**Artificial Intelligence (AI) in K-12 Education: A Literature Review and Annotated Bibliography for Enhancing Student Learning and Decreasing Teacher Workloads**

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**Abstract**

This project explores the research question: 'How can AI-based tools be integrated into K-12 education to enhance teaching and learning experiences.' Through a literature review and an annotated bibliography, this study examines the impact of AI-based tools in K-12 education while investigating what steps must be taken to ensure these technologies' meaningful, appropriate, and ethical implementation. The literature reveals opportunities for integrating AI-based tools in K-12 education to enhance student learning and decrease teacher workloads. The benefits of AI-based tools for teachers include planning, implementation, and assessment support, and for students, these include immediate feedback, personalized tutoring, and metacognitive development. Although the literature review demonstrates the benefits of integrating AI-based tools in K-12 education, there are challenges, concerns, and considerations that educators and AI developers need to address. These include the technical integrity, privacy and security, and ethical concerns of AI-based tools. Although these are valid considerations, depending on the program used, they can be addressed through teachers' professional development, refined AI development processes, and future research opportunities. When these concerns are addressed, the research shows that AI-based tools can effectively integrate into K-12 education, enhancing student learning and decreasing teacher workloads.

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## Literature Review

Artificial Intelligence (AI) has been continually developed, utilized, and researched for decades, but the recent advancements in AI technology are changing how humans live, learn, and work (Chiu, 2021; Crompton & Burke, 2022; Zhang & Tur, 2023). Although some people intentionally use AI programs daily, such as ChatGPT, many others use AI applications without realizing it (Akgun & Greenhow, 2022). Through the development of these applications and programs, AI has become prominent in the fields of healthcare, education, communications, transportation, agriculture, and more (Akgun & Greenhow, 2022, p. 64). However, despite people's opinions about AI, it will continue to grow, develop, and expand into every aspect of human life (Ottenbreit-Leftwich et al., 2023; Touretzky et al., 2019). Since the development of AI technology is inevitable, this impact in "the field of education has garnered considerable attention from researchers" (Luckin & Cukurova, 2019; Zhang & Tur, 2023). This recent increase in research on implementing AI-based tools in K-12 education can be attributed to the rapid evolution of AI technology and the expectation that AI-based tools will revolutionize the field of education (Celik et al., 2022; Roll & Wylie, 2016; Zawacki-Richter et al., 2019).

Generally, AI refers to technology that can design, replicate, and complete tasks like humans. AI programs like ChatGPT can solve, make decisions, and learn through extensive programming, coding, and training (Celik et al., 2022; Hays et al., 2024; Murphy, 2019; Zhang & Tur, 2023). As these AI-based programs can do things humans have been educated about for centuries, there will be changes to teaching, learning, and education in the upcoming years and decades. That said, educators, students, and parents must understand AI's potential positive and negative impacts on K-12 education to implement AI-based tools in learning effectively (Antonenko & Abramowitz, 2023; Hays et al., 2024). It is also important to clarify that although

the thoughtful implementation of AI-based tools enhances student learning outcomes (Elgohary & Al-Dossary, 2022; Hays et al., 2024), AI will not replace teachers (Akgun & Greenhow, 2022; Murphy, 2019). This is because AI programs are not empathetic, personable, and able to understand emotions, which are necessary for effective social, emotional, and academic teaching. However, there are many ways in which AI can benefit education when the risks and challenges of AI-based tools are accounted for. AI can effectively enhance student learning outcomes, support educators, and decrease teacher workloads when utilized meaningfully, authentically, and ethically.

**Importance of AI in K-12 Education**

The widespread introduction of AI into education has been accompanied by uncertainty, excitement, and apprehension amongst students, parents, and educators. Although everyone has different opinions, it is essential to integrate AI-based tools, skills, and lessons in K-12 education (Antonenko & Abramowitz, 2023, p. 64). This is to experiment in improving education and ensuring students have the skills, knowledge, and ability to use AI effectively. Halaweh (2023) and Hays et al. (2024) states that students will use AI programs regardless of permission. Therefore, teachers must use and implement AI-based tools in education to demonstrate and teach students how this technology can be used appropriately. Hence, teachers and students must have access to these different AI applications (Crompton & Burke, 2022, p. 2). Although K-12 students need to learn the basics of these programs, AI can also be utilized in K-12 education to "enhance and enrich the learning process in [learning] environments" (Zhang & Tur, 2023, p. 13). This can mainly be seen through AI applications reducing language barriers, increasing student accessibility, and differentiating instruction (Hays et al., 2024; Lou, 2023; Murphy, 2019; Zhang & Tur, 2023). The primary goal of educators should be to ensure that students get

effective, engaging, and inclusive learning experiences. Therefore, if AI can increase teachers' abilities to provide meaningful education for students, AI-based tools are essential for education. How these tools can enhance education can be categorized into the promises and benefits of AI for teachers and students.

