

# *AI Tutor: Solution for China's Disadvantaged and Under-resourced Children*

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**Abstract:** This academic paper delves into the pressing issue of educational disparities in China, particularly focusing on the challenges faced by disadvantaged and under-resourced children, including both migrant and left-behind children. The paper underscores the socioeconomic and geographical complexities that exacerbate these disparities, emphasizing the need for innovative solutions. It then introduces the transformative potential of AI tutors, leveraging recent advancements in large language models (LLMs), to bridge the educational gap. The study highlights the significant impact of migration on children's access to education, with rural-to-urban migration patterns creating hurdles for migrant children to secure enrollment in urban schools. Additionally, it sheds light on the plight of left-behind children, who face emotional challenges and limited educational resources in rural settings. The paper introduces AI tutors, particularly ChatGPT-based Khanmigo, as innovative solutions that can offer personalized educational support, generate educational materials, assist teachers, and even evaluate student work. It discusses the advantages of these AI tutors, such as cost-effectiveness and accessibility, and their potential to democratize education. However, the paper also acknowledges the limitations of AI tutors, particularly in areas requiring creativity, critical thinking, and emotional intelligence. It raises concerns about exacerbating educational inequality if high-quality human educators become exclusive to the privileged, leaving disadvantaged children reliant on AI-based solutions.

**Keywords:** AIEd, China, Migrant children, Left-behind children, Socioeconomic divide

## 1. INTRODUCTION

In the global pursuit of equitable education, the challenges and disparities faced by different societies often reflect their unique circumstances and demographics. Educational inequality is not a uniform issue; rather, it takes on various forms depending on a nation's socioeconomic landscape, governance structures, and geographical complexities. This paper embarks on a comprehensive exploration of the intricacies surrounding educational disparities, with a specific focus on China, a nation with 44 million children living in deprived rural areas spanning over 3.705 million square miles. Understanding these disparities is crucial not only for addressing immediate educational gaps but also for harnessing the potential of transformative technologies, particularly Generative AI models, in the pursuit of educational equity.

At the heart of this inquiry lies a central question: How can Generative AI models, such as ChatGPT-based Khanmigo, be leveraged to bridge the educational gap, particularly in China, where

disparities exist between urban and rural regions, affecting both migrant and left-behind children? This paper seeks to investigate the multifaceted nature of educational disparities in China and to explore the potential of AI tutors as innovative solutions to this persistent challenge.

While the focus of this paper is primarily on China's educational disparities, it also draws upon international perspectives to provide a broader context for the discussion. It delves into the complexities faced by migrant and left-behind children in China, shedding light on their unique challenges within the larger framework of educational inequality. Additionally, the paper explores the potential of AI tutors, their advantages, limitations, and the critical role of supportive infrastructure in realizing their potential, offering a comprehensive view of the subject matter.

Imagine a vast nation, stretching across diverse landscapes, from bustling metropolises to remote rural villages, encompassing a population of over 1.4 billion people. Within this dynamic tapestry lies the story of educational disparities, where millions of children, both migrant and left behind, grapple with unequal access to quality education. It is a narrative punctuated by the allure of urban opportunities and the scarcity of rural resources, where the future of these young minds hangs in the balance. As we delve into the pages of this paper, we will uncover not only the challenges they face but also the promise of transformative AI technology in leveling the educational playing field.

To navigate the complexities of this investigation, the paper will unfold in a structured manner. We will first delve into the specific challenges faced by migrant and left-behind children in China, exploring the socioeconomic and cultural factors that contribute to their educational disparities. Following this, we will introduce the potential of AI tutors, particularly ChatGPT-based Khanmigo, as innovative solutions to address these disparities. We will discuss their roles in offering personalized educational support, generating content, assisting teachers, and evaluating student work. Additionally, we will examine the advantages and limitations of these AI tutors and underscore the importance of a supportive educational infrastructure. Lastly, we will reflect on the broader implications and potential challenges of integrating AI-driven education in the pursuit of equitable learning experiences.

