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Barriers to Artificial Intelligence Integration in K-12 Education: A Qualitative Study of Teachers and School Leaders

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Abstract

Artificial intelligence is increasingly being incorporated into K-12 education, yet its effective integration depends on more than access to emerging technologies. This qualitative descriptive study examined the barriers experienced by teachers and school leaders when integrating artificial intelligence into school practices. Semi-structured interviews were conducted with 24 participants, including 16 classroom teachers and eight school leaders from eight public schools in a metropolitan school district in the southeastern United States. Data were analyzed using reflexive thematic analysis. Six interconnected themes were identified: uneven knowledge and confidence created different starting points for AI integration; professional development was insufficiently practical and sustained; unclear and inconsistent policies produced uncertainty; ethical and pedagogical concerns limited uncritical adoption; resource, access, and time constraints shaped opportunities for experimentation; and differences between teacher and leader perspectives revealed an implementation gap. The findings indicated that barriers to AI integration were not isolated but interacted across individual and organizational levels. Teachers frequently associated their uncertainty with inadequate preparation, unclear expectations, and limited practical support, while school leaders faced challenges related to policy development, resource allocation, governance, and the rapid evolution of AI technologies. The findings further showed that technological familiarity alone did not ensure pedagogically appropriate or ethically responsible AI use. Effective integration requires sustained professional development, clear and adaptable institutional policies, equitable access to appropriate resources, stronger communication between teachers and school leaders, and continued attention to privacy, accuracy, academic integrity, and human judgment. The study contributes to understanding AI integration as a multidimensional organizational and instructional process rather than solely a technology adoption issue.

Keywords: artificial intelligence, K-12 education, teachers, school leaders, AI integration, barriers, professional development, educational technology

Introduction

Artificial intelligence has become increasingly prominent in education, creating new possibilities for how teachers plan instruction, support student learning, provide feedback, conduct assessment, and manage routine professional responsibilities. Artificial intelligence applications can assist educators in identifying student learning needs, personalizing instructional experiences, generating educational resources, and supporting aspects of assessment and instructional decision making (Celik et al., 2022; Crompton et al., 2024). The rapid emergence of generative artificial intelligence has further expanded these possibilities by placing sophisticated AI capabilities directly within the reach of teachers, students, and school administrators. As these technologies become more accessible, however, their successful integration into K to 12 education depends not simply on whether schools have access to AI tools, but on whether educators and educational institutions possess the knowledge, resources, policies, and organizational capacity required to use them effectively and responsibly.

Research on artificial intelligence in education has demonstrated both considerable potential and substantial implementation challenges. In their systematic review of research on teachers and AI, Celik et al. (2022) found that AI technologies could support teachers in instructional planning, classroom implementation, and assessment. At the same time, the review identified challenges involving the technical limitations of AI systems, reliability, contextual applicability, and educators' ability to use such technologies effectively. Similarly, Crompton et al. (2024), in a systematic review of 169 studies concerning artificial intelligence in K to 12 education, identified opportunities related to pedagogy, administration, and subject content, but also found challenges involving negative perceptions, limited technological skills among teachers and students, ethical concerns, and problems with the usability and design of AI technologies. These findings suggest that the educational value of AI cannot be understood solely in terms of its technological capabilities. The conditions under which teachers and schools attempt to implement AI are equally important.

Teachers occupy a central position in this implementation process because they must translate technological possibilities into meaningful instructional practices. Effective AI integration requires more than the ability to operate a particular application. Teachers must determine whether an AI tool supports instructional goals, evaluate the quality and reliability of AI generated outputs, decide when human judgment should take precedence, and understand the ethical implications associated with the use of automated systems. Chounta et al. (2022), in their study of 140 K to 12 teachers, found that educators recognized the potential of AI to support teaching while also demonstrating limited knowledge of AI and expressing concerns regarding its use. The study highlighted issues connected with teachers' understanding of artificial intelligence as well

as fairness, accountability, transparency, and ethics. Such findings indicate that willingness to use AI does not necessarily mean that teachers possess the knowledge or confidence necessary to integrate it appropriately.

The importance of teacher knowledge is further demonstrated by research examining the intersection of technological, pedagogical, and ethical competencies. Celik (2023) argued that teachers require AI specific technological and pedagogical knowledge to integrate AI based tools effectively. The study found that technological knowledge alone was insufficient for meaningful educational integration. Rather, teachers needed to connect their understanding of technology with pedagogical knowledge and the ability to make ethical assessments regarding AI based decisions. This distinction is especially important in K to 12 settings, where teachers are responsible not only for determining whether a technology functions but also for deciding whether its use is educationally appropriate for particular learners, subjects, activities, and developmental levels. Consequently, insufficient preparation may restrict AI integration even in schools where technological tools are readily available.

Professional development therefore represents a significant component of AI integration. Educators may require opportunities to develop practical competencies in using AI while simultaneously learning how to evaluate its pedagogical value, limitations, and ethical implications. Recent evidence suggests that this preparation remains uneven. Kim (2025), in a mixed methods study of K to 12 educators, identified insufficient professional development, ethical concerns, infrastructural inequities, varying levels of familiarity with AI, and differences in institutional preparedness as important challenges to generative AI adoption. The study also emphasized the need for targeted training, equitable access to resources, and clear institutional policies. These findings indicate that professional development cannot be treated as a one time introduction to AI tools. Effective preparation must address how educators can incorporate AI into instructional practice while exercising professional judgment concerning accuracy, student learning, responsible use, and appropriate boundaries.

At the same time, barriers to AI integration are not limited to teachers' individual knowledge or attitudes. The organizational environment of a school can either enable or constrain technology adoption. School leaders influence decisions involving technology acquisition, professional development, infrastructure, institutional priorities, policy development, and the allocation of time and resources. Cheng and Wang (2023) examined barriers to artificial intelligence integration in primary and secondary schools and found that both teacher related barriers and organizational conditions were relevant to implementation. Their

findings also emphasized the importance of digital leadership in facilitating educational transformation. This suggests that AI integration should be examined as a school level process in which individual and organizational factors interact. A teacher who is motivated to experiment with AI may still encounter barriers when institutional guidance is unclear, technological resources are inadequate, or professional support is unavailable. Conversely, a school may invest in AI technologies without achieving meaningful classroom adoption if teachers do not perceive those technologies as useful, trustworthy, manageable, or aligned with instructional goals.

Ethical and governance concerns add another layer of complexity. Artificial intelligence may introduce questions concerning privacy, bias, fairness, transparency, reliability, academic integrity, and the appropriate role of automated systems in educational decision making (Celik, 2023; Chounta et al., 2022; Crompton et al., 2024). These issues can be particularly consequential in K to 12 environments because schools have responsibilities toward students who may have limited understanding of how AI systems collect information, generate outputs, or make recommendations. Teachers and leaders must therefore make decisions not only about whether AI can be used, but also about the circumstances under which its use is responsible and educationally defensible. When policies are unclear or absent, educators may face uncertainty regarding acceptable applications of AI, student use of generative technologies, protection of information, assessment practices, and the extent to which AI generated content can be relied upon. Such uncertainty may lead some educators to avoid AI, while others may adopt it without consistent standards across classrooms or schools.

Equity presents an additional challenge to sustained AI integration. Differences in access to technological infrastructure, institutional resources, professional development, and organizational support can shape educators' opportunities to experiment with and learn about AI. Kim (2025) identified infrastructural inequities and unequal access to resources among the challenges confronting educators and institutions. These disparities suggest that AI integration may develop unevenly across schools if some educators have access to extensive technological and professional support while others do not. Accordingly, understanding barriers to AI integration requires consideration not only of individual teacher readiness but also of the broader conditions within which teachers work.

The significance of these barriers has also increased within the United States policy environment. In April 2025, Executive Order 14277, *Advancing Artificial Intelligence Education for American Youth*, established a federal policy promoting AI literacy, the appropriate integration of AI into education, and comprehensive

AI training for educators (Executive Office of the President, 2025). The order specifically called for professional development that would help educators integrate the fundamentals of AI across subject areas and directed federal agencies to support teacher training opportunities involving AI based tools. The policy therefore places educators and educational institutions at the center of efforts to expand AI competency. However, policy priorities alone do not explain whether or how AI can be implemented within individual schools. Achieving such objectives requires a clearer understanding of the practical barriers experienced by the teachers expected to integrate AI and the school leaders responsible for creating the organizational conditions that support its use.