**Promises and Benefits of AI for Teachers**

The job of an educator is demanding, consistent, and exhausting. Hashem et al. (2023) state that teachers have higher burnout levels than other human service professionals primarily due to lesson planning and preparation, administrative duties, and the additional role of instructing, supporting, and assessing students through under-resourced school environments (Celik et al., 2022; Murphy, 2019). Although some believe AI will negatively impact education, AI programs can increase the capacity for K-12 education and positively support, enhance, and develop teachers' abilities to instruct students (Akgun & Greenhow, 2022; Trust & Pektas, 2018). Through the thoughtful implementation of AI in K-12 education, this technology can support teachers, improve student learning, and decrease teacher workload (Akgun & Greenhow, 2022; Celik et al., 2022; Crompton & Burke, 2022). AI-based tools provide opportunities for personalized feedback, instructional support, and streamlined administrative tasks.

Educators are required to communicate, evaluate, and assess student learning through formative and summative assessment methods. Although assessment is essential to learning, providing meaningful, accurate, and informative feedback on students' learning is time-consuming. The additional task of assessing students with diverse learning needs makes this process more challenging. Therefore, teachers can use AI-based tools to support them in providing student feedback (Akgun & Greenhow, 2022; Murphy, 2019; Zhang & Tur, 2023). This can "free teachers from the burden of possessing all knowledge and give them more room to

support their students" (Akgun & Greenhow, 2022, p. 431). Using these tools to support student feedback ultimately decreases teachers' workloads (Celik et al., 2022).

In addition, to ensure that all students' learning needs are met, teachers can benefit from AI-based tools to address students' diverse learning needs and provide instructional support (Akgun & Greenhow, 2022; Celik et al., 2022; Hays et al., 2024; Murphy, 2019; Zhang & Tur, 2023). As classrooms are composed of groups of students with various abilities, there are Intelligence Tutoring Systems (ITS) that can be implemented into K -12 education to differentiate content and accommodate students' learning (Celik et al., 2022; Murphy, 2019). These programs can quickly identify where students need extra support and provide learning content at their grade level. This enables teachers to meet all students' needs without the challenge of personalizing information for individual students (Murphy, 2019). For example, ChatGPT can identify insights, resources, and teaching strategies to support teachers in selecting appropriate learning activities. This makes teachers' lesson planning more efficient and effective without sacrificing lesson quality (Murphy, 2019; Zhang & Tur, 2023).

As a result, AI is enhancing education and decreasing teacher workloads by utilizing AI-based tools in education to assess students' work, provide differentiated instruction, and monitor student learning (Celik et al., 2022; Crompton & Burke, 2022; Hays et al., 2024; Trust & Pektas, 2018). This process "reduces the teaching burden on teachers" (Celik et al., 2022, p. 7) and supports teachers in focusing on aspects of their roles as educators that need immediate attention, such as timely intervention and assessment. If the integration of AI in education made teachers less effective, engaged, or supportive, then it would be detrimental to education and student learning. However, the research identifies that AI-based tools can positively support teachers and

student learning when educators are overworked, under-supported, and lacking the resources to effectively impact each student's learning.

**Promises and Benefits of AI for Students**

Whether students are natural learners or struggle with specific subjects, everyone has different learning needs, requirements, and preferences. In addition, all students are at different levels of understanding, connecting, and demonstrating their learning. This can make it challenging for all students to feel successful, included, and challenged in their learning. Although research has shown that integrating AI into education can positively address teacher workloads, it can also enhance student engagement and learning outcomes (Akgun & Greenhow, 2022; Celik et al., 2022; Murphy, 2019; Zhang & Tur, 2023). The benefits of students utilizing AI-based tools in K-12 education include immediate feedback, personalized tutoring, and receiving support for their learning requirements and preferences (Elgohary & Al-Dossary, 2022; Murgia et al., 2023; Murphy, 2019).

Although teachers can benefit from AI-based tools by providing meaningful, informative, and applicable feedback regarding students' work, "AI-generated feedback supports students' writing skills, metacognitive skills, and self-confidence" (Hays et al., 2024, p. 282). When used appropriately, students can receive immediate and detailed feedback, allowing them to learn from their mistakes, improve, and be proud of their work (Akgun & Greenhow, 2022; Hays et al., 2024). The AI-based programs can also guide students through their writing, produce quizzes on the content, and help students develop metacognition. Hays et al. (2024) found that AI-produced feedback supports students' abilities to recognize their mistakes, build on their writing process, and identify improvement areas. The benefits of utilizing AI-based programs in student learning can be seen through personalized tutoring systems, such as ITS (Crompton & Burke,

2022; Hays et al., 2024; Murphy, 2019; Zhang & Tur, 2023). These programs can support learning by tutoring students in specific subjects or providing outlines, suggestions, and assistance through one-on-one conversations. They can be utilized in all content areas and are as effective as human educators (Crompton & Burke, 2022; Hays et al., 2024).