## **2. THE MIGRANT AND THE LEFT-BEHIND**

Amidst China's rapid economic growth, stark economic contrasts between various regions have fueled a large-scale internal migration since the early 1990s. According to research by Chan et al., in China, the definition of migrants is closely linked to the hukou system, which governs migration. Officially, only individuals with hukou status are recognized as migrants and are entitled to the same social benefits and privileges as local residents [1]. Other types of relocations are categorized as population movements or the "floating population," indicating a temporary move to a place where one is not expected to permanently reside. The majority of China's migrants are rural laborers, individuals with rural hukou who lack local hukou status in their destination. They leave rural areas due to the limited employment opportunities in agricultural regions. The rural migrant labor force has grown from around 50-60 million in the early 1990s to over 100 million in the early 2000s, with the most recent estimate reaching approximately 150 million. These rural migrant workers are primarily unskilled or have low skills and are commonly employed in manufacturing and construction sectors.

Researchers further indicate that the primary driver for rural migrants to relocate is the substantial wage gap between urban and rural sectors, as well as among different regions in China. They seek improved job prospects and higher earnings in urban settings. Migration trends in China indicate a significant increase in interprovincial migration since the early 1990s, primarily propelled by wage disparities between economically underdeveloped provinces and those with thriving industrial centers. Long-distance migrants tend to concentrate in Guangdong, the heart of China's manufacturing industry, and the Shanghai region.

Their children confront two potential fates: becoming migrant children or left-behind children.

Zhang et al.'s research revealed the situation of migrant children [2]. Based on findings from the RUMiC (Rural Urban Migration in China) survey, conducted among rural-urban migrants in China, it was identified that in 2010, there existed a minimum of 20 million children from rural backgrounds residing in urban areas. Nonetheless, the presence of these migrant children in urban settings does not guarantee their seamless admission into urban schools.

Firstly, migrant children often confront formidable hurdles when attempting to secure enrollment in urban public schools, owing to local institutional regulations and administrative obstacles. They frequently find themselves obligated to produce an array of documents, such as temporary residence permits, evidence of housing purchase or rental, and proof of their parents' employment status. Meeting these requirements can be especially onerous for migrant families, particularly if they are engaged in precarious or seasonal employment. Consequently, many migrant children are unable to fulfill these bureaucratic prerequisites, leading to their exclusion from urban schools. Even when migrant children do succeed in enrolling in urban schools, they may still be subjected to segregation and limited access to school resources. In certain instances, they are segregated into distinct classes or experience reduced opportunities for extracurricular activities compared to their urban peers. This segregation and discrimination contribute to the perpetuation of disparities in education between urban and rural areas. Financial constraints pose an additional barrier to accessing urban schools.

To tackle these issues, the Chinese government has implemented policies to ensure compulsory education for migrant children. In 2012, the Ministry of Education established a target in the Twelfth Five-Year Plan for Educational Development, aiming to enroll more than 85% of migrant children in urban public schools. This initiative aims to protect their equal educational opportunities and promote fairness in education. However, according to Ma, a conflict arises between central education improvement policies and local hukou-based regulations, which maintain social hierarchies and differing rights [3]. As a result, many migrant children end up attending substandard, unlicensed private schools with insufficient resources and teachers. Even if they manage to receive basic education in cities, entry restrictions limit their access to higher education, leading to lower enrollment and academic performance compared to their urban counterparts. Additionally, challenges in cultural integration contribute to marginalization and discrimination, exacerbating adaptation difficulties. These disparities in education perpetuate the cycle of poverty, hindering the ability of migrant children to break free from poverty through education.

Approximately two-thirds of the children impacted by population migration are those who remain in rural areas. In China, the count of "Left-behind children" (LBCs) has surged in the past decade, surpassing 69.7 million youngsters in 2019. To provide context, the total child population in the United States is approximately 74 million.