Although existing scholarship has identified numerous factors associated with AI adoption, important questions remain regarding how these barriers are experienced within everyday school contexts and how they interact. Systematic reviews have identified recurring challenges across the literature (Celik et al., 2022; Crompton et al., 2024), while survey and mixed methods studies have examined educators' perceptions, preparedness, institutional conditions, and leadership (Cheng & Wang, 2023; Chounta et al., 2022; Kim, 2025). These studies provide an important foundation, but the implementation of AI involves experiences and organizational processes that may be difficult to capture fully through measures of readiness, frequency, or attitude alone. For example, a reported lack of professional development may reflect insufficient training opportunities, training that is overly technical, inadequate time for application, uncertainty about school expectations, or professional development that does not correspond with teachers' instructional needs. Likewise, a reported policy barrier may involve restrictive rules, absence of guidance, inconsistent expectations, or uncertainty among leaders themselves. Exploring participants' experiences in greater depth can reveal how such barriers develop and how they influence actual decisions about AI use.

There is also value in examining teachers and school leaders together. Teachers experience AI integration primarily through classroom instruction, student interaction, lesson planning, assessment, and daily professional practice. School leaders, by contrast, must consider broader responsibilities involving organizational policy, resource allocation, staff development, technology infrastructure, accountability, risk, and schoolwide implementation. These roles may produce different interpretations of the same implementation environment. School leaders may perceive that adequate technological resources or training have been provided, while teachers may experience those resources as insufficient or poorly aligned with classroom needs. Alternatively, teachers may be willing to experiment with AI while leaders remain concerned about governance, privacy, or consistency across the institution. Understanding points of convergence and divergence between these groups can provide a more complete explanation of why AI

integration advances in some circumstances and remains limited in others.

A qualitative approach is particularly suitable for examining these experiences because it allows participants to explain how they understand barriers, how those barriers influence their decisions, and how multiple challenges interact within particular school contexts. Rather than treating technological skills, professional development, leadership, policy, infrastructure, ethics, and organizational support as isolated variables, qualitative inquiry can examine how these conditions are experienced in combination. Such an approach can also identify barriers that may not be adequately represented in predetermined survey instruments and can provide greater insight into the meanings that teachers and leaders assign to AI integration.

Accordingly, the purpose of this qualitative study is to explore the barriers experienced by teachers and school leaders in the integration of artificial intelligence within K to 12 education. The study seeks to examine technological, pedagogical, professional development, organizational, ethical, policy, infrastructure, and resource related barriers from the perspectives of those directly involved in classroom practice and school leadership. By investigating both teacher and leader experiences, the study aims to identify areas of shared concern, points of divergence, and interactions among individual and organizational barriers. In doing so, the research seeks to contribute a more contextualized understanding of what constrains responsible and meaningful AI integration and to provide evidence that can inform professional development, school leadership, institutional policy, resource allocation, and broader educational efforts to implement artificial intelligence effectively.

Literature Review

Artificial Intelligence Integration in K to 12 Education

Artificial intelligence has expanded the range of digital technologies available to schools and has introduced new possibilities for teaching, learning, assessment, and educational administration. Unlike conventional educational technologies that primarily provide access to information or facilitate communication, AI based systems can analyze data, generate content, provide recommendations, adapt learning experiences, and automate selected instructional and administrative tasks. These capabilities have increased interest in how artificial intelligence can be incorporated into K to 12 education. At the same time, the characteristics that distinguish AI from earlier educational technologies also introduce new challenges involving teacher knowledge, pedagogical appropriateness, transparency, reliability, privacy, bias, and institutional

governance.

Crompton et al. (2024) provide one of the broadest examinations of AI use in K to 12 education. Their systematic review analyzed 169 studies published between 2011 and 2021 and identified applications of AI across pedagogical, administrative, and subject specific contexts. The review demonstrated that AI can provide instructional benefits through personalized learning, student support, assessment, and other educational functions. However, the authors also identified recurring challenges involving insufficient technological skills, negative perceptions of AI, ethical concerns, and limitations associated with the usability and design of AI systems. The coexistence of these affordances and challenges suggests that the availability of AI does not itself ensure effective adoption. Instead, integration depends on the conditions within schools and on the capacity of educators to translate technological functionality into educationally appropriate practice.

Celik et al. (2022) reached a similar conclusion in their systematic review of AI and teachers. Their synthesis demonstrated that AI technologies could assist teachers with planning, implementation, and assessment while also creating challenges related to technological knowledge, system reliability, infrastructure, and the appropriateness of AI recommendations for particular educational contexts. Importantly, the review positioned teachers as active professional decision makers rather than passive users of AI. The effectiveness of AI depends partly on teachers' ability to interpret AI generated information and determine whether it is appropriate within a particular pedagogical situation.

The distinction between having access to AI and successfully integrating AI is therefore important. AI integration can be understood as a process through which artificial intelligence becomes meaningfully incorporated into instructional, administrative, or organizational practices rather than merely becoming available within a school. Meaningful integration requires alignment among technological capabilities, pedagogical goals, educator competencies, institutional resources, leadership, policy, and ethical expectations. This perspective suggests that barriers to AI integration can emerge at multiple levels simultaneously.

Conceptualizing Barriers to Technology and AI Integration

Research on educational technology has long distinguished between barriers originating outside the individual teacher and barriers arising from teachers' own beliefs, knowledge, attitudes, and practices. Ertmer (1999) characterized these as first order and second order barriers. First order barriers are external

to teachers and include limitations involving resources, equipment, access, time, training, and institutional support. Second order barriers are internal and include teachers' beliefs about teaching and learning, attitudes toward technology, confidence, and established instructional practices. Although this distinction predates contemporary artificial intelligence, it remains useful for understanding why technological availability does not automatically result in instructional adoption.

Research focusing specifically on AI suggests that these two categories remain relevant but are increasingly interconnected. Wang and Cheng (2021) conducted a collective case study of AI incorporation in two K to 12 schools using semi structured interviews with key stakeholders. Their findings revealed both first order and second order barriers. More importantly, the barriers did not operate independently. Resource limitations, institutional conditions, teacher beliefs, knowledge, and confidence interacted with one another, and the nature of the barriers varied according to how schools sought to incorporate AI. Wang and Cheng therefore argued for a more dynamic understanding of AI integration in which schools examine relationships among barriers rather than addressing each barrier separately.

This interconnected perspective is particularly relevant to contemporary AI adoption. For example, limited teacher confidence may appear to be an individual barrier, but confidence can also be influenced by the availability of professional development, opportunities for experimentation, leadership encouragement, and clear institutional guidance. Similarly, reluctance to use an AI application may reflect an unfavorable attitude toward technology, but it could also represent legitimate concerns about privacy, accuracy, curriculum alignment, or unclear school policies. Separating barriers into purely individual or organizational categories may therefore obscure the processes through which barriers reinforce one another.

Teacher Knowledge and AI Readiness

Teacher knowledge has emerged as one of the most consistent issues in the AI integration literature. Educators must understand enough about artificial intelligence to identify appropriate applications, recognize limitations, evaluate outputs, and make pedagogically informed decisions about its use. This requirement extends beyond general digital literacy because AI systems can produce outputs or recommendations that appear authoritative even when they are inaccurate, biased, inappropriate, or disconnected from instructional objectives.

Chounta et al. (2022) examined the perceptions of 140 K to 12 teachers in Estonia and found that teachers generally recognized the potential of AI to support their professional practice. At the same time, participants

demonstrated limited knowledge of artificial intelligence and raised concerns involving reliability, transparency, fairness, accountability, and the consequences of AI use. The findings reveal an important distinction between positive perceptions of AI and preparedness to use it. Teachers can recognize potential benefits while remaining uncertain about how AI systems function or how their outputs should be evaluated.

Velander et al. (2024) similarly found substantial uncertainty concerning AI among teachers and teacher educators. Their qualitative analysis showed that participants often acquired AI knowledge incidentally through media and everyday experience rather than through systematic professional preparation. This sometimes contributed to incomplete understandings or misconceptions about AI. Participants also identified vague policy and curriculum guidance, insufficient understanding of AI and its limitations, and emotional responses such as uncertainty and apprehension as challenges to developing AI related professional knowledge.

Large scale evidence reinforces these findings. Yue et al. (2024) surveyed 1,664 K to 12 teachers to examine technological pedagogical content knowledge readiness and attitudes toward AI education. Their results revealed substantial gaps in AI related technological and content knowledge. The authors also found relationships among teachers' knowledge, attitudes, and prior experience, leading them to emphasize the importance of professional development designed specifically for AI education. These findings indicate that teachers' preparedness cannot be inferred from their general competence with digital technologies. AI introduces knowledge requirements that may require specialized preparation.

The Intelligent TPACK framework proposed by Celik (2023) provides additional insight into the competencies required for AI integration. Building on the technological pedagogical content knowledge framework, Celik incorporated ethical knowledge into the conceptualization of teachers' AI related professional competence. The study demonstrated that technological knowledge alone was insufficient for effective AI integration. Teachers needed to combine their understanding of technology with pedagogical knowledge to determine how AI could meaningfully contribute to learning. Ethical evaluation was also necessary because teachers must be able to assess the consequences of AI based decisions and applications.