While students can receive support, guidance, and personalized lessons from AI-based programs, implementing AI in K-12 education can encourage active engagement, understanding, and creativity. Also, learning about and interacting with AI technology can motivate students to pursue a career in developing AI technologies. Elgohary and Al-Dossary (2022) state that utilizing AI-based tools helped students' motivation and creative thinking skills (p. 282). This is beneficial for students learning as it ensures that students have positive mindsets regarding education, can move toward their learning goals, and have opportunities to explore new opportunities, situations, or content areas to pursue their interests effectively. When AI-based tools are implemented in education, students are exposed to new technologies and "this can inspire future users, ethical designers, software developers, and researchers." As Chiu (2021) states, introducing these technologies in K-12 education can inspire students to pursue AI in their education and jobs (p. 804).

The possibilities of implementing AI in K-12 education to support student learning are endless. Research has shown the benefits of AI-based tools in supporting students' learning through feedback, learning support, and metacognition. Although students and teachers can use AI-based tools to enhance their work, some challenges and ethical considerations must be addressed to ensure these technologies are used appropriately and responsibly.

**Challenges of Implementing AI in K-12 Education**

  Educators and students need to be educated on how to implement AI appropriately in K-12 education, as there can be limitations and concerns regarding AI's integrity, limitations, and bias (Celik et al., 2022; Hays et al., 2024; Murphy, 2019). A challenge in integrating AI into K-12 education is the lack of technical infrastructure throughout many school systems (Celik et al., 2022; McCarthy et al., 2016). This directly impacts teachers' ability, motivation, and understanding of how AI-based tools can support them in student learning and teacher tasks. In addition, Celik et al. (2022) state that although there can be limited technological infrastructure in K-12 education systems, there are other concerns about AI-based programs' limited reliability, technical capacity, and applicability in multiple settings (p. 12). These are challenges for implementing AI-based tools because if these programs inaccurately evaluate student learning, these tools have limited benefits in K-12 education. However, even if schools were equipped to support the teachers' and students' use of AI-based tools in education, there could still be concerns regarding AI's limitations and bias (Hays et al., 2024; Murphy, 2019; Zhang & Tur, 2023).

  While AI-based programs, such as ChatGPT, have been shown to impact teacher workloads and enhance student learning positively, Zhang and Tur (2023) have found limitations in ChatGPT's ability to complete tasks accurately. Their findings have shown that ChatGPT can have low task specificity, limited reasoning abilities, and an inability to complete specific tasks (p. 10). In some instances, students have decreased productivity because they over-rely on AI program features (Zhang & Tur, 2023, p. 9). Another concern that Zhang and Tur (2023) and Murphy (2019) found was regarding AI program bias. Those studies have found bias in AI programs' output, and the authors emphasize that users need to review content, fact-check

information, and use the programs thoughtfully. Although AI programs' technical capacity, limitations, and bias are valid concerns, ethical considerations are the primary challenges for supporting the implementation of AI-based tools in K-12 education.

As Akgun and Greenhow (2022) state, "the ethical drawbacks of [AI] are rarely considered in K-12 contexts [and] these challenges of AI must be introduced to teachers and students" (p. 431). These ethical risks of implementing AI programs for students in education include privacy concerns, surveillance, autonomy, and academic dishonesty (Akgun & Greenhow, 2022; Hays et al., 2024; Zhang & Tur, 2023). However, there are continual conversations regarding educational technologies. Educators, administrators, and school systems need to ensure the safety of students' data and autonomy while using different technological tools to support learning. However, if these challenges of implementing AI-based tools are addressed, integrating these technologies in K-12 education can benefit student learning and teacher workloads.

**Future Directions for AI in K-12 Education**

Research has demonstrated that AI-based tools can enhance student learning outcomes and decrease teacher workloads. However, as noted above, challenges, concerns, and considerations must be addressed before AI can effectively impact K-12 education. These include addressing educators' misconceptions regarding AI through professional development, developers of AI programs recognizing changes that need to be made, and researchers providing more information about the impacts of AI in education.

**Professional Development**

As new technologies are developed, there will always be misconceptions regarding how they are used, what they are for, and how they will impact education. This is evident with AI

programs as society, especially K-12 teachers, has misconceptions regarding AI (Antonenko & Abramowitz, 2023, p. 65). Hays et al. (2024) state that some teachers make significant decisions regarding AI with misconceptions about what it is, how it is used, and what it can do for education (p. 283). Educators need to have an educated understanding of AI-based tools and how they can be utilized in K-12 education, as when teachers have misconceptions, false information is spread throughout communities. These misconceptions about AI must be corrected (Antonenko & Abramowitz, 2023), and Craig et al. (2022) have shown that this can be done through professional development workshops.