Among the 69.7 million Left-Behind Children (LBCs), various factors contribute to their situation, with gender playing a significant role. In a 2019 survey conducted by Fudan University researcher Tong et al., encompassing 117,573 children under 18 years old, the demographic data revealed that 53.3% of the participants were boys, while 46.7% were girls [4]. Although lacking statistical analysis, this breakdown implies a potential imbalance, suggesting a higher representation of boys among LBCs compared to girls. This connection can be attributed to two key factors:

1. Cultural norms and expectations in rural China may have led to boys being left behind more frequently. Traditionally, boys might have been seen as better suited for agricultural labor or the care of elderly family members who remained in their hometowns.

2. Leaving boys behind could have served as a means for migrant parents to preserve their family lineage, particularly through their sons, within agricultural communities.

With the wide coverage of internet connection and lack of parental guidance, depression has been spotted as a typical syndrome in LBCs. In a 2012 survey by Cyberpsychology researcher Guo et al., it was discovered that depression is more common among left-behind children (LBC) in China, with

a prevalence of 14.3%, compared to 10.9% in non-left-behind rural children [5]. Similarly, internet addiction rates are slightly higher among LBCs at 3.2%, compared to 3.7% among their non-left-behind peers. The study also investigated the link between depression and internet addiction in LBCs, finding a significant correlation. Depression was notably more prevalent in the group addicted to the internet (37.8%) compared to the non-addicted group (13.6%) within the LBC population.

Several factors contribute to these elevated rates of depression and internet addiction among LBCs in China. Firstly, the absence of parental care and supervision due to parents working in urban areas can result in feelings of loneliness, isolation, and a lack of emotional support, which may foster depression. Secondly, the internet can serve as a coping mechanism for LBCs facing daily challenges, offering a means to connect with others, access information, and engage in activities that temporarily alleviate sadness or boredom. However, excessive internet use can lead to addiction, worsening depressive symptoms. Furthermore, the study suggests that being an LBC and having internet addiction interact to increase the risk of depression. LBCs, already vulnerable due to parental separation, may be more inclined to use the internet as an emotional coping strategy, creating a cycle where internet addiction reinforces feelings of depression.

In rural China, left-behind children (LBCs) encounter numerous obstacles that significantly impact their education. Chief among these challenges is the absence of parental guidance and support, leaving these young individuals without essential direction in their academic pursuits. Research conducted in rural China by Hu et al. in 2014 has revealed troubling outcomes for left-behind girls, including increased unhappiness, thoughts of self-harm, and contemplation of leaving home, highlighting the detrimental effects of limited parental involvement on LBCs' emotional well-being, which, in turn, diminishes their motivation and ability to focus on their studies[6]. Compounding this issue is the restricted access to educational resources prevalent in rural China. A nationwide study has confirmed that LBCs in these regions grapple with the hurdles posed by their low socioeconomic status and a lack of educational facilities. This scarcity of resources obstructs their academic progress and limits their future prospects, as quality education remains elusive, impeding their acquisition of vital knowledge and skills. Additionally, the low socioeconomic status of LBCs' families in rural areas exacerbates their situation, as financial constraints often hinder their access to supplementary educational support, such as tutoring or extracurricular activities. Research on rural LBCs in China has indicated that parental migration for work further compounds economic hardships for these children, creating additional barriers to their educational development. Communication also presents a significant challenge for LBCs, who may struggle to maintain contact with their parents working in urban areas. This limited communication hampers emotional support and guidance, making it difficult for LBCs to effectively navigate academic and personal challenges. A study focusing on LBCs in rural China indicated that the estrangement from their migrant parents profoundly affected children's sense of loneliness in their parent's absence. Moreover, LBCs often lack extracurricular opportunities due to the combination of limited resources and parental support. Extracurricular activities play a vital role in holistic development, fostering social skills, creativity, and overall well-being. Research in rural China has revealed that a significant portion of LBCs prefer staying at school, where they can interact with peers, underscoring their desire for more avenues for social engagement and participation in extracurricular pursuits.