Together, these studies suggest that teacher readiness is multidimensional. Teachers may require technical knowledge about AI tools, pedagogical knowledge concerning how those tools can support learning, content knowledge for evaluating whether AI generated materials are appropriate for particular subjects, and ethical knowledge for assessing potential risks. Deficiencies in any of these areas can constrain integration.

Teacher Attitudes, Confidence, and Perceptions

Knowledge alone does not explain educators' willingness to integrate AI. Teachers' attitudes, perceptions, confidence, and beliefs about the role of technology in education can also affect adoption. Second order barriers become particularly important when educators encounter technologies that challenge established understandings of teaching, assessment, authorship, and professional expertise.

Chounta et al. (2022) found that teachers simultaneously expressed optimism regarding AI's potential and concerns about its implications. This coexistence of positive and negative perceptions demonstrates that attitudes toward AI are not necessarily binary. An educator can perceive AI as useful for particular activities while distrusting it for others. Similarly, Velander et al. (2024) identified emotional responses ranging from curiosity and optimism to anxiety and concerns about loss of control. These responses were related partly to participants' understandings and misunderstandings of AI.

Filiz et al. (2025) provide more recent qualitative evidence. Their exploratory study involved 66 K to 12 teachers from 11 disciplines who participated in professional development focused on AI enhanced teaching. Teachers identified advantages associated with efficiency, interactivity, adaptability, personalization, and lesson planning. However, they also reported technical difficulties, curriculum misalignment, ethical concerns, and problems adapting AI generated materials to local cultural and educational contexts. The findings demonstrate that teachers can value AI while simultaneously encountering practical and pedagogical obstacles to its integration.

This body of evidence suggests that teacher resistance should not automatically be interpreted as opposition to innovation. What appears to be resistance may reflect uncertainty about pedagogical value, insufficient knowledge, concerns about student learning, ethical reservations, or frustration with institutional conditions. A qualitative investigation is therefore valuable because it allows teachers to explain the reasoning behind their decisions rather than reducing their perspectives to measures of favorable or unfavorable attitudes.

Professional Development and Capacity Building

Professional development is frequently identified as a mechanism for reducing teacher related barriers to AI integration. However, the literature indicates that effective professional development must extend beyond demonstrations of particular AI applications. Teachers require opportunities to develop conceptual

understanding, pedagogical strategies, ethical judgment, and practical experience with AI within their subject and grade level contexts.

Yue et al. (2024) argue that professional development should address age appropriate AI content, AI specific pedagogical approaches, teacher confidence, and opportunities to practice AI teaching. This recommendation is consistent with Celik's (2023) finding that technological knowledge becomes educationally meaningful when combined with pedagogical knowledge. Professional development that concentrates only on how to operate an AI tool may therefore produce technical familiarity without necessarily improving instructional integration.

Velander et al. (2024) further demonstrate why systematic professional learning is necessary. Teachers and teacher educators in their study frequently relied on incidental learning to develop their understanding of AI, and incomplete understanding sometimes contributed to misconceptions. Structured professional development can provide a mechanism for correcting misconceptions, increasing AI literacy, and connecting technological knowledge to curricular and pedagogical practice.

Kim (2025) found that insufficient professional development remained a major concern among K to 12 educators in the context of generative AI. The study also identified ethical concerns, infrastructure disparities, varying familiarity with AI, and differences in institutional preparedness. These findings indicate that professional development cannot be separated from organizational conditions. Training may have limited effects if educators subsequently lack access to appropriate technologies, time to experiment, administrative support, or clear policies governing AI use.

Professional development should therefore be understood as an ongoing organizational process rather than a single intervention. Because AI technologies evolve rapidly, teachers may require continued opportunities to update their knowledge, share experiences, evaluate emerging applications, and develop instructional strategies. School leaders play an important role in creating these conditions.

School Leadership and Organizational Support

Although much of the early AI education literature concentrated on teachers and students, growing evidence indicates that leadership and institutional capacity are essential to successful integration. School leaders influence technology purchasing, professional development, infrastructure, policy formation, staff expectations, access to technical assistance, and the allocation of time and resources. Their decisions can

therefore shape both first order and second order barriers.

Cheng and Wang (2023) examined the relationship between digital leadership and barriers to AI incorporation in basic education. Their findings indicated that external barriers and internal teacher barriers were associated with AI integration and that digital leadership could play an important role in reducing barriers. Their work shifts attention from the individual educator toward the organizational environment within which technology adoption occurs.

Leadership is especially important when technologies are new and institutional expectations remain unsettled. Teachers may hesitate to use AI if they are uncertain whether particular applications are permitted, whether student information can be entered into AI systems, or how AI use aligns with school assessment and academic integrity policies. Conversely, leaders may support AI in principle while lacking sufficient expertise to determine appropriate tools, formulate policies, or provide meaningful guidance to staff.

Wang and Cheng's (2021) case study further demonstrates that barriers depend partly on organizational context and on the particular form of AI integration pursued by a school. Different objectives may require different resources, professional competencies, curricular adjustments, and leadership strategies. Their finding that barriers are interconnected also suggests that leadership interventions aimed at a single issue may be insufficient. Providing technological resources without professional development, for example, may leave internal barriers unresolved. Similarly, professional development may have limited impact when teachers lack the infrastructure, time, or institutional authorization necessary to apply what they have learned.

The organizational perspective is important for the present study because teachers and school leaders occupy different positions within the same implementation process. Teachers primarily experience AI through curriculum, instruction, assessment, classroom management, and interactions with students. School leaders are more likely to encounter questions involving budgeting, technology selection, risk, professional development, governance, schoolwide consistency, and accountability. Examining both perspectives can identify whether barriers perceived by teachers are also recognized by leaders and whether organizational responses correspond to classroom needs.

Infrastructure, Resources, and Equity

Technological infrastructure remains a fundamental condition for AI adoption. AI based applications may require reliable internet connectivity, appropriate devices, software access, technical support, and in some cases subscription based services or specialized platforms. When these resources are unevenly distributed, opportunities for AI integration may also become uneven.

Crompton et al. (2024) identified technological skills and usability challenges among the recurring difficulties associated with AI in K to 12 education. Celik et al. (2022) similarly identified infrastructure and technological limitations among challenges affecting teachers' use of AI. Kim (2025) more specifically highlighted infrastructural inequities as a challenge to generative AI adoption among K to 12 educators.

Resource disparities have implications beyond simple access. Schools with greater technological and financial capacity may be able to provide teachers with approved AI platforms, professional development, technical support, and opportunities for experimentation. Schools operating under greater resource constraints may have fewer opportunities to develop similar organizational capacity. Within individual schools, differences in device availability, internet access, student resources, or teacher support may also shape implementation.

Equity therefore operates at multiple levels. It can involve differences among schools, differences among educators, and differences among students. The potential educational value of AI may be undermined if access to its benefits depends heavily on the technological or financial resources available in a particular school environment. For school leaders, questions of AI adoption are consequently connected to decisions about resource allocation and equitable access as well as to instructional effectiveness.

Ethical, Privacy, and Governance Barriers

Ethical concerns distinguish AI integration from many earlier forms of educational technology. AI systems can depend on substantial amounts of data, produce inaccurate or biased outputs, generate content whose origins may be difficult to determine, and make recommendations through processes that are not always transparent to users. These characteristics raise questions involving privacy, fairness, transparency, accountability, intellectual property, academic integrity, and human oversight.

Gouseti et al. (2025) conducted a systematic review of 25 peer reviewed studies addressing AI ethics in K to 12 education. Their review found that although AI ethics guidelines had expanded, the development of policies specifically addressing children and K to 12 settings had lagged. The study identified multiple

ethical concerns associated with AI use in compulsory education and emphasized the need for continued research and policy development.

Ethical competence is also closely connected to teacher knowledge. Celik (2023) incorporated ethical assessment into the Intelligent TPACK framework because teachers need to evaluate not only whether an AI tool functions but also whether its use is responsible within an educational context. Chounta et al. (2022) similarly identified concerns involving fairness, accountability, transparency, and reliability among teachers considering AI use.

Governance becomes especially important when schools lack clear institutional policies. Teachers may face uncertainty about whether generative AI can be used for lesson planning, student feedback, grading, or assessment development. Questions may also emerge about what information can be shared with external AI systems and what constitutes acceptable student use. When institutional expectations remain unclear, educators may develop inconsistent practices or avoid AI altogether.

The U.S. Department of Education (2023) similarly emphasized the importance of involving educators, educational leaders, researchers, policymakers, and technology developers in decisions surrounding AI in teaching and learning. The report highlighted the need to maintain humans in decision making processes and to develop policies that address emerging risks while enabling educational innovation. These concerns reinforce the importance of examining AI integration as both an instructional and governance issue.

