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Literature Review

Introduction

Students in rural areas have faced numerous challenges that have limited their access to equitable learning opportunities compared to their urban peers (Hannan, 2025; Kim, 2025). The integration of technology into education further amplified these inequities, exacerbating what has become known as the digital divide (Hannan, 2025; Khazanchi, 2024; Kim, 2025). Although the advent of artificial intelligence (AI) has led to innovations that target some of the persistent barriers faced by rural school districts, providing access to technology alone has not been sufficient to close the achievement gap (Hannan & Eynon, 2025).

Inequities Created Through the Digital Divide

The digital divide consists of three distinct levels, each of which has limited rural students' ability to access and benefit equitably from technology (Hannon, 2025; Kim, 2025). The first level refers to disparities in physical access to technology. Students in rural areas have faced a lack of access to devices such as computers and tablets, but also access to reliable broadband internet (Kim & Wargo, 2025). Digital access has been limited in rural regions due to outdated technological infrastructure, insufficient funding, and a lack of professional training (Kim & Wargo, 2025). Without equitable access, students have missed vital opportunities to build technical skills, while teachers have been cut off from the shared knowledge and the collaboration that technology enables (Hannon, 2025; van den Berg, 2023). The second level of the digital divide centers on differences in digital literacy, or the extent to which individuals can

use available technologies for learning and communication; while the third level refers to "the disparities in outcomes that people obtain from their use of digital technologies" (Hannan & Eynon, 2025). In other words, individuals with greater privilege have been found to use technology more effectively and derive greater benefits from it (Hannan & Eynon, 2025). The development of digital literacy skills at an early age is essential, as these competencies lay the foundation for students' future success in STEM fields and prepare them to engage meaningfully with technology (Lee, 2021). Rural schools have been disadvantaged by a need for highly qualified teachers with training specific in the use of AI in the classroom, which has inhibited the development of digital literacy skills in rural students (Kim & Wargo, 2025). Although the digital divide has exacerbated existing inequities in rural schools, educational researchers Brody Hannan and Rebecca Eynon (2025) found that improved infrastructure and teacher preparation alone were not sufficient to close the achievement gap.

The Impact of AI on Student and Teacher Learning

Persistent teacher shortages, along with limited access to professional development and curricular resources, have directly impacted the quality of educational opportunities offered to rural K-12 students (Kim, 2025; Li, 2025). Advances in AI, which include generative language models such as ChatGPT, have shown the potential to level the playing field by providing open access to learning materials, support mechanisms, and lesson plans (van den Berg & du Plessis, 2023). While some have argued that access to premade lesson plans is not an innovation, teachers in rural areas historically lack the funding to pay for such materials, services, and training (van den Berg & du Plessis, 2023). The use of AI in lesson planning has been found to increase teacher efficiency, reduce cognitive load, and accelerate planning, all while reducing the burden of entry into tasks that would otherwise be demotivating (Li et al., 2025). These time-

saving benefits have enabled teachers to access more targeted instructional materials and spend more time working directly with students (Kim, 2025; Li, 2025; van den Berg, 2023). This has been a significant advantage for rural educators who have faced resource limitations and those who have taught mixed-age, mixed-ability classrooms (Kim, 2025; Li, 2025; van den Berg, 2023). While concerns about the potential of AI to generate erroneous or copyrighted material have been raised, educators have demonstrated ethical restraint through critical evaluation and verification of AI-generated content before its incorporation into instruction (Li et al., 2025). Generative AI has also shown promise as a tool for self-directed professional development (SDPD), which has been especially valuable for rural educators with limited access to formal training opportunities (Li et al., 2025). The technology provided personalized support aligned with teachers' immediate instructional needs, offered expert modeling, and curated targeted resources, functioning much like an instructional coach or facilitator (Li & Van den Berg, 2025). AI has emerged as a powerful tool to develop teachers' critical thinking skills, as it requires them to evaluate the relevance of AI-suggested materials in relation to lesson objectives, learner ability, and classroom context (van den Berg & du Plessis, 2023). Through this process, educators can continuously evaluate, adapt, and refine their instructional practices to better meet the diverse needs of their students (van den Berg & du Plessis, 2023). Furthermore, teachers have demonstrated the ability to effectively manage time while organizing their professional development activities and applying various learning strategies (Li et al., 2025).