These challenges emphasize the immediate need for targeted interventions and support systems tailored to address the unique needs of LBCs, ultimately enhancing their educational outcomes.

### **3. AI TUTORING IN RURAL SETTINGS**

However, groundbreaking advancement in large language models (LLMs) by the end of 2022 has offered a glimmer of hope in addressing the issue of uneven distribution of educational resources, despite encountering bottlenecks over the years.

Established in 2015, OpenAI initially focused on advancing friendly AI, quickly becoming a prominent AI research lab, similar to DeepMind within Alphabet. However, in 2019, OpenAI shifted from a nonprofit to a for-profit entity, raising concerns about its commitment to democratizing and keeping AI accessible. In 2020, OpenAI introduced GPT-3, a revolutionary language model celebrated for its ability to generate coherent and comprehensive responses across various knowledge areas. This marked the first instance of a powerful chatbot available to the public through a free web interface. On November 30, 2022, OpenAI launched ChatGPT, its latest AI chatbot, which gained widespread popularity, attracting one million users in just five days. Building on the GPT-3 foundation and enhanced through supervised and reinforcement learning, ChatGPT excels at engaging in human-like conversations and providing detailed responses to user queries [7].

According to Jeon et al., ChatGPT distinguishes itself from earlier chatbot technology in several key ways. Firstly, it draws its power from a vast language model that has undergone extensive training on internet text data. This enables ChatGPT to produce a broader spectrum of responses that closely resemble human language, setting it apart from previous chatbots that often relied on predefined scripts or had limited data sources. Secondly, ChatGPT possesses the capacity to recall prior user statements within a conversation, comprehend subsequent corrections, and decline inappropriate requests. These capabilities empower ChatGPT to engage in more natural and contextually relevant dialogues, mirroring human-to-human interactions. Lastly, ChatGPT excels in maintaining potentially limitless conversational turns within goal-oriented discussions on specific topics. This means it can facilitate extended and meaningful exchanges with users, overcoming a limitation that plagued earlier chatbot technology [8].

The explosive popularity of ChatGPT marked the first instance where the general public truly experienced the impact of artificial intelligence on education. New York City public schools banned using the AI tool ChatGPT due to concerns about cheating and then removed the ban [9]. University professors caught students submitting essays entirely written by ChatGPT [10]. Numerous American educational institutions have adopted advanced artificial intelligence technology, which includes tools for analyzing and detecting plagiarism. While the media has primarily focused on the negatives of generative AI in the education domain, few headlines have been about opportunities for disadvantaged children, especially the migrant and the left-behind ones in China.

Some are saying humans are at the “Oppenheimer moment”, while the optimists say we are at the “iPhone moment” - “We are at the cusp of using AI for the biggest positive transformation that education has ever seen.” said Sal Khan. Recent research by Jaeho Jeon and Seongyong Lee suggests that ChatGPT has versatile applications within the realm of education [11]. Firstly, it can function as an interactive partner for conversation practice, enabling students to engage in role-plays and language games, thereby offering valuable language learning experiences. Secondly, it serves as a valuable content generator, capable of producing a variety of educational materials such as dialogue scripts, short stories, and sample sentences, which can be tailored by educators to meet their instructional needs. Thirdly, ChatGPT operates as a teaching assistant, aiding teachers in tasks like answering students' queries, explaining concepts, and providing additional illustrative examples, thereby enhancing teaching effectiveness. Lastly, it can also evaluate students' written work by offering initial grading and feedback, as well as generating testing materials like multiple-choice questions or gap-filling exercises to assist in assessing student progress. These multifaceted roles underscore ChatGPT's potential to enrich language learning, augment educational resources, and support teachers. Nevertheless, it is crucial to emphasize that these roles should be integrated alongside teachers' pedagogical expertise to ensure their effective utilization in educational contexts. One example of this is Khanmigo, an AI tutor built on Open AI's GPT-4 model [12]. Khanmigo, the AI tutor in question, represents a groundbreaking development in education technology. Built upon an LLM foundation, this innovative tool offers personalized academic support to students across