Interdependence of Barriers

Although the literature often categorizes barriers separately, increasing evidence suggests that barriers to AI integration are mutually reinforcing. Limited technological knowledge may reduce teacher confidence. Insufficient professional development may contribute to uncertainty about ethical use. Unclear policies may increase reluctance even among teachers who are technically competent. Resource limitations may prevent teachers from applying knowledge acquired through training. Weak leadership support may limit opportunities for experimentation, while negative prior experiences may influence teacher attitudes toward subsequent AI initiatives.

Wang and Cheng (2021) provide direct empirical support for this interconnected view, finding that barriers in K to 12 AI integration did not operate independently. Their analysis indicates that strategies for overcoming barriers should consider relationships among them. This insight is particularly important for

research because studying barriers as isolated variables may fail to explain why an apparently minor difficulty becomes consequential when combined with other organizational or individual constraints.

For example, inadequate training might be manageable in a school where teachers have substantial technical support, collaborative planning time, and leadership encouragement. The same training deficit could become a major barrier in an environment where policies are unclear, technical assistance is unavailable, and teachers have little time for experimentation. Understanding integration therefore requires attention to context and to participants' interpretations of how different conditions combine.

Research Gap

Existing research has established that AI integration in K to 12 education can be affected by teacher knowledge, attitudes, confidence, professional development, infrastructure, leadership, institutional support, ethical concerns, and policy uncertainty (Celik et al., 2022; Cheng & Wang, 2023; Chounta et al., 2022; Crompton et al., 2024; Kim, 2025; Wang & Cheng, 2021; Yue et al., 2024). However, several limitations remain in the literature.

First, a substantial portion of existing research has examined individual components of AI adoption, such as teacher readiness, AI literacy, attitudes, or technological pedagogical knowledge. These studies provide valuable evidence about particular barriers but offer less insight into how multiple barriers interact within the everyday organizational environment of a school.

Second, studies frequently emphasize teachers while giving comparatively less attention to the perspectives of school leaders. Yet many barriers experienced by teachers, including professional development, resources, policy, technical support, and time, are influenced by organizational decisions. Simultaneously, school leaders may confront barriers that classroom teachers do not directly experience, including budgeting, governance, procurement, institutional liability, schoolwide consistency, and strategic planning.

Third, the empirical literature demonstrates that educators can hold positive attitudes toward AI while still experiencing substantial obstacles to implementation. Consequently, measurements of attitudes or readiness alone may not adequately explain why educators adopt, restrict, modify, or avoid AI in specific situations. Greater attention to participants' experiences and interpretations is required.

Fourth, much of the frequently cited empirical research has been conducted within particular national,

institutional, or professional contexts. Chounta et al. (2022) studied teachers in Estonia, Wang and Cheng (2021) and Cheng and Wang (2023) examined schools in Hong Kong, Velander et al. (2024) examined Swedish teachers and teacher educators, and Filiz et al. (2025) studied teachers in Türkiye. These studies provide important insights, but their findings also demonstrate that AI implementation is influenced by local curricula, policy environments, institutional resources, and educational cultures. Additional context sensitive investigation is therefore warranted.

Finally, although several studies have identified categories of barriers, fewer studies have examined how teachers' and school leaders' perceptions of the same school environment converge or diverge. This distinction is important because the effectiveness of organizational responses depends partly on whether leaders accurately understand the challenges experienced by teachers and whether teachers understand the constraints influencing leadership decisions.

The present qualitative study addresses these gaps by examining AI integration from the perspectives of both K to 12 teachers and school leaders. Rather than treating technological, pedagogical, organizational, ethical, policy, and resource barriers as independent variables, the study explores how participants experience these barriers, how the barriers interact, and how their significance varies across professional roles. This approach can provide a more contextualized understanding of the conditions that facilitate or inhibit meaningful AI integration and can contribute to the development of professional development programs, leadership strategies, policies, and resource decisions that respond more closely to the realities of K to 12 schools.

Method

Research Design

This study employed a qualitative descriptive design to examine barriers to artificial intelligence integration in K to 12 education from the perspectives of teachers and school leaders. Qualitative description was considered appropriate because the study sought to provide a detailed account of participants' experiences, perceptions, and interpretations while remaining relatively close to the meanings expressed in their narratives (Sandelowski, 2000, 2010). The study was not intended to generate a formal theory of AI adoption or to identify the essential structure of a lived phenomenon. Instead, it focused on understanding the technological, pedagogical, organizational, ethical, and policy related conditions that influenced the use of artificial intelligence within school environments.

The study was informed by an interpretive orientation that recognized participants' accounts as shaped by their professional responsibilities, institutional contexts, prior experiences with technology, and organizational expectations. Teachers and school leaders were included because they occupied distinct but interconnected positions within the AI integration process. Teachers encountered artificial intelligence primarily through instructional planning, classroom practice, assessment, student interaction, and routine professional activities. School leaders, in contrast, were responsible for broader matters involving professional development, technology adoption, resource allocation, institutional policy, governance, and organizational accountability. Examining both groups provided an opportunity to identify shared concerns as well as differences in how AI integration barriers were understood across professional roles.

Individual semi structured interviews served as the primary method of data collection. Semi structured interviewing provided sufficient consistency across participants while allowing the interviewer to pursue examples, explanations, and contextual issues that emerged during the conversations. This approach was appropriate because the study addressed a clearly defined phenomenon while requiring flexibility to explore experiences that could not be fully anticipated through predetermined response categories (Kallio et al., 2016).

Research Setting

The study was conducted within a large public school district located in a metropolitan area in the southeastern United States. At the time of data collection, the district served approximately 48,000 students across elementary, middle, and high schools. The schools differed in enrollment size, socioeconomic composition, technological resources, and prior experience with digital learning initiatives. Participants were recruited from eight schools, comprising three elementary schools, two middle schools, and three high schools.

The schools varied in the extent to which artificial intelligence had been incorporated into professional practice. Some schools had begun offering professional development related to generative AI, while others had addressed AI primarily through discussions of student use, academic integrity, instructional appropriateness, or technology policy. The district had not adopted a single mandatory instructional AI platform during the period of data collection, although educators had access to several commercially available and district approved digital tools that incorporated AI functions. This variation provided a useful context for examining how AI integration barriers were experienced across schools operating within the same district structure but under different technological and organizational conditions.

Participants and Sampling

The final sample consisted of 24 participants, including 16 classroom teachers and eight school leaders. The teacher group included five elementary school teachers, five middle school teachers, and six high school teachers. Their instructional areas included elementary general education, English language arts, mathematics, science, social studies, business education, and special education. Teachers had between 3 and 27 years of professional experience, with an average of approximately 11 years.

The school leader group consisted of four principals and four assistant principals. Their leadership experience ranged from 2 to 18 years, with an average of approximately 8 years. All leaders had responsibilities related to instructional supervision, professional development, technology implementation, or school policy. Participants ranged in age from 27 to 61 years. Fourteen participants identified as women and 10 identified as men. The participating schools served students from diverse racial, socioeconomic, and linguistic backgrounds.

Purposive sampling was used to recruit participants who could provide information directly relevant to the research questions. Purposive sampling is appropriate in qualitative inquiry when participants are selected because of their experience with or knowledge of the phenomenon under investigation (Patton, 2015). Teachers were eligible if they were currently employed in a K to 12 classroom, had completed at least one full academic year of teaching, and had encountered artificial intelligence through personal use, student use, professional development, institutional discussion, or school policy. School leaders were eligible if they were currently serving as principals or assistant principals, had at least one year of leadership experience, and held responsibilities related to instructional supervision, professional development, technology implementation, or institutional decision making.

Participants were not required to be frequent users of artificial intelligence. This criterion was intentionally broad because reluctance, limited use, uncertainty, and avoidance represented potentially important dimensions of the phenomenon being examined. The adequacy of the sample was considered using the concept of information power described by Malterud et al. (2016). The research questions were relatively focused, participants had direct professional experience relevant to the topic, and the interviews produced substantial descriptive information. Recruitment concluded after 24 interviews when the dataset provided sufficient depth and variation to address the research questions.

Recruitment

Recruitment began after institutional and district approval had been obtained. An electronic invitation describing the purpose of the study, eligibility requirements, interview procedures, confidentiality protections, and voluntary nature of participation was distributed through the district research office. To minimize the possibility of perceived coercion, principals did not directly recruit teachers working under their supervision. Interested individuals contacted the researcher independently using the email address provided in the recruitment notice.

Individuals who expressed interest received an information sheet describing the study and were screened for eligibility before interviews were scheduled. Twenty seven individuals initially expressed interest in participating. Two individuals did not meet the eligibility requirements, and one individual withdrew before an interview was scheduled. The remaining 24 participants completed interviews and were included in the analysis. Each participant received a $20 electronic gift card following completion of the interview in recognition of the time required for participation.

