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Challenges and Solutions in Integrating AI for Personalized Learning in Early Childhood Education

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Abstract. This study examines how artificial intelligence is used in early childhood education through interviews with four teachers in China and the United States. It highlights five issues: limited teacher training, structural constraints, uneven use of personalized learning, developmental mismatch, and mixed teacher attitudes. These issues are shaped by both classroom practice and institutional context. Teachers play a key role in how these tools are used. In practice, they are more effective when they support teacher judgment and fit the interactive and experience-based nature of early learning.

Keywords: early childhood education, artificial intelligence, personalized learning, cross-cultural comparison, developmentally appropriate practice

1. Introduction

Recently, artificial intelligence is becoming more common in education. People usually link it with automation, personalized learning, and data usage. Secondary schools and universities have seen some good outcomes [1,2]. But in early childhood education, it's still pretty new.

Young kids learn in various ways. They depend more on play, interaction, and hands-on activities. They don't learn well with set up or separate things to do. So we have to teach following the child's development and interest. Personalization is important in both China and America. But people understand it differently. In China, people tend to "teach based on individual aptitude". In the US, teachers tend to use UDL (Universal Design for Learning). It brings up an important question. Can today's tech actually make this kind of child-centered learning possible?

Most current tools aren't made with young kids in mind. Many systems assume that kids can work by themselves. And they need a lot of attention and screen-based understanding. They don't fit how young children grow up [3]. In actual classrooms, this sort of content tends to feel inflexible. It doesn't show the interactive and relational part of early learning. Also at the same time, teachers get different training. Institutional support also differs. So the usage of such tools is inconsistent from one place to another.

Some studies show that they can help with adaptive learning, learning multiple languages, and analyzing data [4,5]. But most of it is about bigger kids. And there's hardly anything out there about how teachers are using them in early childhood classrooms. Even fewer studies examine the role of culture and institutional context in this process [6]. It is particularly important for countries such as

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China and the USA. They have different curriculums, teacher training and policies. Not considering these contexts makes it difficult to assess the true worth of these tools.

This research investigates teachers' experiences in China and the US. It centers on early childhood and lower elementary classrooms. Teachers' experiences reveal a distinct gap. One side has algorithm-based systems, the other side has learning practices based on play, storytelling, interaction, and relationship. These two sides don't often match up. According to the interviews in this study, it shows both the possibilities and the boundaries of these technologies for early learning.

In early childhood classrooms, these tools are not just about the tech. The main thing is how we can make use of them according to kids' growth and what goes on in the classroom. And it depends on where you live. Teachers have found that better tools might be storytelling kind of things, playing around with toys, and being able to speak different languages, rather than just having to do certain tasks.

In general, one thing is certain. They can only be used if they fit into the daily teaching. Without training, support and clear boundaries, they may seem advanced but are hard to use.

2. Literature review

2.1. AI in education and early childhood context

Artificial Intelligence is becoming more important for education. Lots of people think it's a means to change the way teaching happens. It can help automate some tasks, support personalized learning, and help teachers use data to make decisions [1]. Secondary schools and higher education have been using these tools differently. They could adapt the learning material according to the student's performance, make grading simpler, and boost student participation [2,4]. Systems such as DreamBox and MATHia can change instruction immediately depending on learning data, whereas platforms such as IBM Watson can aid with academic research and writing. And these examples also indicate that such tools work well in a more structured learning environment [7].

In early childhood education, it's not so easy. This stage covers children from birth until the early primary years. At this stage learning is mainly through play, interaction and hands-on exploring rather than formal teaching [3]. Some tools have been used, including phonics programs, early literacy games, and teacher-focused assessment systems. But there are still not many tools that can be integrated into everyday classroom activities and align with young children's development.

Problems usually show up in just a few places. Some tools don't fit with how teaching works in real classrooms. Many teachers haven't had enough training. Some technologies can also be hard to use. If we want those tools to work better, there might need to be some changes in research and policy as well. They should be more like what really happens in classrooms, not just fancy designs.

2.2. AI applications in personalized learning

2.2.1. Adaptive learning systems

Adaptive learning systems are becoming an integral part of AI-based personalization in education. They use learner interaction data to change content and help each person move at their own speed [2]. Such systems work best with math and reading lessons because those skills move forward in steps that can be measured. DreamBox and MATHia, for instance, give out different tasks that react to how well a student does on something right away, which helps keep them interested and learn by themselves.