These workshops for educating teachers regarding AI-based tools can encompass the basics of AI, ethical considerations, and how they can effectively incorporate them into their classrooms (Akgun & Greenhow, 2022; Antonenko & Abramowitz, 2023; Hays et al., 2024). These workshops, programs, and support for educators are essential because, as Antonenko and Abramowitz (2023) state, many teachers have yet to participate in AI training, have been informed by non-AI experts, and have not yet used AI-based tools (p. 65). This must change as students need educated, informed, and appropriate guidance on appropriately using these programs. These workshops can provide instruction and resources to educators to recognize the importance of AI-based tools and how they can enhance student learning while decreasing teacher workloads.

**AI-Program Developers**

To effectively implement AI-based tools into education, there must be open communication between students, educators, and programmers. Many AI programs are created by developers who are not educators and lack pedagogical awareness (Celik et al., 2022; Luckin & Cukurova, 2019). This is challenging as the developed programs may not be implemented in

education as they lack essential aspects of usability, ethical considerations, and applicability to learning. As Celik et al. (2022) state, teachers must be included in creating, developing, and implementing AI in K-12 education for AI-based tools to be successfully implemented and utilized in education (p. 2). It is also crucial for AI program developers to ensure that educational AI-based tools are culturally responsive and ethically appropriate regarding student surveillance, privacy, autonomy, and bias (Akgun & Greenhow, 2022; Murphy, 2019). Suppose AI program developers can address these concerns and include educators' thoughts, ideas, and perceptions in the design of different applications. In that case, implementing AI in K-12 can be ethical, appropriate, and beneficial for students and teachers.

**Future Research Needs**

Although educational technology studies regarding the implementation of AI-based tools in education have increased in the past decade, many topics, issues, and concerns still need further research (Celik et al., 2022; Crompton & Burke, 2022; Hays et al., 2024). Notably, further research needs to be completed on teachers' AI use (Celik et al., 2022), students' AI use (Hays et al., 2024), pre-service teachers' awareness and skills of AI, and ethical considerations (Crompton & Burke, 2022). Conducting education research on AI's impact on K-12 education is necessary as AI will continue to impact student learning, and educators must know how to appropriately address, integrate, and utilize AI technologies to enhance student learning and decrease their workload.

**Conclusion**

Artificial Intelligence (AI) has radiated throughout K-12 education and communities. The use of technology that can think, create, and complete tasks like humans has shown that it will impact teaching and learning. Although people are skeptical and hesitant regarding implementing

AI technology into K-12 education, recent research has shown that the appropriate integration of AI-based tools can enhance student learning and decrease teacher workloads. This can be seen through students' receiving immediate feedback, personalized tutoring, and support from AI-based tools for their various learning needs, requirements, and preferences. On the other hand, teachers can utilize these technologies to provide personalized feedback, instructional support, and streamlined administrative tasks. These tools can reduce teachers' time spent on non-teaching tasks, but integrating these tools into K-12 education also has challenges, concerns, and complications.

Educators must be aware of current AI-based tool's limitations, biases, and ethical concerns before implementing these technologies in their classrooms. As seen through recent research studies, school systems may need more technological infrastructure to implement different AI programs for learning, and there are limitations on how these programs can be utilized for students, as non-certified educators have developed many AI-based tools. However, this does provide opportunities for future directions for AI-based tools in education. AI programmers need to ensure that their programs are ethical, appropriate, and responsible so that students can use these programs without concerns regarding privacy, autonomy, and bias. Another future direction for appropriate implementation of AI-based tools in education is through educators' professional development. Teachers must understand and have the skills to use AI-based tools to enhance student learning appropriately. This also includes ensuring that their misconceptions of AI are corrected and that they are leaders in technology rather than their students having more knowledge about these technologies. The final future direction for AI in K-12 education is regarding research. More studies are needed regarding teachers' use of AI,

students' use of AI, and how to implement AI ethically, appropriately, and respectfully in K-12 education.

Although there is a need for professional development, educator-informed AI-based tools, and more research on AI in education, these tools have shown many benefits for learning and teaching. Through the thoughtful implementation of AI-based tools in K-12 education, these technologies can effectively, meaningfully, and authentically enhance student learning and decrease teacher workloads.