Intelligent tutoring systems (ITS) have also advanced in capability with the advent of AI, and have been shown to accelerate student learning across contexts (Hannan & Eynon, 2025). ITS have accelerated learning by creating personalized learning experiences that dynamically adapt content to students' abilities (Khazanchi et al., 2024). The systems work by identifying

knowledge gaps and creating individualized learning paths that have enabled students to progress at their own pace (Khazanchi et al., 2024). The use of AI-based systems have boosted mathematics achievement in students with disadvantaged backgrounds, which holds promise for students in rural settings, where access to highly qualified teachers and differentiated instruction has historically been limited (Hannon, 2025; Khazanchi, 2024). AI-based learning experiences have also been used to target learning in STEM, as society has grown to recognize the importance of an AI-literate populace (Lee et al., 2021). Hannan and Eynon (2025) caution that students who are unable to adapt to and utilize technology with agility, such as those from rural environments, risk losing opportunities to fully participate in a technology-driven workforce.

Leadership, Policy, and a Path to Integration

As AI has become increasingly integrated into education, the foundational inequities of the digital divide have required deliberate leadership and policy efforts to ensure that AI-driven innovations are accessible, equitable, and sustainable for rural learners (Kim & Wargo, 2025). It has become essential for teachers to develop digital literacy skills to remain critical and ethical whilst using technology in the classroom (Li et al., 2025). The development of these digital literacy skills has largely depended on the educational policies and attitudes adopted by leaders in the field (Hannan, 2025; Kim, 2025; Lee, 2021; Li, 2025). Despite the growing demand for AI-based educational tools, rural educators have frequently expressed reluctance to adopt these technologies due to limited confidence and familiarity (Kim 2025; Lee, 2021). This has underscored the critical need for comprehensive, context-specific professional development programs tailored to the unique challenges faced by rural teachers (Kim, 2025; Lee, 2021). With limited IT support, many leaders described how outdated technology would frequently malfunction, which further reduced teacher motivation to incorporate new tools (Kim & Wargo,

2025). The persistent digital divide, particularly in broadband access and infrastructure, has continued to place rural schools at a disadvantage compared to urban districts (Kim & Wargo, 2025). District leaders who proactively sought external funding and leveraged community partnerships were better positioned to implement AI sustainably (Kim & Wargo, 2025). Collaborations with policymakers, local businesses, and technology firms were found helpful in the expansion of internet access and modernization of school technology infrastructure (Kim & Wargo, 2025). A 2025 study by Kim and Wargo, investigated rural educational leadership and revealed a clear gap between optimism and action. While many leaders expressed confidence in the potential of AI and technology to enhance classroom learning, 51.9% indicated they had no concrete plans or strategies for implementation (Kim & Wargo, 2025). The lack of institutional support, as well as negative connotations that surround the use of generative AI in academic and educational contexts, was found to create a reluctance amongst teachers to share the learning and materials they had derived (Kim, 2025; Li, 2025; van den Berg, 2023). Zixi Li (2025) has suggested that meaningful policy reform must extend beyond providing access to AI tools and should restructure institutional systems to promote ethical use and foster ongoing professional learning for educators. Such reform would encourage continued collaboration among educators and enable them to refine and strengthen their instructional practices over time (Kim, 2025; Li, 2025).

Rural schools have also faced heightened privacy concerns, which have stemmed from the sensitivity of student data within small communities. Because these districts historically lack robust infrastructure and cybersecurity resources, they have faced increased risk when adopting AI tools that depend on extensive data collection (Kim & Wargo, 2025). To mitigate these challenges, researchers have suggested that leaders establish AI ethics committees or task forces

to develop governance structures, evaluate tools, and provide ongoing training in responsible implementation (Kim, 2025; Hannon, 2025). A large-scale 2025 study found that students with higher socioeducational advantages benefited more from intelligent tutoring systems (ITS) than their less advantaged peers (Hannan & Eynon, 2025). This finding is significant as it indicates usage of ITS may inadvertently heighten educational inequalities if implementation strategies fail to account for contextual disparities (Hannan & Eynon, 2025). The observed Matthew effect, where advantages compound for already privileged groups, is consistent with broader literature, which indicates that innovations can unintentionally reinforce systemic inequities when equitable access, training, and oversight are lacking (Hannan & Eynon, 2025). Overall, the findings reinforce the view that while ITS platforms hold considerable promise, their impact is heavily influenced by pre-existing disparities, calling into question the notion that technology alone can remedy systemic inequities in educational outcomes (Hannan & Eynon, 2025).

Conclusion

Understanding the long-term effects of AI-based systems on academic performance, retention rates, and career trajectories will be critical to developing sustainable and equitable pathways for AI integration in rural education (Khazanchi et al., 2024). While AI technologies have shown great promise to bridge the gap between rural and urban education by offering rural students access to resources and opportunities previously unavailable, this potential can only be realized through targeted improvements in access, digital literacy, and outcomes. Successful technology adoption in rural schools will be contingent upon strong leadership advocacy, resource mobilization, and strategic professional development (Kim & Wargo, 2025).

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