A Case Study on Critical Thinking and Artificial Intelligence in Middle School

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ABSTRACT
The purpose of the case study was to understand the use of technology, particularly AI, for public middle school teachers in Michigan for critical thinking and problem-solving skills among students. The theory that guided this study was the constructivist theory. The constructivist learning theory involves people learning from their experiences and prior background knowledge. Consistent with the case study, the focus was on using AI in the classroom to engage learners and create criical thinkers and problem solvers for 21st-century skills. This qualitative study primarily sought to investigate educators' views regarding students' critical thinking abilities and assess how educators use artificial intelligence in the classroom to facilitate student opportunities to participate in problem-solving activities. The qualitative case collected data from middle school educators and gained insight into experiences with technology, particularly AI, in the classroom. Data collection consisted of observations and interviews. The analysis used triangulation to determine themes and reveal if AI correlates in the classroom with instruction to create critical thinking skills and authentic experiences. The results from the study included a minimal amount of AI in the middle school setting, participants not being comfortable with how to implement AI in the educational setting, and students not progressing adequately in critical thinking.
KEYWORDS constructivism, Artificial Intelligence, personalized Learning, critical thinking

INTRODUCTION

The educational system, is in question if students are being prepared to be critical thinkers and have the necessary 21st century skills. Critical thinking takes on new meaning to different people. As time progresses society and educational systems as a whole must adapt to the changing times including the technical society that is rapidly forming. The increasing integration of artificial intelligence (AI) across various sectors has yet to be fully embraced by the educational field, which struggles to find a balance between technology and traditional methods. However, the potential of introducing artificial intelligence technologies in schools is valuable, leading to student-centered learning opportunities. AI, a transformative force in societies, can potentially alter the educational setting, offering a new way for student engagement in learning. This potential could contribute to students working through additional application tasks in school to prepare to be critical thinkers. The US Census Bureau (2023) indicated that student enrollment in elementary and secondary schools reached 49.4 million in 2020, with projections suggesting a decline to 47.3 million by 2030, representing a two percent reduction. The teaching workforce is expected to diminish by five percent, resulting in 3.5 million teachers. As technology, particularly artificial intelligence, continues to evolve, the education landscape may transform, potentially reshaping the skills required for future employment (The Future of Learning, 2024).

The educational system needs to catch up in providing relief for educators in meeting the variety of student needs to prepare students for college and careers and to meet the demands of students. Research is emerging on incorporating AI into educational practices and preparing students for a technical world. This article examines how AI is used in middle school education to strengthen students' problem-solving and critical-thinking skills, essential for success in the 21st century. If we need to ensure students are prepared for the future, then we need to change the practices of the educational field. The time for change is now, and we must act to ensure our students are equipped for future challenges.

Students live in an advancing technological society, and preparation for the future is vital to an ever-changing society. Education needs to catch up (McDiarmid & Zhao, 2022). Research shows that AI offers many new technology advancements and can support various educational needs. The literature has discussed AI, but debate remains on how it aligns with academic practices. However, AI's capacity to shift educational content to each student's learning styles and needs offers a promising future for all learners. For instance, AI can analyze a student's learning pace and style and then adapt the curriculum and teaching methods accordingly. This personalized approach can significantly enhance learning outcomes (Walter, 2024). The problem is that students lack the critical thinking and problem-solving skills needed to engage in learning effectively and struggle to apply what they know to practical situations. This problem is also linked to the relationship between knowledge and motivation (Almulla, 2023). Critical thinking skills include expanding the thinking of knowledge and creating reflective judgments

through problem-solving opportunities (Dwyer, 2023). Students exhibit limited essential skills of thinking and low development (McCormick et al., 2015).

This case study explores AI across various sectors to gain understanding if AI can be leveraged to benefit education and foster critical thinking as AI evolves in the middle school setting (Schiff, 2021). The research question in this qualitative study aims to explore educators' perspectives on students' critical thinking skills and to understand if AI creates opportunities for students to engage in problem-solving in the educational setting. Limited research has been conducted on middle school student's preparedness for 21st-century skills and the potential role of artificial intelligence in addressing their lack of readiness. Future individualized learning opportunities exist with the power of AI, which creates individualized instruction based on the demands of the student learning goals and provides more tailored education (Ayeni et al., 2024).

Chat GPT is one of the most intelligent machines today, with the possibility of doing away with traditional learning assignments and assessments (Zhai, 2022). Still, additional research highlights that it can provide personalized learning, aid for language learners, and assist in research, writing, and exam preparation (Allam et al., 2023). Chat GPT is not even a year old from the introduction, but many people already have a connection to it in some way. The idea of Chat GPT in the classroom takes on a controversial role. There are few findings of teacher results using Chat GPT in the classroom. This is something that this research stems from to gain additional perspective, and additional research will be necessary.