## Annotated Bibliography

Before completing the literature review and annotated bibliography, 20 research articles were selected for their applicability to the research question: 'How can AI-based tools be integrated into K-12 education to enhance teaching and learning experiences.' The University of Victoria (UVic) library's online database was the primary source for these articles, and the Boolean language "education*" AND "K-12" AND "Artificial Intelligence" was utilized. The limitations of the sources were "full text online," "peer-reviewed," and "Journal articles" on the subjects of "Artificial intelligence" and "Education." This yielded 212 sources, and 20 articles were used in this study through the eliminatory process. Ten of the 20 articles in the literature review were selected for the annotated bibliography.

Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, *2*(3), 431–440. https://doi.org/10.1007/s43681-021-00096-7

This article by Akgun and Greenhow (2022) focuses on the ethical considerations and challenges of integrating Artificial Intelligence (AI) in K-12 environments. Through this

synthesis study, although Akgun and Greenhow (2022) have stated that utilizing AI can support student learning and teachers' practices, they argue that AI's ethical and societal implications are rarely considered. The article aims to explore the utilization of AI programs in K-12 education by providing a framework and resources for the ethical implementation of AI-based programs. Through this synthesis study, the authors stated that the benefits of AI include personalized learning, automated assessment systems, and facial recognition. In contrast, the ethical challenges of integrating AI into K-12 education include privacy, surveillance, autonomy, bias, and discrimination. It was interesting that Akgun and Greenhow (2022) assessed automated assessment systems as a benefit, not an ethical consideration, as assessments should be utilized to personalize learning, guide instruction, and provide meaningful feedback. While automated assessment systems are efficient, they can negatively impact meaningful evaluations to improve student learning. Regardless, the authors presented resources and tools from MIT Media Lab and Code.org to ensure that AI-based tools are authentically and ethically implemented in K-12 education. This research was completed in affiliation with Michigan State University, contributes to research regarding AI in K-12 education, and addresses the research gap in the ethical implications of AI education. Akgun and Greenhow (2022) provide reliable information regarding AI in education to further support teachers, students, and administrators in engaging with AI technologies. This article is beneficial for this research question as it is situated in K-12 education, shows the benefits of AI-based tools for teachers, and addresses ethical and responsible use challenges. Although AI has significant opportunities to improve teacher practices and enhance student learning outcomes, the ethical implications of AI-based tools must be discussed, researched, and evaluated. As noted by Akgun and Greenhow (2022), more

research is essential for designing future resources that address AI privacy and bias-related ethical concerns. (326 words)

Antonenko, P., & Abramowitz, B. (2023). In-service teachers' (mis)conceptions of artificial intelligence in K-12 science education. *Journal of Research on Technology in Education*, *55*(1), 64–78. https://doi.org/10.1080/15391523.2022.2119450

This quantitative research study conducted by Antonenko and Abramowitz (2023) from the University of Florida focuses on science teachers' misconceptions of Artificial Intelligence (AI) in science education. The authors state that society's future relies on informed AI perspectives and skills, and to effectively integrate these AI tools, skills, and lessons into K-12 education, teachers must be appropriately educated on AI and its possibilities in education. This study highlights K-12 science teachers' conceptions and misconceptions about AI in education. This is a survey-based research study, like the study conducted by Hays et al. (2023), and 53 teachers from the Southeastern United States participated in the (Mis)conceptions of AI survey (MAIS). The participants included 21 elementary school educators, 14 middle school educators, and 18 high school educators. Through the authors' data analysis, common participant misconceptions regarding AI were that it inherently possesses bias, struggles to process complex data, and programs can self-learn. These are valuable professional development opportunities for clarifying AI misconceptions, as the authors state that these misconceptions affect educators' willingness to implement AI into their teaching practices. In addition to the misconceptions identified by Antonenko and Abramowitz (2023), the authors state that teachers are enthusiastic about the potential of AI for K-12 education, believe it is essential for their students to

understand the basics of AI, and are overall not concerned or unsure about the ethics of AI in K-12 education. This study provides valuable insights and information for minimizing AI misconceptions as they negatively affect the effective implementation of AI in K-12 education. While this study focuses on States in the Southeastern USA, the data and its analysis are more generalizable than Chiu (2021), as Antonenko and Abramowitz (2023) incorporate a larger population and diversity of educators. This study demonstrates the importance of accurate, informative, and practical teacher education on AI, and the data, analysis, and information in this study are essential for this research question as it provides an awareness of educators' misconceptions, readiness, and ability for implementing AI in K-12 education. The study's findings demonstrate that professional development workshops would be valuable in minimizing teachers' AI misconceptions and preparing teachers for effectively implementing AI in education, which would increase teacher efficiency, reduce workload, and improve student learning outcomes. (371 words)

Celik, I., Dindar, M., Muukkonen, H., & Järvelä, S. (2022). The promises and challenges of artificial intelligence for teachers: A systematic review of research. *TechTrends*, *66*(4), 616–630. https://doi.org/10.1007/s11528-022-00715-y