diverse subjects like math, English, and computer science. It does not stop at aiding comprehension and answering questions. Instead, it emulates a genuine teacher, providing guidance, prompts, and recommendations to foster active participation in writing, debating, and collaborative tasks. Operating through a Socratic method, this platform not only sparks critical thinking but also promotes dialogue, self-analysis, and creative thinking, ushering students into new realms of interaction and ideation.

In China's rural settings, the strengths of this educational paradigm are multifaceted. At the base level, key infrastructures make this model possible: Large Language Models (LLMs), reliable network connectivity, and proficient electronic devices. In response to the ban of OpenAI's products in China due to Internet restrictions [13], Chinese companies have entered the competition to develop LLMs, with Baidu pioneering ChatGPT-Ernie's rival [14]. Other notable models, such as Alibaba's Tongyi Qianwen and iFlyTech's Spark, have also gained prominence. China's extensive 5G coverage, with over 2.937 million deployed base stations by June, ensures connectivity in rural areas, according to MIIT chief engineer Zhao Zhiguo [15]. Additionally, a crucial aspect of the education infrastructure includes Informatization Classes equipped with individual student laptops and SEWO smart whiteboards for each class [16].

Personalization lies at its core, tailoring learning paths and methodologies to suit each student's inclinations, progress, and aptitudes. One innovative AI strategy, known as PL2 (Personalized Learning 2), combines human mentoring and AI tutoring to tailor educational experiences for students, particularly those from underserved backgrounds, through after-school initiatives. According to China, in this approach, undergraduate mentors undergo training to provide personalized guidance and resources to students based on their specific requirements [17]. Simultaneously, AI tutoring, powered by computer software, offers tailored content and feedback. The underlying principle here is that unequal educational opportunities contribute to achievement gaps, which PL2 aims to bridge by merging the motivational support from human mentors with the adaptive capabilities of AI tutoring, all aimed at enhancing student learning outcomes. One significant advantage of PL2 is its potential to reduce the costs of personalized tutoring while improving learning outcomes. By utilizing undergraduate mentors, the approach minimizes the need for highly skilled and costly teachers, making it a cost-effective solution. Furthermore, AI tutoring offers affordable personalized learning that is accessible to students at any time. Additionally, PL2 takes a holistic approach, addressing not just academic needs but also social and motivational development. Human mentors play a critical role in providing essential social and motivational support, building relationships, fostering a growth mindset, and emphasizing the value of STEM (Science, Technology, Engineering, and Mathematics) education. This comprehensive strategy significantly enhances student engagement and motivation, both of which are key factors in achieving academic success.

To validate its efficacy in addressing educational disparities, PL2 relies on rigorous data analysis. A joint research effort by Carnegie Mellon University and the University of Pittsburgh in 2022 assessed the impact of PL2 through the Ready to Learn (RtL) program, comparing students who received the intervention to a carefully matched control group [13]. They employed standardized math assessments (NWEA Measures of Academic Progress) conducted a year apart as a metric for student progress. The findings demonstrated a significant enhancement in math achievement for the treatment group benefiting from PL2, with an average gain of 6.8 points, compared to the control group's 3.6 points. Interestingly, there were no discernible variations in reading achievement between the two groups, indicating that PL2's positive influence was specifically geared toward math learning and not affected by general improvement or selection bias. Emphasizing math achievement is paramount, as it forms the cornerstone of future academic and career success. Additionally, the data analysis unveiled a remarkable impact on marginalized students, particularly those from Black backgrounds. These students experienced substantial growth in math achievement. This is especially

noteworthy considering the persistent racial and economic learning gaps that have plagued our education system, with PL2 offering promise in narrowing these disparities. Lastly, PL2's cost-effectiveness, achieved through undergraduate mentors and affordable computer-based tutoring software, renders it a viable choice for broader implementation. This scalability holds the potential to reach more marginalized students, further mitigating educational inequalities. This financial feasibility, combined with their accessibility, highlights the potential of AI tutors to democratize education and cater to diverse learners.