Customized learning and the potential for opportunities for critical thinking and problem-solving are more likely to be coexistent (Etefe, 2023). Researchers, educators, employers, and policyholders worldwide relate that critical thinking is one of the skills needed in education and society (Thornhill-Miller et al., 2023; Cenka et al., 2022). A strength of Chat GPT is that the components are closely connected to people's daily lives, there is a deeper connection with individuals, and patterns of behavior can be learned over time (Yu, 2023). The role of Chat GPT in the educational field potentially alters the role of the teacher as a facilitator, a learning partner, and, more importantly, creating new learning (Shidiq, 2023). The support for technology integration and the potential for personalized learning through experimental and practical experiences are more likely to occur. Research reveals that activity-based learning provided significant gains in critical thinking, problem-solving, and collaboration, and the blend of technology created more essential opportunities for learner engagement (Shoul et al., 2024; Li et al., 2024). The question would be, what does this look like in the classroom through implementation, success, and challenges?

The significance of the case study is to understand how to implement instructional material to various learners, keep learners engaged and challenged within their learning capabilities, and use critical thinking skills. Diversity among student learners has only widened, and students come to the classroom with skills on and above grade level, but many are behind multiple grade levels. Teaching a direct lesson to the whole class might no longer be a favorable way to reach the learners where they are with their interests and understanding. Prior knowledge ensures students succeed with the task, but previous knowledge can be at different levels. The concern is whether the educational system successfully meets the needs of all students. Students must be equipped to live in an environment that continues to change and progress. Technology is not going to go away but only continue to advance. With all the new technology and AI components, the research looks to understand where this fits into the classroom and meets the needs of students.

The criteria about both the internal and external dimensions of the educator's role and students' learning and comprehension reveal a disparity in assessment outcomes (Morgan et al., 2016). Students' performance data significantly influences the educator's evaluation score, underscoring the need to explore strategies to enhance teaching effectiveness in a middle school environment. With the ongoing trend of re-shaping parts of education, research has favored personalization with the use of AI in the classroom to provide students with more meaningful experiences and opportunities for critical thinking. The skills of critical thinking and new skills for tomorrow need to be taught quickly (Abrams, 2024). Technology is progressing quickly and inequity exists in the schools. A concern is that students continue to be grade levels behind in learning, what tools are being used currently. With AI, students' individual learning styles and skill levels are more readily available and can be created from their personalized learning and assessment. Technology allows learning to be done within classroom walls. Again this creates a different teacher role but a role where the educator, expands the students individual learning.

Theoretical Framework

The constructivist approach to learning with AI strongly emphasizes students actively constructing knowledge through hands-on experiences and interactions. AI serves as a tool to facilitate and personalize these learning processes (Grunbaugh et al., 2023). The constructivist theory aligns with the research, as learning is created through

new and existing knowledge. The teacher's role in a constructivist learning environment is crucial and integral, as they facilitate and guide students' learning, creating a student-centered learning environment (Keiler, 2018). Educators are not just facilitators but are at the heart of the learning process, guiding students toward a deeper understanding of the subject matter. Their role is irreplaceable, even in an AI-integrated educational system. John Dewey valued learner experiences and emphasized engaging in real-life situations to solidify learning and promote social learning opportunities. His philosophy, experimentalism or instrumentalism, primarily focused on the human experience's role in education (John et al., 2014). The educational philosophies of John Dewey significantly influence student achievement and the interplay between the environment and society (Dewey, 2002). Future research indicates that academic approaches should integrate critical thinking, problem-solving, assessments, and additional preparation for future studies (Livberber & Ayvaz, 2023). Classroom experimentation with Chat GPT is feasible and can provide valuable experiences (Rudolph et al., 2023). Interactive learning with Chat GPT has boosted students' motivation, engagement, and critical thinking skills (Scloul et al., 2024). Chat GPT has the potential to create more hands-on learning and opportunities for students to align their learning with their interests and backgrounds.

However, integrating AI into education also raises potential challenges and ethical considerations. For instance, there are concerns about data privacy, algorithmic bias, and the potential for AI to replace human educators. (Akgun & Greenhow, 2021). It is essential to address these issues to ensure that AI is used responsibly and ethically in education. However, the potential of AI, particularly Chat GPT, to provide personalized learning is immense. Integrating Chat GPT in education could further empower teachers and create significant opportunities for critical thinking and enhanced learning outcomes (Tlili et al., 2023; Qadir, 2022). Integrating AI in student learning through practical application presents opportunities to engage students and strengthen their twenty-first-century skills. AI provides learner-centered support and personalized instruction to address individual student needs (Ng et al., 2023; Li et al., 2024; Liu et al., 2022). Chat GPT can create learning tailored to students from diverse backgrounds (Prananta et al., 2023). A learning environment that creates personalized learning creates more opportunities for students to be met where they are and to engage in relevant experiences. This potential for customized learning through AI should inspire optimism about the future of education.