Interview Protocol

The semi structured interview guide was developed from the research questions and previous literature concerning artificial intelligence integration, educational technology barriers, teacher readiness, professional development, school leadership, infrastructure, ethics, and institutional governance. The protocol contained a common set of questions for teachers and school leaders, followed by questions tailored to the responsibilities associated with each professional role.

Participants were initially invited to describe how artificial intelligence had become part of their professional experience. Subsequent questions explored situations in which they had used, considered using, or chosen not to use AI. Participants were asked to discuss the factors that made AI easier or more difficult to use within their schools, the knowledge and competencies educators required, the adequacy of available professional development, access to technological resources, and the clarity of institutional expectations. Questions also addressed concerns related to inaccurate AI generated information, student use, privacy, bias, academic integrity, ethical responsibility, and school policy.

Teacher interviews placed additional emphasis on instructional planning, classroom implementation, assessment, student interaction, confidence, and administrative support. Interviews with school leaders focused more extensively on organizational readiness, professional development, technology approval, resource allocation, staff preparation, policy development, governance, and implementation challenges.

Follow up prompts were used throughout the interviews to encourage participants to provide specific examples and to clarify the meaning of their responses.

The interview guide was reviewed by two university faculty members with expertise in qualitative research and educational technology. Their feedback resulted in revisions to question wording and sequencing. The revised protocol was then piloted with one K to 12 teacher and one former school administrator who were not included in the final sample. The pilot interviews indicated that the term AI readiness was interpreted differently by participants. Questions using that terminology were therefore revised to focus on concrete forms of knowledge, preparation, resources, and professional experience.

Data Collection

Data were collected between February 3 and April 18, 2025. All interviews were conducted individually through Zoom to maintain a consistent format and accommodate participants' professional schedules. Before each interview, participants reviewed the consent form and provided electronic informed consent. Permission to audio record the interview was also confirmed verbally before the discussion began.

The interviews lasted between 41 and 73 minutes, with an average duration of approximately 52 minutes. The 24 interviews generated approximately 21 hours of recorded data. Interviews began with broad questions about participants' experiences with AI before moving toward more specific questions about barriers and organizational conditions. This sequencing was intended to allow participants to identify issues in their own terms before more specific topics were introduced by the interviewer.

Follow up questions were used when additional clarification or depth was required. Participants were frequently asked to describe specific incidents, explain why particular experiences were difficult, or discuss how their schools responded to AI related concerns. Brief field notes were written immediately after each interview to document emerging ideas, contextual observations, unexpected responses, and issues that warranted further exploration in later interviews.

Data Management

Zoom generated preliminary interview transcripts, which were subsequently checked against the audio recordings and corrected manually before analysis. Personally identifying information, including participant names, school names, and names of colleagues, was removed during transcript preparation.

Teachers were assigned identification codes ranging from T01 to T16, while school leaders were assigned codes ranging from L01 to L08.

Audio recordings, transcripts, consent materials, and analytic documents were stored in password protected university approved electronic storage. Consent materials were stored separately from interview data to reduce the possibility of linking participant identities to their responses. Verified transcripts were imported into NVivo qualitative data analysis software, which was used to organize the data, manage coding, retrieve coded passages, and maintain analytic memos.

Data Analysis

The interview data were analyzed using reflexive thematic analysis following the approach developed by Braun and Clarke (2006, 2021). Reflexive thematic analysis was selected because it allowed the researcher to identify and interpret recurring patterns across participants' accounts while acknowledging the researcher's active role in developing themes from the data.

Analysis began with repeated reading of each verified transcript to develop familiarity with the dataset. The researcher also listened again to relevant portions of the audio recordings and recorded preliminary observations concerning recurring experiences, contradictions, participant language, and potential relationships among barriers. The complete dataset was read more than once before formal coding commenced.

Initial coding was conducted at both semantic and interpretive levels. Semantic codes captured explicit statements made by participants, while interpretive codes addressed broader meanings related to the research questions. Early codes included insufficient AI training, uncertainty about appropriate classroom use, concerns regarding inaccurate AI generated information, lack of approved tools, student misuse of generative AI, unclear academic integrity expectations, privacy concerns, limited planning time, inconsistent administrative guidance, subscription costs, unequal student access, curriculum misalignment, lack of technical support, and leadership uncertainty.

Coding remained open and iterative throughout the early stages of analysis. Although previous literature concerning first order and second order barriers informed the researcher's understanding of educational technology integration, those categories were used only as sensitizing concepts rather than as predetermined coding categories. This approach allowed the analysis to remain responsive to AI specific and context

specific experiences described by participants.

Following initial coding, related codes were compared and organized into broader patterns of meaning. Candidate themes were developed through repeated consideration of relationships among codes and the extent to which those patterns addressed the research questions. The significance of a theme was not determined solely by how frequently a particular issue was mentioned. Less frequently reported experiences were retained when they provided important insight into organizational, ethical, or contextual dimensions of AI integration.

Candidate themes were repeatedly compared with both coded excerpts and complete transcripts. Themes that lacked conceptual coherence were revised, combined, separated, or removed. The final thematic structure consisted of six overarching themes representing interconnected dimensions of barriers to AI integration.

A comparative analysis was subsequently conducted to examine similarities and differences between teachers and school leaders. Teacher and leader accounts were reviewed separately and then compared across the major themes. Particular attention was given to situations in which both groups identified the same issue but differed in their interpretation of its significance. Professional development, policy clarity, technological access, student AI use, ethical concerns, and organizational support received particular attention during this stage of analysis. For example, school leaders' descriptions of existing professional development opportunities were compared with teachers' assessments of the usefulness, accessibility, and relevance of those opportunities. Similar comparisons were conducted in relation to technology availability and institutional guidance.

The comparative analysis therefore moved beyond generating separate lists of teacher and leader concerns. Instead, it examined how participants occupying different professional positions understood the same organizational environment and how differences in responsibility influenced their perceptions of AI integration barriers.

Researcher Reflexivity

Reflexivity was maintained throughout the study because qualitative interpretation is influenced by the researcher's assumptions, experiences, and analytic decisions. A reflexive journal was maintained from the beginning of recruitment through completion of the analysis. Entries documented expectations concerning

AI integration, responses to participant accounts, emerging interpretations, methodological decisions, and assumptions that required reconsideration.

Particular attention was given to avoiding the assumption that greater AI adoption necessarily represented more effective educational practice. Participants who expressed reluctance or skepticism toward AI were therefore not automatically categorized as resistant to technology. Their accounts were examined for concerns related to pedagogy, ethics, student learning, privacy, reliability, and institutional uncertainty. Similarly, participants who expressed enthusiasm for AI were not assumed to have resolved the practical or ethical challenges associated with its use. Reflexive documentation supported a more deliberate examination of both supportive and critical accounts.

Trustworthiness

Trustworthiness was addressed through procedures associated with credibility, dependability, confirmability, and transferability (Lincoln & Guba, 1985). Credibility was strengthened through repeated engagement with the interview data, comparison of accounts across professional roles, and deliberate attention to negative or contradictory cases. Participant quotations were retained throughout the analytic process so that interpretations could be repeatedly assessed against the original data.

Analytic peer discussions were conducted with a qualitative research colleague at three stages of the analysis. These discussions focused on the coherence of candidate themes, possible alternative interpretations, and the distinction between descriptive categories and broader patterns of meaning. Numerical interrater reliability was not calculated because reflexive thematic analysis recognizes coding as an interpretive process rather than an objective procedure requiring coder agreement (Braun & Clarke, 2021).

Dependability was supported through an audit trail containing recruitment materials, interview protocols, field notes, coding records, analytic memos, theme maps, and documentation of changes made during analysis. Confirmability was strengthened through reflexive journaling and explicit documentation of analytic decisions. Divergent accounts were retained where they challenged dominant interpretations rather than being excluded from the analysis.

Transferability was supported through detailed description of the participants, professional roles, school contexts, and organizational setting. Providing this contextual information allowed readers to assess the

extent to which the findings might be relevant to other K to 12 educational environments. Reporting of the study was also informed by the Consolidated Criteria for Reporting Qualitative Research developed by Tong et al. (2007).

Ethical Considerations

Ethical approval was obtained from the sponsoring university's Institutional Review Board before participant recruitment commenced, under Protocol No. 2025-041. Permission to conduct research involving district employees was also obtained from the school district's research review office.

Participation was voluntary, and participants were informed that their decision to participate or decline participation would have no effect on their employment, professional evaluation, or relationship with the school district or university. Electronic informed consent was obtained before each interview, and participants were informed that they could decline to answer any question or discontinue participation without penalty.

Confidentiality received particular attention because participants discussed organizational practices, technology policies, administrators, colleagues, and potentially sensitive workplace experiences. School and district names were not reported, and potentially identifying details were generalized when necessary. Teachers and administrators from the same schools were not informed about one another's participation, and individual responses were not shared with supervisors, district officials, or other participants.