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But these organized ways don't work well for young kids who love asking questions, making things up, and working together with others. Young children mostly learn by exploring and playing around with other people, but most adaptive platforms are still giving them information in a straight line and having them look at screens [3]. Programs such as KIBO robotics try to make it more adaptable for children but still need a lot of help from grown-ups. There's a shortage of adaptive systems made for how early learning flows and relates, which shows a hole in what we know and create [1].

2.2.2. Intelligent Tutoring Systems (ITS)

Intelligent Tutoring Systems (ITS) mostly provide immediate feedback during learning. They show obvious advantages in the field of STEM, particularly for older kids [7]. But it doesn't work so well in early childhood education. Many of these systems are still using a set question and answer form that doesn't match how teachers teach in early learning, which is more flexible and centered around the child. In the early classroom, children learn by imitating others, interacting with their peers, and listening to stories. These processes are difficult for present technologies to identify or comprehend. Conversational AI and chatbots can help with early literacy to some degree. But they usually can't notice kids' faces, bodies, or feelings. And these cues are important for engaging and comprehending [8].

2.2.3. Automated assessment and feedback

AI based evaluation instruments could lessen teachers' work burden and provide swift feedback on pupils' improvement. Automated grading and data tools have been used by many secondary schools already. They let teachers have more time for teaching that goes into more depth [4]. But when it comes to early childhood education, things get complicated. Not just about academic skills. Also includes creativity, social and emotional development, and physical growth. These places are still difficult for algorithms to catch. Some systems attempt to record observations and follow development over time. But they frequently overlook the minute and sensitive details necessary for comprehending children's total development [7].

2.3. Challenges in AI integration for personalized learning

2.3.1. Pedagogical challenges

One of the major problems when using AI in early childhood education is that these systems don't match how young kids learn. Many tools are task-focused and structure-focused. But young children learn by playing and interacting. These tools work good for repeating things and keeping track of numbers. But they have trouble with feeling sorry for someone, answering quickly, and giving backtalk, those are needed for teachers talking to kids [8,3]. So, learning might end up focusing too much on getting results instead of exploring. In order to make these tools more appropriate, it has to change its focus. Rather than automating things, they need to help facilitate play, inquiry, and social-emotional growth.

2.3.2. Teacher preparedness and AI literacy

Teacher readiness is another important thing. Many early childhood teachers have little training about AI and educational technology. Most pre-service programs are still focused on traditional

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teaching, and they don't often make connections between technology and early learning [9]. Teachers do not know how to use or assess these tools without the right training and help. Also research indicates that even the best systems will fail if teachers are unsure or unclear about what they want to teach [6].

2.3.3. Technical and infrastructure constraints

And the use of such technologies for early childhood education also relies on certain basic conditions. Stable Internet, new devices, and tech support are necessary. But some places, particularly rural or poorly funded ones, don't have all those things [6]. And many apps are pretty complicated too. Teachers who don't know much about computers might have trouble using them. Some researches also show that it could make inequality worse by giving more money to schools that already have lots of it [7].

2.4. Research gaps and future directions

Although there has been an increase in research on AI in education, some important aspects of early childhood education are still not fully understood. Especially, we know very little about its effect on children's growth and teaching methods. And there are hardly any tools that support play-based and inquiry-based learning, which means teachers don't have many options [3]. Long term studies are still uncommon, particularly those involving creativity, cooperation and emotion. Teacher training is neglected and how to integrate AI into teacher education is practically challenging [9].

And another question would be if these tools will work everywhere. A lot of research focuses on better-off schools and gives less attention to those with fewer resources. Future work might examine cheaper options and think about how rules could make it easier for people all over the place and from different backgrounds to use them [10]. Looking at different systems, say China and the US, may also show us how culture and institutions affect the use of these technologies.

2.5. Implications for AI integration in ECE

Using such technologies in personalized learning for early childhood education has great possibilities, but there are many problems too. They have to match how kids grow and learn through playing for them to do their best. Teachers need better skills and help, and simple things need to be ready in all places. If we ignore these problems, those tools could make the differences between people bigger instead of making learning better. Moving forward, research and policies need to work together more. Designing tools that fit real classrooms, supporting teachers with continuous training, and examining long-term results are included. Then these technologies can be integrated into daily teaching and promote more equal and personalized learning.

