록 발전하고 있다. 인공지능 기반 교육 플랫폼(AI-based education platform)은 학습자의 행동 추적 등을 통해 이들의 특성을 분석하고 진단을 제공한 뒤 분석 결과를 토대로 학습자에게 인지 수준에 맞는 맞춤형 학습자원과 피드백을 제공한다. 인공지능 기반 교육 플랫폼은 교사와 학생에게 실시간 학습 데이터와 분석 결과, 그리고 피드백을 제공할 수 있어 인공지능 기반 교육 플랫폼이 맞춤형 학습에 긍정적인 의미가 있다는 선행 연구도 있었다. 그럼에도 불구하고, 기존 연구는 모델 개발의 차원에서나 엄밀한 실험실 환경에서 인공지능 기반 교육 플랫폼의 효과를 연구해왔으며, 인공지능 기반 교육 플랫폼에 대한 교사의 인식과 관련된 연구는 드물었다. 교사는 인공지능 교육 기술의 사용자이기 때문에 인공지능 교육 기술의 교육 도입에 있어 교사들의 인식과 의견은 중요하다.

본 연구는 인공지능 기반 교육 플랫폼을 활용하는 것에 대한 교사들의 인식을 탐구하였다. 아래 연구 문제를 다루기 위해 질적 연구를 시행하였다. 첫째, 중국 교사들은 인공지능 기반 교육 플랫폼이 중학교 교육에 활용 있어 어떠한 장점이 있다고 인식하는가? 둘째, 중국 교사들은 인공지능 기반 교육 플랫폼과 중학교 교수 활동 요소 간 어떠한 모순이 있다고 인식하는가? 셋째, 중국 교사들은 인공지능 기반 교육 플랫폼을 중학교 교육에 도입할 때 무엇이 필요하다고 인식하는가? 본 연구는 중국 교사들을 연구대상으로 온라인 심층 면담을 하였다. 문헌 리뷰를 통해 면담 질문지를 설계하되 눈덩이표집법 (snowball sampling)을 통해 중국 중학교 교사 14명을 연구참여자로 선정하였다. 선정된 교사들은 모두 인공지능 기반 교육 플랫폼 사용 경험이 있으며 각 교사를 대상으로 약 1시간 정도 면담을 진행하고 녹음하였다. 면담이 끝난 후 녹음 내용을 전사하였으며, 주제분석을 사용하여 면담 내용을 초기 코드 생성하고 면담 자료 속에서 주제를 도출하였다. 특히 연구 문제 2번의 경우, 인공지능 기반 교육 플랫폼 활용과 교수 학습활동 내 여러 요소 간의 모순을 분석하기 위해 활동이론을 연구의 틀로

이용하였다. 최종적으로 연구문제 1에 대한 주제 4개, 연구문제 2에 대한 주제 6개, 연구문제 3에 대한 주제 4개를 도출하였다.

연구 결과로 교사들은 인공지능 기반 교육 플랫폼의 장점에 대해 즉각적인 피드백 제공, 교수학습 지원, 교사의 업무량 감소 등으로 인식하였고, 인공지능 기반 교육 플랫폼이 다양한 교수학습 자원을 통합할 수 있다고 인식하였다. 아울러 교사들은 인공지능 기반 교육 플랫폼의 사용에 있어 기존의 교수학습 활동과 상충된 부분이 있다는 점을 인식하였다. 교사들은 기존 인공지능 기반 교육 플랫폼의 추천 모델이 차별화된 학생들에게 잘 적용되지 못한다는 것을 인식하였다. 그리고 기존 인공지능 기반 교육 플랫폼이 다양한 학습 자원을 잘 분류되지 못하기 때문에 교사들이 사용하기 불편하다. 인공지능 기반 교육 플랫폼을 이용할 때 교사의 지적재산권을 보호하기 위한 명확한 규제가 부족하다고 인식하였다. 이와 함께 학부모들은 인공지능 기반 교육 플랫폼을 사용함으로써 발생할 수 있는 학습자의 인터넷 남용과 시력 저하 문제를 우려하였다. 또 중국의 사회문화적 배경과 교육 특성으로 인해 인공지능 기반 교육 플랫폼을 활용하는 데 학생들의 글씨 쓰기 능력에 영향을 미칠 수 있으며, 학교 내 전자기기 사용 제한도 데이터 수집의 지속성과 효율성에 영향을 미칠 수 있다고 인식하였다. 교사들은 위의 문제들이 인공지능 교육 플랫폼 사용에 대한 규칙 마련과 인공지능 기술을 개선함으로써 완화될 수 있다고 인식하였다. 또한 교사의 실제 요구에 맞게 개발될 수 있도록 인공지능 기반 교육 플랫폼 개발 과정에 교육 전문가와 교사가 참여할 필요가 있다.

본 연구는 중국 교사들이 인공지능 기반 교육 플랫폼에 대한 인식을 탐색하였으며, 인공지능 기반 교육 플랫폼이 교수학습에서의 장점과 문제점을 밝혔다. 아울러 본 연구는 인공지능 기반 교육 플랫폼이 교육 분야에 대규모로 도입될 수 있도록 규칙, 인공지능 기술, 그리고 교육 공학의 차원에서 사용 규범과 기술 개선을 제안하였다. 본 연구를 통해 탐색한 내용이 향후 교육 분야의 인공지능 기반 교육 플랫폼 도입에 활용된다면 인공지능 교육 기술에 관한 연구의 발전에도 기여할 수 있을 것으로 기대된다.

주요어: 인공지능 기반 교육 플랫폼, 활동이론, 인공지능교육, 교사인식
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