Research data were stored in secured university approved electronic storage and were accessible only to the research team. Identifiable information was stored separately from interview transcripts and analytic materials. Data were retained for five years following publication and were scheduled for permanent deletion at the conclusion of the retention period.

Results

Analysis of the 24 interviews identified six interconnected themes that characterized barriers to artificial intelligence integration across the participating schools. The themes reflected both individual and organizational dimensions of implementation. Although teachers and school leaders frequently recognized similar challenges, they did not always interpret their causes, severity, or appropriate responses in the same

way. The findings indicated that AI integration was constrained not by a single dominant barrier but by the interaction of teacher preparedness, professional development, institutional guidance, ethical and pedagogical concerns, technological resources, and organizational leadership.

Uneven Knowledge and Confidence Created Different Starting Points for AI Integration

The first theme concerned substantial differences in participants' knowledge of artificial intelligence and their confidence in applying it professionally. Most teachers reported some familiarity with widely available generative AI applications, but familiarity varied considerably. Several teachers had incorporated AI into lesson planning, instructional material development, or administrative tasks, whereas others had experimented only occasionally. A smaller group had deliberately avoided using AI because they were uncertain about its reliability or appropriate educational applications.

Fourteen of the 16 teachers described their knowledge of AI as primarily self developed. Participants reported learning through personal experimentation, conversations with colleagues, social media, online videos, or informal professional networks rather than through systematic preparation provided by their schools. This informal learning produced considerable variation in how educators understood both the capabilities and limitations of AI.

One middle school teacher explained the uncertainty associated with this process:

"Most of what I know came from trying it myself. Nobody really sat us down and explained what it can do, what it cannot do, and where we should be careful. You learn something from another teacher, then you go home and experiment."

Teachers who reported greater familiarity with AI generally described higher levels of confidence, but technological familiarity did not always translate into instructional confidence. Several participants distinguished between knowing how to generate content with an AI application and knowing whether the resulting material was educationally appropriate. Teachers expressed uncertainty regarding how extensively AI generated materials should be modified, whether outputs were developmentally appropriate, and how to evaluate information produced by systems whose sources were not always transparent.

A high school teacher described this distinction:

"I can make it give me a lesson plan. That is not really the difficult part. The difficult part is deciding

whether what it gave me is good enough for my students and whether using it actually improves what I would have done."

School leaders recognized differences in teacher readiness but frequently characterized those differences as individual variation in technological comfort. Teachers, however, tended to connect their confidence to the amount and quality of institutional preparation they had received. This difference in interpretation became important across later themes because leaders sometimes perceived teachers as reluctant adopters, while teachers attributed their hesitation to insufficient preparation and unclear expectations.

The findings therefore suggested that AI readiness was not a uniform characteristic of the teaching workforce. Participants entered the implementation process with different levels of knowledge, prior exposure, technological confidence, and pedagogical understanding. These differences shaped whether AI was perceived as a useful instructional resource, an uncertain innovation, or a potential professional risk.

Professional Development Was Viewed as Insufficiently Practical and Sustained

Professional development emerged as a second major barrier. Although six of the eight school leaders reported that their schools or district had provided some form of AI related professional learning, teachers generally considered the available preparation insufficient for sustained classroom integration.

Eleven teachers recalled participating in at least one formal presentation, workshop, or professional development activity addressing artificial intelligence. However, participants frequently described these experiences as introductory rather than instructional. Professional development commonly focused on explaining what generative AI was, demonstrating particular applications, or discussing concerns about student use. Teachers reported fewer opportunities to develop subject specific strategies, practice using AI with authentic instructional tasks, or receive follow up assistance after initial training.

An elementary school teacher described the problem as a difference between exposure and preparation:

"We had a session about AI, but I would not say we were trained to use it. Someone showed us some tools and examples. When I went back to my classroom, I still had to figure out what made sense for third graders."

Teachers also emphasized that professional development needs varied according to grade level, subject area, and professional responsibility. High school teachers were particularly concerned with assessment,

academic integrity, and the authenticity of student work. Elementary teachers more frequently raised questions about age appropriate use and the role of AI in developing foundational skills. Special education teachers discussed accessibility and differentiation but also expressed concern about relying on generated content without sufficient knowledge of individual student needs.

School leaders generally agreed that additional training was needed, but resource and scheduling constraints affected what could be provided. Leaders described competing professional development requirements and limited time within the academic calendar. One principal explained:

"There are many things we are required to train teachers on. AI is moving very fast, but we cannot simply remove everything else from the professional development calendar."

Participants also emphasized the speed with which AI applications changed. Several teachers reported that training on individual tools could become outdated quickly, making professional development centered exclusively on particular platforms less useful than training focused on broader competencies. Teachers expressed greater interest in understanding how to evaluate AI outputs, design appropriate instructional uses, protect student information, and make decisions about when AI should or should not be used.

Professional development therefore functioned as more than an individual capacity issue. Its adequacy depended on organizational decisions involving time, expertise, priorities, and continuing support. Participants' accounts suggested that brief exposure to AI applications did not provide the pedagogical and ethical preparation necessary for sustained integration.

Unclear and Inconsistent Policies Produced Uncertainty

Policy ambiguity represented one of the most frequently discussed organizational barriers. Participants reported uncertainty regarding what forms of AI use were authorized, what information could be entered into AI systems, which applications were approved, and how student use should be addressed.

Thirteen teachers described school or district expectations concerning AI as unclear, evolving, or inconsistent. Some participants reported receiving guidance concerning student academic integrity but little information about teachers' professional use of AI. Others described differences among departments or schools in how AI related practices were interpreted.

A high school teacher explained:

"We have rules about students using AI to write assignments, but there is much less clarity about what teachers can use it for. Can I use it to help make a rubric? Can I put student work into it? Those are the kinds of questions where people give different answers."

School leaders acknowledged the difficulty of developing policies while AI technologies were changing rapidly. Several leaders expressed concern that overly restrictive policies could prevent beneficial experimentation, while policies written too broadly might expose schools to privacy, ethical, or instructional risks. Leaders therefore described policy development as an ongoing process rather than a completed organizational response.

One assistant principal stated:

"The challenge is that by the time you feel comfortable writing a rule around one tool, the technology has already moved. You want teachers to innovate, but you also have responsibilities for students and data."

The absence of clear policy affected educators differently. Some teachers responded by experimenting cautiously with AI, while others avoided applications when they were uncertain about institutional expectations. Participants repeatedly indicated that uncertainty itself operated as a barrier. Teachers were concerned not only about whether a particular practice was appropriate but also about whether a decision made independently could later conflict with school or district expectations.

Policy inconsistency also influenced student expectations. Teachers reported that students could encounter markedly different rules across classrooms. A practice permitted by one teacher might be prohibited by another, creating confusion about acceptable AI assisted work. Participants suggested that such inconsistency made academic integrity more difficult to communicate and enforce.

The findings indicated that policy was not perceived simply as a mechanism for restricting technology. Participants frequently described clear policy as a form of support because it established boundaries within which educators could experiment with greater confidence.

Ethical and Pedagogical Concerns Limited Uncritical Adoption

The fourth theme involved ethical and pedagogical concerns. Participants emphasized that many of their reservations about AI were not caused by opposition to technology but by uncertainty regarding its effects on teaching, learning, professional judgment, and student development.

Accuracy was a prominent concern. Teachers described encountering incorrect, misleading, or fabricated information in AI generated content. Several participants stated that the need to verify outputs reduced the time saving benefits associated with AI. Teachers working in specialized content areas expressed particular concern about materials that appeared plausible but contained subtle factual or conceptual errors.

A science teacher explained:

"The answer can sound completely confident and still be wrong. If you already know the content, you can catch it. My concern is what happens when someone assumes that because the response sounds professional, it must be accurate."

Participants also raised concerns about overreliance. Teachers worried that extensive use of generative AI could reduce opportunities for students to develop writing, problem solving, creativity, and independent thinking. These concerns were especially pronounced among high school teachers, who frequently discussed the difficulty of determining whether submitted work represented students' own thinking.

However, teachers did not generally reject AI on this basis. Instead, many differentiated between applications they considered educationally productive and applications they believed could substitute for learning. AI use for brainstorming, differentiated examples, instructional planning, or feedback was often regarded more favorably than use that allowed students to bypass cognitive work central to an assignment.

Privacy represented another major concern. Teachers expressed uncertainty about what happened to information entered into public AI applications and whether student information should ever be included in prompts. School leaders were particularly sensitive to these issues because of their responsibility for institutional compliance and risk management.

Bias and fairness were discussed less frequently than accuracy and privacy but remained important. Participants questioned whether AI generated materials could reproduce cultural assumptions or provide different quality responses depending on the language and context supplied. Several educators serving culturally and linguistically diverse populations reported modifying AI generated examples because they did not adequately reflect the experiences of their students.