#### 4. POTENTIAL CHALLENGES

Despite all the benefits AI tutoring brings, further discretion should be taken into account before massive spread among China's disadvantaged and under-resourced children.

At this stage, AI teaching systems based on large language models do have a degree of competence of a real human teacher, however, in terms of some core qualities, such as creativity, critical thinking, and mathematical abilities, AI is still a long way from a high-quality human teacher. According to Mills et al., AI's shortcomings in creativity and critical thinking are evident, especially in creative writing [18]. For instance, AI-generated stories or poems may lack depth, emotional resonance, or unique perspectives found in human-authored works. This limitation stems from AI's reliance on patterns and training data, which restricts its capacity to create genuinely innovative content. Their reliance on predefined algorithms and patterns can hinder their critical thinking and adaptability when confronted with new scenarios demanding creative problem-solving skills. AI systems also lack emotional intelligence, a vital quality in educational settings where empathy and understanding play pivotal roles. For instance, AI systems may struggle to interpret non-verbal cues like facial expressions or body language, which are crucial indicators of emotions. This limitation restricts their ability to provide personalized emotional support and guidance to students. A study conducted by researchers at the University of Washington explored students' emotional responses while interacting with an AI tutor [19]. The findings revealed that students felt less understood and supported when engaging with the AI tutor compared to human tutors. The AI tutor lacked the capacity to empathize, adapt to students' emotional states, and provide suitable emotional support.

The existing disparity in the quality of tutoring between artificial intelligence and human educators has the potential to exacerbate educational inequality among urban and rural children. Despite its original intent to reduce the educational resource gap between rural and urban areas, there is a risk that the outcome may be contrary if the aforementioned limitations are not addressed. In such a scenario wherein high-quality human educators cater exclusively to the affluent while disadvantaged individuals are limited to AI-based tutors, essential cognitive proficiencies such as critical thinking and creativity could evolve into privileges primarily accessible to the privileged, thereby intensifying the preexisting disparities in education.

#### 5. CONCLUSIONS

In conclusion, the advancements in Large Language Models (LLMs) represent a watershed moment in the field of education, akin to the "iPhone moment" of technological transformation. These developments have the potential to revolutionize the allocation of educational resources, particularly in addressing the stark disparities that exist in present-day China, marked by socioeconomic, geographic, and demographic gaps. The transformative power of Artificial Intelligence (AI) promises to bridge these divides by connecting migrant and left-behind children with a world of educational opportunities.

While disparities in education are not unique to China, the country's vast size and complex demographic landscape magnify the challenges. The migration of millions of people from rural to

urban areas has led to a division between the migrant children who face barriers to accessing education in cities and the left-behind children who struggle with isolation and limited resources in rural areas. However, advanced LLMs like ChatGPT, offer a ray of hope in addressing these disparities. ChatGPT's ability to engage in natural conversations, generate educational content, assist teachers, and evaluate student work opens up new possibilities for enhancing the educational experience. Khanmigo, an AI tutor built on the GPT-4 model, exemplifies the potential of AI in education, providing personalized support and fostering critical thinking skills.

This innovative approach to education presents challenges. AI, while powerful, still lags behind in creativity, critical thinking, and emotional intelligence compared to human teachers. Widespread adoption of AI-based education, particularly among disadvantaged and under-resourced children, requires caution. The limitations of AI in areas like creativity and emotional support could unintentionally exacerbate educational inequality if not comprehensively addressed. Thus striking a balance between AI-driven education and human guidance is essential for a holistic learning experience.

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