3. The role of teachers in the integration of AI for personalized ECE

In this part, we will shift our attention towards the teachers' point of view and how these tools are used in practice. It takes advantage of interviews with 4 teachers from China and America to investigate how AI is perceived and utilized in early childhood classrooms. From the results, we can see that these tools are hard to use. A lot of teachers don't get enough training, so they're not sure how to use them when they teach. At the same time, inflexible curricula, assessment requirements, and restricted instructional time make it difficult to support personalized learning. Teachers acknowledge the promise of such tools, especially their ability to cater to various learning

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requirements. But many of them don't fit how little kids learn, because they play, talk to each other, and feel things instead of doing tasks. So, teachers are interested and worried at the same time. They stress the requirement for instruments that are more appropriate for classroom usage, have more defined limits, and match the ideas behind early childhood education.

3.1. Theme 1: teacher AI literacy and training gaps, the foundation left unbuilt

Personalized learning in early childhood education works well when teachers can use those tools to help kids grow and learn in their classrooms. Teachers from both China and America have an interest in AI, but they are unable to make use of it due to a lack of training and instruction. According to earlier studies, these tools' effects are more related to teachers' preparedness for using them than to the technology itself [1].

The interview data indicate that many teachers do not have either the technical skills or the teaching methods. Take for example, Teacher J who pointed out that her district brought in quite a few AI platforms without offering any kind of training with them. Teacher D in China also wanted to follow up on students' progress but didn't know how to make sense of or act on the information. These examples show that AI literacy is about more than just knowing how to use technology; it's also about making good choices about how to teach and understanding the world around us. When they are restricted, teachers often use these tools in simple ways, such as translating or doing basic drills, instead of using them for personal learning.

A few teachers said they used AI-generated data to change how they taught or answer students' needs. Teacher B, for example, used ChatGPT to make lessons more interesting, but didn't link the content to students' development level or language ability. It shows that this is a general problem: when there's no way to transform data into teaching methods, these tools are not fully utilized. So the difference between what could be done and what actually gets done is more about how experienced teachers are and how much they trust themselves with the tech, rather than anything wrong with the tech itself [1].

There's no AI-related training in teacher education making it even harder. Many teachers consider these tools to be optional rather than essential to their teaching. And it's even more so for those working with multilingual learners or students with additional needs, who frequently doubt its importance. Without training based on actual classroom practice, these tools might be considered an added burden instead of assistance.

Developmental factors make it more complicated in early childhood classrooms. Teacher Q explained that young kids had trouble doing AI phonics things even though the computer said they did wrong things right. She still had to go back and teach it in person. It shows a difference between what was designed for the system and how young children learn. Personalization at this point consists of emotions, peers, and motivation, not just grades. Teachers will fall back on old methods without being able to adapt their tools to such requirements.

In general, using AI well for early learning needs more than just having digital tools. It needs continuous teacher preparation, hands-on training, and ongoing professional growth that covers both technical and teaching sides. Without it, these tools might make existing inequalities worse instead of better.

3.2. Theme 2: curricular and structural constraints, innovation within the boundaries

When people try to use AI for personalizing learning in early childhood classrooms, they often run into problems caused by the system instead of the teachers themselves. Teachers may know a little

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about AI, but they still teach according to a set schedule, policies, and school expectations that prefer being the same all the time. These conditions make it difficult to adapt teaching to the needs of the students.

Interviews from China and the US show a similar trend. AI tools are generally expected to go along with the current curriculum rather than altering it. A first grade teacher from the US said that she has to stick to the same order, even if the AI data shows that some kids aren't ready yet. In this case, the tool gave good info, but couldn't change what went on in class. The same thing happened in China. A math teacher said she had to stick to her textbooks and exam schedules, even though AI reports showed that some of her students needed extra help. She said there was no time to stop for each student. In both cases, the teaching is based on the progress of the group, not on the differences between individuals.