These accounts indicated that ethical and pedagogical concerns were intertwined. Participants did not conceptualize responsible AI use solely in terms of abstract ethical principles. They connected ethics to

concrete professional decisions involving accuracy, student development, privacy, fairness, instructional purpose, and the preservation of human judgment.

Resource, Access, and Time Constraints Shaped Opportunities to Experiment

The fifth theme involved material and organizational resources. Although all participating schools had internet connectivity and access to student devices, participants emphasized that these conditions did not eliminate resource barriers.

Teachers identified differences between free and subscription based AI applications as a practical concern. Free versions sometimes imposed usage limitations or provided fewer features, while paid applications created questions about who should bear the cost. Teachers who independently purchased subscriptions described doing so because they found particular tools useful, but they did not consider personal purchasing a sustainable model for schoolwide adoption.

One teacher stated:

"I pay for the version I use because it saves me time, but that cannot be the district's plan. You cannot say we are integrating AI and then expect every teacher to buy whatever tool they need."

School leaders described the difficulty of determining which applications justified institutional investment. Decisions involved not only cost but also privacy, compatibility with existing systems, technical support, and evidence of educational value.

Time was an equally important resource. Teachers reported that learning how to use AI productively required experimentation, evaluation, and revision. Participants frequently rejected the assumption that AI automatically saved time. Initial adoption sometimes increased workload because teachers had to learn unfamiliar systems, verify generated content, and redesign existing practices.

Unequal access among students was another concern. Participants noted that differences in home internet access, family resources, subscription access, and familiarity with AI could create disparities when students were expected to use such technologies outside school. Teachers therefore expressed caution about assignments that assumed equivalent access to AI resources.

These findings suggested that infrastructure should be conceptualized more broadly than the availability of

computers and internet connectivity. Sustainable AI integration required access to appropriate applications, technical support, professional learning, planning time, and equitable opportunities for students and educators.

Differences Between Teacher and Leader Perspectives Revealed an Implementation Gap

The final theme concerned differences between how teachers and school leaders interpreted the overall implementation environment. Teachers and leaders shared many concerns, but their accounts revealed several meaningful discrepancies.

The most prominent difference concerned institutional support. Six of the eight leaders believed their schools were generally supportive of teachers experimenting with AI. Teachers were less certain. Nine teachers described institutional support as limited or ambiguous, even when they acknowledged that administrators had not explicitly discouraged AI use.

This discrepancy appeared to result partly from different understandings of what constituted support. Leaders frequently described support in terms of providing access to workshops, permitting experimentation, distributing information, or making approved technologies available. Teachers more frequently defined support as practical guidance, sustained professional development, planning time, clear policy, and access to knowledgeable assistance when problems arose.

A teacher explained:

"They are not telling us not to use it, but that is different from helping us use it well."

A principal articulated the issue from a leadership perspective:

"We are learning at the same time. Teachers sometimes expect administrators to have definitive answers, but in many cases the guidance is still developing above the school level."

This distinction revealed that leaders themselves experienced barriers. They described uncertainty about evaluating rapidly changing technologies, limited district guidance, competing resource priorities, and concerns about making decisions with insufficient evidence. Leadership was therefore not simply a source of either support or resistance. School leaders were also participants in an evolving implementation process.

Taken together, the six themes demonstrated that barriers to AI integration were interdependent. Limited professional development contributed to uneven knowledge and confidence. Uneven knowledge increased concern about accuracy and ethical use. Policy ambiguity intensified hesitation and inconsistent practice. Resource constraints affected the availability of training and approved technologies. Differences in how teachers and leaders understood support further complicated organizational responses. AI integration therefore emerged as a multidimensional process shaped by interactions between individual professional capacity and the organizational environment.

Discussion

The purpose of this study was to examine barriers to artificial intelligence integration in K to 12 education from the perspectives of teachers and school leaders. The findings suggest that AI integration cannot be adequately explained as a problem of technological access or individual teacher willingness. Instead, implementation was shaped by interactions among educator knowledge, professional development, policy, ethics, resources, pedagogy, and leadership. The findings extend previous research by illustrating how these barriers were experienced within the same organizational settings and by identifying areas in which teachers and school leaders interpreted implementation conditions differently.

The finding that teachers differed substantially in AI knowledge and confidence is consistent with previous research showing uneven preparedness among K to 12 educators. Chounta et al. (2022) found that teachers could recognize the potential value of artificial intelligence while possessing limited knowledge of the technology. Yue et al. (2024) similarly identified gaps in teachers' AI related technological and content knowledge. More recently, Cheah et al. (2025) found that teachers in their U.S. sample were generally underprepared for generative AI integration and that fewer than half incorporated generative AI into educational practice. The present findings add contextual detail by suggesting that uneven readiness may partly reflect the informal pathways through which teachers acquire AI knowledge. When educators depend largely on personal experimentation or colleagues, professional capacity can vary substantially even within the same school.

The distinction participants made between technological familiarity and pedagogical competence is also theoretically important. Knowing how to operate an AI application did not necessarily provide teachers with the capacity to determine whether its outputs were accurate, developmentally appropriate, aligned with curriculum, or educationally valuable. This finding supports Celik's (2023) Intelligent TPACK perspective, which emphasizes the interaction of technological, pedagogical, and ethical knowledge in teachers' AI

related professional competence. AI integration therefore appears to require more than generalized digital literacy.

Professional development emerged as an important mechanism connecting teacher capacity with organizational support. Participants did not simply request more training. They distinguished introductory exposure from sustained preparation that addressed actual instructional problems. This pattern is consistent with Chen et al. (2025), whose study of 1,454 teachers in a large urban district found differing AI related concerns and professional development needs across grade levels. It is also consistent with Filiz et al. (2025), who found that teachers participating in AI focused professional development continued to encounter technical problems, curriculum alignment difficulties, ethical concerns, and contextual challenges. Professional development may consequently be most effective when it is differentiated by instructional context, connected to authentic professional tasks, and sustained beyond introductory demonstrations.

The findings also reinforce the distinction between first order and second order technology integration barriers initially articulated by Ertmer (1999). Resource availability, policy, training, time, and institutional support represent largely external conditions, whereas confidence, beliefs, perceptions of value, and concerns about instructional practice operate more directly at the level of the individual educator. However, the present findings support later arguments that these categories should not be treated as independent. Wang and Cheng (2021) found that barriers to AI incorporation in K to 12 schools were interconnected, and the current analysis illustrates similar relationships. Teachers' confidence, for example, was influenced by professional development and policy clarity. Their willingness to experiment was affected by whether leaders provided explicit guidance and whether appropriate technologies were available.

This interaction complicates explanations that attribute limited adoption primarily to teacher resistance. Participants who restricted their AI use frequently articulated specific professional reasons for doing so. They raised concerns about accuracy, student learning, privacy, academic integrity, and the preservation of professional judgment. Such reservations should therefore not automatically be interpreted as negative attitudes toward innovation. Filiz et al. (2025) likewise found that teachers perceived meaningful benefits from AI while simultaneously identifying ethical, technical, curricular, and cultural challenges. Adoption and concern can coexist.

Policy ambiguity emerged as an especially important organizational barrier. Teachers were more comfortable experimenting when the boundaries of acceptable use were clear, while uncertainty produced

inconsistent practice and, in some cases, avoidance. This finding is consistent with Cheah et al. (2025), who identified the absence of policies and guidance among barriers affecting generative AI integration among U.S. teachers. It also aligns with Gouseti et al. (2025), whose systematic review concluded that ethical policy development specifically addressing children and K to 12 education had lagged behind broader discussions of AI ethics.

The policy findings suggest an important distinction between regulation and enablement. Participants did not necessarily perceive policy as a constraint on innovation. Clear guidance could enable responsible experimentation by reducing uncertainty. Effective AI policy may therefore need to specify both boundaries and permitted practices. Policies concerned exclusively with academic misconduct may be insufficient because teachers also require guidance regarding their own professional use of AI, data privacy, approved applications, assessment, and appropriate human oversight.

Ethical concerns were similarly integrated into participants' everyday instructional reasoning rather than treated as separate philosophical questions. Accuracy, bias, privacy, fairness, academic integrity, and student dependence were discussed in relation to concrete decisions about teaching and learning. Gouseti et al. (2025) identified pedagogical appropriateness, children's rights, AI literacy, and teacher well being as particularly relevant dimensions of AI ethics in K to 12 settings. The present findings support the argument that ethical competence should be embedded within teachers' professional preparation rather than addressed only through compliance policies.

Concerns about student cognition were especially significant. Teachers distinguished between uses of AI that supported learning and those that potentially replaced the cognitive activity an assignment was designed to develop. This distinction suggests that debates surrounding AI integration should move beyond whether students should be permitted to use AI and instead consider what intellectual work students are expected to perform. An AI application may be appropriate for one instructional purpose and counterproductive for another.