This systematic review of research study, conducted by Celik et al. (2022), explores the use of Artificial Intelligence (AI) in education. It is published in *TechTrends*, a peer-reviewed journal focusing on technology in education. This article aims to explore the promises and challenges of AI for teachers. The authors state that most AI programs are developed for profit, and since teachers do not develop these programs, Celik et al. (2022) argue that there needs to be

more understanding and research on AI-based tools from the teachers' perspective. Therefore, this study attempts to address this gap. Through a review of research, the authors found that AI-based tools can positively impact teachers' planning, implementation, and assessment in education. It was discovered that the challenges of implementing AI-based tools in education for teachers include the limited reliability, technical capacity, and infrastructure of these AI-based tools and a lack of technological knowledge and interest from teachers regarding AI. Through this study, the researchers reviewed 44 studies published since 2004, 22 of which were published since 2018. Although the researchers used reliable and valid sources, this discrepancy in the year of publication shows that research on AI in education is increasing, and the amount of trustworthy, usable, and applicable sources on AI in K-12 education is accumulating. This study offers valuable insights and reliable information on the research topic of how AI-based tools can be utilized in education. It emphasizes the importance of teacher involvement in AI program development, showcases the promises of AI-based tools for teachers, and provides a foundation of understanding for the AI landscape in education. (264 words)

Chiu, T. K. F. (2021). A holistic approach to the design of artificial intelligence (AI) education for K-12 schools. *TechTrends*, *65*(5), 796–807. https://doi.org/10.1007/s11528-021-00637-1

This article provides a holistic framework for integrating K-12 Artificial Intelligence (AI) in education, focusing on curriculum design's content, product, process, and praxis. Like Celik et al. (2022), this study is published in *TechTrends*, a reputable and peer-reviewed journal for educational technology. Chiu (2021) states that few studies have addressed how to design effective and valuable AI educational curricula, and this study aimed to develop a model of AI

curriculum that incorporates teachers' thoughts, perspectives, and ideas. Chiu (2021) argued that many studies of AI in K-12 education focus on the tools and skills needed to utilize AI. However, curricular design is a dynamic process involving personalized learning for teachers' classrooms of diverse learners. Through the author's study, he used a qualitative research method which incorporated interviews, document analysis, and meetings with 24 teachers from 12 Hong Kong middle schools. He interviewed the educators about their perspectives on effective AI curricular design regarding what content, learning outcomes, and strategies should be implemented in K-12 education. The participants identified knowledge, process, impact, student relevance, communication, and flexibility as aspects of a holistic approach to designing AI curricula. A strength of this study is the diverse teaching perspectives, attitudes, and thoughts throughout the research and data. Limitations of Chiu's (2021) article for this project include its context in Hong Kong, data collected from a small geographic area, and the fact that its curricula were not tested. Although this study is focused on Hong Kong middle schools, future research would be beneficial in increasing the generalizability of Chiu's study and framework. This article is relevant and applicable to how AI can be implemented in K-12 education. It offers a structured approach to integrating AI into K-12 education and states the importance of teacher input in curricular design. Chiu (2021) has provided a foundation for the multitude of aspects regarding AI in K-12 education and highlighted the importance of flexible, adaptable, and teacher-informed curricula. (320 words)

Crompton, H., & Burke, D. (2022). Artificial intelligence in K-12 education. *SN Social Sciences*, *2*(7), 1–14. https://doi.org/10.1007/s43545-022-00425-5

Crompton and Burke (2022) completed this study, published in the Springer Nature Social Sciences journal, focusing on how Artificial Intelligence (AI) is used in K-12 education. The authors have stated a gap in teachers' and students' understanding of the educational benefits of using AI-based tools. Their study examines how AI-based tools support teaching and learning in K-12 education environments. Through a thematic systematic review of 204 studies utilizing PRISMA principles, Crompton and Burke (2022) answered their research questions on how AI-based tools can support K-12 educators and students. They discovered that AI could support teachers in student monitoring, group management, automatic grading, and data-driven decisions. In addition, Crompton and Burke (2022) found that AI can help students through personalized, individualized, and differentiated learning. This article is reliable and unbiased, as demonstrated through the study's methodology, and it highlights that future research is required to understand the ethical implications of integrating AI-based tools in K-12 education, which connects to the research completed by Akgun and Greenhow (2022). Crompton and Burke (2022) provide a comprehensive summary of teachers' and students' utilization of AI-based tools in education, and the authors show the potential of using AI programs to decrease teacher workload and enhance the personalization of student learning. This article emphasizes the importance of integrating AI thoughtfully, authentically, and meaningfully into education. Their data and information provide an approach for implementing technology in K-12 education. This article applies to this research question as it discusses the benefits of AI in education and the ethical considerations of implementing AI in K-12 education. The study's findings support the integration of AI in K-12 education, demonstrating positive effects on teacher workload and student learning outcomes. (279 words)