This problem is related to the understanding of early learning. AI systems tend to concentrate on personal development and definite results. In contrast, early childhood education places emphasis on interaction, play, and shared experiences. The two methods don't go hand in hand all the time. Open ended play or emotional interaction activities are difficult to measure and there aren't many current systems that support them. One preschool teacher from Xiamen stated this plainly. She used AI for her lessons but not when teaching in class. She thought they were too focused on tasks and interrupted play. Instead, she observed and interacted with the children to teach.

Also there are some practical limitations. One teacher said that with 25 kids in a class, it's tough to plan different activities for everyone. Classroom teaching requires handling time, routines, and group interactions. These conditions make it hard to have total personalization in real life.

These findings show that using AI is more than just having tools or teacher skills. It is also affected by schools and classrooms. As prior research has shown [6], new tech tends to get employed in ways that align with current practices instead of altering them. And some limitations have to be set at the same time. Storytelling and playing together as a group are important for little kids. If AI replaces them with individual tasks, it could make people less able to interact with each other and feel emotions. Teachers are careful when they use AI because they care about how students learn these things [11].

In short, AI in early childhood classroom should suit teaching practice rather than just technical design. Teachers have a part in choosing how those tools are used. Without changing the structure of the curriculum and giving teachers more freedom to teach, AI will not make much of an impact.

3.3. Theme 3: the promise of AI for personalized learning, potential unlocked but unstable

Personalized learning has been regarded as one of the main promises of AI in early childhood education, yet it is actually applied unequally and based on classroom conditions. Teachers from both China and the US agree that such tools can change the content and monitor the students' progress. But in reality, this potential is not achieved. There's usually a difference between what these tools are meant to do and how they get used for teaching.

One example is a teacher from the US. Teacher B used ChatGPT to make her lessons more interesting, but she didn't link the material to what her students were developmentally ready for, how well they could understand it, or things they liked. No teaching method was established so the tool became something extra rather than a means of supporting learning. It indicates that technical capability doesn't necessarily imply good usage.

Teachers in China had similar experiences, but they were also more restricted structurally. Teacher D recognized the worth of employing AI to create follow-up questions, yet she was still bound by set lesson plans and curriculum pacing. It made it hard to change how I taught based on

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what the students needed. Without flexibility and teacher autonomy, the potential of these tools is limited [6]. Some teachers thought some of these tools were good for certain situations. For example, Teacher J utilized ChatGPT to make texts simpler and translate them into other languages for her multilingual students, so they could understand the classroom material better. At the same time, she stressed that such tools could not take the place of the trust and interaction required for true learning. This shows that AI should help teachers, not replace them [4].

Personalized learning in early childhood settings relies not just on adaptive systems, but how those systems work with what's happening in classrooms. AI should mirror students' language, culture, and social-emotional growth. Teachers also need help connecting these tools to their everyday teaching. Without it, AI stays out of actual classrooms.

In the end, it's teachers' choices and the classroom that shape personalization, not just technology. When these tools are used with purpose and teacher support, they can help guide learning and promote equity. When they are not, they tend to be shallow and ineffective.

3.4. Theme 4: developmental mismatches, when innovation overruns readiness

AI tools are frequently promoted as supporting personalized learning, but many don't match up with how young kids really learn. Personalization in early childhood education is not just about changing the level of difficulty. Emotional support, social interaction, and engaging activities are involved too. Both teachers from China and the US said that the majority of the existing systems do not represent learning by playing and interacting.

Teacher B from the US provided a good example. She employed phonics apps and adaptive literacy tools that tracked reactions and supplied hints. But lots of kids didn't have the motor skills, attention, or understanding to make use of them. As she pointed out, the system could spot mistakes, but the kid didn't know what to do about it. It indicates a difference between what the system recognizes and what children require at that moment [1]. Without teachers' help, these tools might make students confused rather than assist them.

Similar problems occurred in China. Teacher Q, who teaches three- to four-year-olds, stated that some tools had visuals and sounds but did not allow for hands-on play or group interaction. Young children frequently learn via imagination and shared activities. Repetition or simple reward focused tools might restrict rather than encourage exploration. Teachers also noted that lots of systems were too set in stone. The tasks usually follow a certain order, and there isn't much room for choices or changes. This doesn't fit with the idea of personalized learning, which needs to be flexible and pay attention to what kids like. As the prior research states [4], good systems have to take into account how people learn differently and the culture they're in. Without this, personalization is limited.