Resource barriers also extended beyond conventional conceptions of technological access. Although participants worked in schools with internet connectivity and devices, they identified subscription costs, availability of approved applications, technical assistance, professional learning, and time for experimentation as important constraints. This broader understanding of infrastructure corresponds with the findings of Celik et al. (2022), Crompton et al. (2024), and Kim (2025), which collectively indicate that technological resources operate alongside institutional and professional conditions.

One of the most consequential findings concerned differences between teacher and leader perceptions of organizational support. Leaders generally perceived their schools as more supportive of AI experimentation than teachers did. This divergence appeared to reflect differences in how support was defined. Leaders frequently interpreted availability, permission, or introductory training as evidence of support, whereas teachers expected practical guidance, continued learning, policy clarity, and accessible assistance.

This finding contributes to the literature by positioning the teacher and leader relationship as an important component of AI implementation. Previous research has demonstrated the role of leadership in reducing barriers to AI integration (Cheng & Wang, 2023), but the present findings suggest that leadership support must also be recognized as meaningful by the teachers expected to implement technological change. Organizational support may therefore depend not only on what leaders provide but also on whether those resources correspond to teachers' actual instructional needs.

At the same time, school leaders should not be conceptualized simply as actors who possess the authority to remove barriers. Leaders in this study faced uncertainty of their own. They were required to make decisions concerning technology adoption, privacy, professional development, resource allocation, and institutional policy while AI capabilities and external guidance continued to develop. Effective implementation therefore requires capacity building at both the teacher and leadership levels.

The findings are also relevant to the broader policy environment surrounding AI education. Executive Order 14277, issued in April 2025, emphasized AI literacy and professional development for educators as part of the federal government's effort to advance AI education (Executive Office of the President, 2025). The present findings suggest that achieving such objectives depends on the organizational conditions through which national priorities are translated into school practice. Expanding access to AI education without simultaneously addressing educator preparation, leadership capacity, governance, infrastructure, and ethical guidance may produce uneven implementation.

Implications for Practice

The findings have several implications for schools and school districts seeking to integrate artificial intelligence responsibly. Professional development should be conceptualized as sustained capacity building rather than a single introduction to AI applications. Teachers require opportunities to develop technological understanding alongside pedagogical and ethical judgment. Training should be sufficiently flexible to address differences among grade levels, disciplines, and professional roles.

School leaders also require structured professional learning. Their responsibilities differ from those of classroom teachers and include technology evaluation, organizational governance, policy development, privacy, staff support, resource allocation, and risk management. Leadership preparation should therefore address both the instructional possibilities of AI and the organizational systems required to support responsible implementation.

The findings further suggest that schools should establish clear but adaptable AI guidance. Policies need not prescribe every possible use of rapidly evolving technologies, but they should clarify fundamental expectations concerning student data, approved applications, academic integrity, teacher use, human oversight, and the verification of AI generated information. Clear guidance can reduce uncertainty while preserving professional discretion.

Schools should also consider equity when making AI related decisions. If instructional use depends on personally purchased subscriptions, home technology access, or individual teachers' ability to independently learn new systems, implementation may reproduce or intensify existing differences in educational opportunity. Institutional strategies should therefore consider access to approved tools, professional learning, technical assistance, and time as components of equitable AI implementation.

Finally, implementation efforts should create mechanisms through which teachers can communicate their experiences to school leaders. The discrepancies identified in this study indicate that leaders may perceive organizational support differently from teachers. Regular opportunities for feedback can help schools determine whether policies, professional development, and resources are functioning as intended.

Implications for Research

The findings also identify several directions for continued research. Additional studies should examine AI integration across different school systems, geographic contexts, and institutional environments because barriers are likely to vary according to resources, policy structures, student populations, and organizational capacity. Comparative research involving urban, suburban, and rural schools could clarify how contextual conditions shape implementation.

Longitudinal research would be especially useful because educator perceptions and institutional responses are likely to change as AI technologies become more established. A barrier identified during an early stage of adoption may become less important after professional learning or policy development, while new

challenges may emerge as applications become embedded more deeply in instruction and administration.

Future qualitative research should continue to include multiple organizational roles. Teachers provide essential insight into classroom implementation, but school leaders, instructional technology specialists, students, parents, and district administrators may interpret AI related challenges differently. Examining these perspectives together can provide a more comprehensive understanding of how implementation decisions are negotiated within educational systems.

Research should also examine the effectiveness of particular organizational responses. Identifying insufficient professional development, for example, is only a first step. Further investigation is needed to determine which forms of professional learning produce sustained changes in educators' competence and practice and which governance models allow schools to respond to technological change while protecting students and preserving educational quality.

Limitations

The findings should be interpreted in light of several limitations. The study involved 24 participants from eight schools within a single metropolitan public school district. Although purposive sampling produced variation in grade level, subject area, experience, and professional role, the findings were shaped by the particular organizational and policy environment in which participants worked. They should therefore not be interpreted as statistically representative of K to 12 educators nationally.

Participation was voluntary, which may have resulted in greater representation of individuals who were particularly interested in or concerned about artificial intelligence. Educators with limited interest in AI may have been less likely to participate, while individuals with strongly favorable or unfavorable views may have been more motivated to discuss their experiences.

The study relied primarily on self reported interview data. Participants described their perceptions and experiences, but classroom observations, policy analysis, or direct examination of AI use were not used to independently assess reported practices. The findings consequently represent participants' interpretations of implementation rather than objective measures of AI adoption.

The rapidly evolving nature of artificial intelligence creates an additional limitation. The interviews captured participants' experiences during a specific period between February and April 2025. Changes in

AI applications, district policies, professional development, and public understanding may alter some of the barriers identified in the study over time.

The inclusion of both teachers and school leaders strengthened the comparative dimension of the research, but the two groups were not equally represented numerically. The smaller leadership sample reflected the organizational structure of the participating schools but limited the range of leadership perspectives available for comparison. Future studies could include larger samples of principals, district administrators, technology leaders, and curriculum specialists.

These limitations do not diminish the value of participants' accounts but establish the boundaries within which the findings should be interpreted. Consistent with qualitative inquiry, the purpose of the study was to develop a contextualized understanding of AI integration barriers rather than to estimate their prevalence across the entire K to 12 population.

Conclusion

Artificial intelligence is becoming increasingly accessible within K to 12 education, but technological availability alone does not produce meaningful educational integration. The findings of this qualitative study demonstrate that teachers and school leaders encounter a network of interconnected barriers involving professional knowledge, training, policy, ethics, pedagogy, resources, time, equity, and organizational leadership. These barriers operate simultaneously and frequently reinforce one another.

A central finding of the study is that AI integration should not be conceptualized primarily as a question of whether teachers are willing to adopt new technology. Teachers' decisions were shaped by legitimate professional considerations concerning accuracy, instructional purpose, student learning, privacy, academic integrity, and institutional expectations. Greater adoption should therefore not be treated as an educational objective independent of the quality and appropriateness of use.

The findings also demonstrate that professional development remains necessary but is unlikely to be sufficient when considered in isolation. Teachers require sustained opportunities to develop technological, pedagogical, and ethical competence, while school leaders require the organizational capacity to establish policies, allocate resources, evaluate technologies, and support responsible experimentation. Professional learning and organizational readiness must develop together.

The comparison between teacher and leader perspectives further indicates that implementation can be hindered when organizational support is understood differently across professional roles. Leaders may perceive that opportunities and resources have been provided while teachers continue to experience uncertainty about how AI should be used in actual instructional settings. Closing this implementation gap requires communication structures that connect leadership decisions with classroom experience.

Ethical and governance concerns must likewise remain integral to AI implementation. Questions involving accuracy, privacy, fairness, student autonomy, academic integrity, and human judgment are not peripheral issues that can be addressed after adoption. They shape whether and how AI should be used in the first place. Responsible integration consequently requires institutions to establish clear expectations while preserving sufficient flexibility for technologies and educational practices to evolve.

Ultimately, successful AI integration in K to 12 education depends less on the presence of sophisticated technologies than on the capacity of educational systems to create conditions in which those technologies can be used responsibly and purposefully. Schools that address teacher preparation without addressing leadership, policy, resources, and ethics may continue to experience fragmented adoption. Similarly, investments in technology without corresponding investments in professional capacity may produce access without meaningful integration.

The challenge for K to 12 education is therefore not simply to increase the use of artificial intelligence. It is to develop the professional knowledge, organizational structures, ethical safeguards, and leadership capacity necessary to determine where AI contributes to educational goals, where its use requires caution, and where human professional judgment should remain central. By examining the experiences of both teachers and school leaders, this study contributes to a more comprehensive understanding of that challenge and provides a foundation for developing AI integration strategies that are educationally meaningful, organizationally sustainable, and ethically responsible.

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