Hays, L., Jurkowski, O., & Sims, S. K. (2023). ChatGPT in K-12 Education. *TechTrends*, *68*(2), 281–294. https://doi.org/10.1007/s11528-023-00924-z

This quantitative study, conducted by Hays et al. (2023), explores ChatGPT in K-12 education. The authors acknowledge that although there are news articles, opinions, and research on the potential impact of ChatGPT in education, there needs to be more research on how K-12 educators implement ChatGPT in school systems. The study aims to close that research gap and understand teachers' perceptions and uses of ChatGPT in Missouri. A survey-based study by Hays et al. (2023) distributed a questionnaire to all Missouri K-12 schools, and 89 educators responded with a consensus of neutral feelings regarding the integration of ChatGPT in education. More teachers were unfavourable towards implementing ChatGPT in education despite over 40% of educators not being knowledgeable about ChatGPT and only 18% of participants actively integrating ChatGPT into their work as educators. However, the participants were interested in professional development opportunities for integrating ChatGPT into education. Through the survey, participants identified concerns regarding the ethical use, academic integrity, and effective implementation of ChatGPT in education. Participants gave various responses, and there were valuable statistics and insights regarding this survey. Since this study by Hays et al. (2023) was conducted in Missouri, there are limitations regarding the generalizability of their results. Still, the authors provide a framework for expanding their survey into different geographic areas and building on their findings. Overall, Hays et al. (2023) add to the study completed by Akgun and Greenhow (2022) regarding the ethical use of AI in K-12 education. The authors argue for increased guidelines and professional development to implement ChatGPT in K-12 education successfully. This study is relevant and applicable to this

research question as the data from Hays et al. (2023) is diverse, reliable, and informative. In addition, the study provides a foundation for integrating ChatGPT as an AI-based tool in education, and the authors advocate for the balanced, informed, and ethical implementation of ChatGPT in K-12 education. The authors state that there is a need for additional research with larger participant populations and that this survey should be conducted again after one year for a continued study. (344 words)

Murphy, R. F. (2019). Artificial intelligence applications to support K–12 teachers and teaching. *Perspective: Expert Insights on a Timely Policy Issue*, 1–20. https://doi.org/10.7249/PE315

This literature review by Murphy (2019) examines potential Artificial Intelligence (AI) programs and applications that positively impact K-12 education. Through this article, Murphy (2019) recommends resources, aims to identify AI-based tools that can help teachers address challenges in the classroom, and reviews AI applications used in schools to support instruction. Through Murphy's (2019) review of existing literature, he found that intelligent tutoring systems (ITS), automated essay scoring (AES), and early warning systems can support teachers and student learning. These current uses of AI programs can personalize learning, provide feedback on writing, and identify at-risk students. Although Murphy (2019) identified positive aspects of AI-based tools in education, he acknowledges that ITS has limitations on student learning, there are concerns regarding learned bias in AI systems, and it is essential for the transparency of limitations of AI models. Although the author has acknowledged a limited influence and lack of research on AI applications in education, it is essential to note that this article was written in 2019, before the release of major AI programs, such as ChatGPT. However, its information, data,

and analysis are still relevant in AI education research. Murphy (2019) also identifies that AI has the potential to positively impact teachers' capabilities and allow teachers to deliver more effective classroom instruction. The author argues that the most effective AI-based tools in education will support teachers rather than replace them. In addition, Murphy (2019) states that AI developers need to address data privacy regulations, algorithmic bias, and transparency. This article is relevant to this research question as Murphy (2019) identifies promising AI programs, evaluates AI's impact on education, and discusses AI limitations. The author acknowledges how AI-based tools can support teachers, enhance student learning, and decrease teacher workload. (287 words)

Ottenbreit-Leftwich, A., Glazewski, K., Jeon, M., Jantaraweragul, K., Hmelo-Silver, C. E., Scribner, A., Lee, S., Mott, B., & Lester, J. (2023). Lessons learned for AI education with elementary students and teachers. *International Journal of Artificial Intelligence in Education*, *33*(2), 267–289. https://doi.org/10.1007/s40593-022-00304-3