And then there's the feedback. Young children need feedback that is clear, immediate, and supportive. A lot of systems just give simple answers like "try again", which might be difficult for kids to get. Feedback is unclear, so children can become upset rather than remain engaged. Even if useful information exists, teachers are unable to make use of it. Fixed schedules, assessments, and classroom routines do not allow for adjustments to be made to the teaching. Teachers from both contexts mentioned that these conditions restrict the application of AI in reality [6]. Therefore, the data generated by such tools is seldom utilized to its fullest extent. These problems show that AI in early childhood education needs a new way. Instead of just focusing on correcting or measuring, they should help with playing, interacting, and exploring. They should also match how kids learn and how teachers teach.

In the end, personalization comes from teachers' judgments and classroom contexts, not just from technology. AI can help with this process, but it can't take its place. Tools that don't fit kids' needs

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might make learning into easy jobs rather than helping them think creatively and grow.

3.5. Theme 5: hope and concern, the double-edged future of AI in ECE

Teachers from China and the US had different opinions about AI in early childhood education. They saw it as having potential, but were also careful. Most teachers didn't say no to these tools, but they wondered if they worked well with what happens in classrooms and how kids need things.

Some teachers saw some good things. They thought that AI could make their work less busy, help kids who speak many languages learn better, and assist them in changing how they teach. For instance, Teacher J utilized ChatGPT to translate materials and aid with grammar learning. In this situation, AI made it simpler for students to get to the content. And it helped the teacher react faster to different learning needs. This shows that such tools can support teaching if they are applied in a particular and practical way [7]. Teachers were also concerned at the same time. A second-grade math teacher in China named Teacher D used AI to create questions and check answers, but she did not use it as part of her teaching. She was afraid it might lessen students' chances to think and talk about ideas. This represents a frequent worry that such tools might draw attention away from more profound learning [1].

Teachers also pointed out some issues about how students used them. Teacher J gave examples of students handing in AI-generated work without knowing what it was. She had to have individual talks with them to see how much they learned. It made more work instead of less. And it also shows that these tools could bring up new challenges for using them in class [6]. Some teachers felt pressured to use AI even if they weren't ready. Lack of training, unclear objectives, and poor connection to the curriculum. In such cases, AI became something to "use," rather than something that genuinely supported teaching. This implies that having tools does not suffice. Teachers, schools, and policymakers all need to have a common understanding of how these tools should be used [11].

In general, teachers were willing to try AI, but they were cautious about how they used it. They stressed that teaching in early childhood settings is based on relationships, interactions, and trust. These things can't be replaced with tech. To them, using AI well means teachers have to do it. Teachers should be involved in making and using these tools. Their experiences in classrooms can help improve such systems. AI will probably be helpful if it suits actual teaching circumstances and helps instead of replacing teachers' roles.

4. Conclusion

This study indicates that the application of AI in early childhood education is not so much about the technology itself, but rather how teachers apply it in their daily work. It has to match with kids' growth, what goes on in the classroom, and where they come from culturally. AI-based personalization is not merely a technical function; it is formed by teachers' choices and daily teaching.

Teachers from both China and the US have been interviewed, revealing several common problems. A lot of teachers don't get enough training and aren't sure how to use them. Curriculum structure and school needs also restrict the extent of change they can make to teaching. And some of the tools just don't work for little kids because they learn differently and need to interact and feel things. The teachers also had mixed feelings. They recognized the advantages of AI, yet they were worried about how it would affect relationships and their own roles in the classroom.

These results indicate that enhancing AI applications in early education calls for assistance on many fronts. Teacher education should contain fundamental AI knowledge and its relationship with

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teaching practice. Schools have to provide teachers with time to figure out how to use those tools in their lessons. Tool design also has to take into account what happens in classrooms, which includes playing around and different cultures. In the future, we could see how teachers make changes to these tools when they use them, and if it makes a difference for kids over time. Also comparing different education systems would be beneficial to see how context influences AI usage.

In short, AI can help with teaching in early childhood settings but cannot take its place. It's worth depending on whether it matches up nicely with what goes on in a classroom and helps out teachers at their jobs.

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