Ottenbreit et al. (2023), affiliating with Indiana University and North Carolina State University, investigated how to introduce Artificial Intelligence (AI) effectively and meaningfully to K-12 students. Like Roll and Wylie (2016), this study was published in the *International Journal of Artificial Intelligence in Education*, a reputable and reliable source for educational technology research. The authors state that introducing AI to K-12 students must ensure they are well-prepared and successful as workers, creators, and innovators. However, the framework of successful AI curricula for K-12 students is multifaceted and complex. Therefore, through a qualitative study, Ottenbreit et al. (2023) aimed to investigate introductory AI concepts

to implement in education and co-design AI curricula with support from teachers. Many limitations and gaps in previous frameworks were due to the need for K -12 educators who designed AI curricula. Through this study, the authors utilized a two-phased qualitative research design method, including student interviews and collaborative meetings with teachers. The authors' interviews with students examined their understanding of AI, while the meetings with teachers explored how they would teach AI to those students. Ottenbreit et al.'s (2023) data analysis show that students associate AI with programming or coding, and teachers recognize the importance of educating students on AI technology. Students demonstrated that they have a gap in understanding AI's decision-making processes but were able to identify the positive and negative implications of using AI in education. Ottenbreit et al. (2023) argue that designing AI curricula that connect to students' existing knowledge must be meaningful to students, accessible to teachers, and co-designed with educators. This study provides essential insights into successfully designing an AI curriculum for K-12 education. Although this study focuses on a small sample group of 10 students and three teachers, the information is reliable and provides essential information for successful curriculum development. As this is a more recent field of research, it allows for further studies using Ottenbreit et al.'s (2023) approach with larger sample sizes regarding AI curricular design. This study completed by Ottenbreit et al. (2023) is practical for this research question as it identifies introductory AI concepts, emphasizes the importance of teacher involvement, and acknowledges ethical considerations. (358 words)

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, *26*(2), 582–599. https://doi.org/10.1007/s40593-016-0110-3

Roll and Wylie (2016) conducted this literature review and analysis, published in the *International Journal of Artificial Intelligence in Education* (*IJAIED*). As the authors stated, Artificial Intelligence in Education (AIED) has evolved and revolutionized education over the past 25 years. To explore the trends, evolution, and potential directions of AIED, the authors reviewed and analyzed 47 papers in the *IJAIED* and published in 1994, 2004, and 2014. The study aimed to analyze the AIED field, identify shifts in focus, and explore new opportunities for evolution and revolution in AI in education. Through the literature review, Roll and Wylie (2016) discovered that AIED research has been primarily composed of personalized tutoring systems, research trends regarding an increase in empirical research on AIED, and focuses on STEM subjects. The authors argue that AIED research balances evolving existing frameworks and revolutionizes interactive learning environments (ILE). Through this, AIED's frameworks must expand to incorporate informal learning environments, cultural norms, and new technologies. The study's comprehensive analysis of information has created a reliable and valid overview of AIED evolution, and it uniquely describes the trends, evolution, and revolution of AI in education. However, although Roll and Wylie (2016) only focused on papers in the *IJAIED* journal, which may have limited the scope of the study, the authors have identified the growth of AIED implementation and research. This article positively contributes to our understanding of AI in K -12 education, and the authors' findings apply to the research question of how AI-based tools can be effectively implemented in education through needing to revolutionize how AI is implemented to enhance teaching, increase student learning experiences, and address teacher workload. (272 words)

Zhang, P., & Tur, G. (2023). A systematic review of ChatGPT use in K-12 education. *European Journal of Education*, 1–22. https://doi.org/10.1111/ejed.12599

Zhang and Tur (2023), in affiliation with the University de les Illes Balears in Spain, recognized a gap in the research regarding how ChatGPT is implemented in K-12 education. This article was published in the *European Journal of Education* and communicates the use of ChatGPT in educational settings. This study utilized a systematic review of existing literature following PRISMA guidelines and focused on 13 papers that met the authors' criteria. This article aimed to identify the strengths, weaknesses, opportunities, and threats (SWOT) of implementing ChatGPT in K-12 education. Zhang and Tur (2023) state that the strengths of ChatGPT in education are personalized learning, student achievement, and the ability of AI programs to improve teacher efficiency. This has potential opportunities for differentiated instruction, AI-supported curriculum development, and teacher support. However, the weaknesses of ChatGPT include low task specificity and content output, while the threats of AI programs include data privacy and ethical concerns. These themes of the positives and challenges of teacher support, ethical considerations, and personalized learning have also been identified in the studies of Celik et al. (2022), Hays et al. (2023), and Murphy (2019). Through Zhang and Tur's (2023) data analysis, the authors recommend developing policies for implementing AI in K-12 education and ensuring teachers are appropriately educated on ChatGPT uses. This study provides reliable data analyses and information regarding how ChatGPT can be utilized in K-12 education. The authors focus on gaps in existing literature, which supports this research question in acknowledging how AI programs, specifically ChatGPT, can positively impact student learning outcomes and teacher workload when done

meaningfully, appropriately, and ethically. Although this study was conducted in Spain, the data reflects similar studies completed in other areas worldwide, especially in Canada. Therefore, the data is applicable, reliable, and valid for this research question. This study will be utilized in this research question through further understanding and critical thinking about how educators can adopt AI-based tools in their educational practices. (323 words)

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