Adaptive/customized learning is crucial in education systems and in working toward higher student achievement levels (Xie et al., 2019). Children participating in their goals are assumed to be more likely to learn more effectively (Dishon, 2017). Psychological studies indicate that children who lack challenges or prior knowledge in the learning process are more prone to underperform academically. Providing cognitive stimulation to every student is essential, as this approach fosters academic success for all children (Dumont & Ready, 2023).

The fulfillment of the gap in learning contains two additional factors: a call to new possibilities of applications and a continuous adaption of AI as more sophisticated results show value (Jose et al., 2021). Technology is essential in offering excellent personalized learning opportunities (Semshack & Spector, 2020). With technology, teachers can meet each student's demands, which is challenging. Dewey argued that education should stem from students, interests, experiences, and abilities (Dumont & Ready, 2023). Research highlights that personalized learning is not a new way to offer instruction but can offer a more significant opportunity for equity in learning. Some studies show that adaptive learning is more effective in raising students' achievements than traditional non-adaptive instruction (Dumont & Ready, 2023). Future studies suggest that academics must find new teaching strategies and methods that include critical thinking, problem-solving, assessments, and additional preparation for future academics (Livberber & Ayvaz, 2023).

STUDY

Research data should be gathered within theoretical frameworks to demonstrate their utilization, albeit to a limited capacity (Luft et al., 2022). Middle school students have access to technology. However, with the advancement of artificial intelligence, studies are scarce exploring its potential contributions to the middle school setting (Lee & Kwon, 2024). The design process chosen was a qualitative study because research on the topic has often been conducted through quantitative data collection, but not at the middle school level. The qualitative case study also gives an insight into people's beliefs related to the topic and their experiences. A hermeneutic approach in a case study was chosen to analyze and interpret data by focusing on the meaning and context, relying on the researchers' understanding and interpretation of the situation. Participants were voluntarily selected for the survey. The participants were teachers with around five years of experience and twenty years of teaching experience. The backgrounds varied; some teachers came from charter and private schools before working at a public school. Teaching subjects included math, science, language arts, STEM, and special education courses. The research was conducted at a middle school in 6th through 8th grade in Michigan. The school is urban and is a Title I school with over ninety languages represented in the district. Data was collected through classroom observations, teacher interviews, and collection of lesson plans. The classroom observations were around thirty minutes of time. Data

collected included teacher time teaching whole group, classroom set-up, interaction with teacher to student, technology used, critical thinking opportunities, and personalization of instruction. The interview consisted of ten questions that were open ended. The questions asked if teacher's use technology, AI in the classroom, what opportunities students have for showing learning, if student's are able to use problem solving and critical thinking skills. The document included a rough over view of the lesson plan format.

Findings

The research's findings were quite compelling. AI is generally not used in the classroom, except for two classroom lessons that used a little form of AI in the instruction. The educators said they would like to know more about incorporating AI into the classroom learning environment but need professional development because the technology is too overwhelming. Professional development is offered, and teachers are required to take a minimum of thirty hours a year, but they have not been to one on using AI in education.

Overall, all participants were concerned that students do not have the necessary problem-solving and critical-thinking skills, which was a significant concern for future learning. Educators all agreed that students' problem-solving/critical thinking skills need to be addressed and taught; students are significantly behind in pushing thinking and solving fundamental problems. My teacher observations revealed each classroom with an overall teacher lesson directed to all students. From the lesson, students practiced the learned skill in the same manner. Personalized learning was only partially observed when observing the participants. The observations included students completing their writing ideas when creating a summary. Customized learning was not observed with AI. The only observation of hands-on learning was in a STEM course with measurements but the teaching was all teacher-led.

The results of the observation collection and the interview answers were read multiple times to look for common themes. The website dovetail.com was used to sort and find common themes. One participant said, "The approach to teaching needs to change; students need to be given choice." Another participant mentioned, "Critical thinking skills are so valuable, but they must be taught many times and at a young age to prepare students for what this means." Prior knowledge was built on in the math, science, and special education classrooms, this was teacher led. Three main themes were identified and are listed below.

Lack of AI:

Teachers are not opposed to using AI in the classroom and have had some personal experience using AI. The participants are not sure where to start with AI in education. There is a gap in knowledge and confidence among educators. The participants are overwhelmed with the day-to-day requirements and only have a little time to add more to their requirements. The participants feel that AI could provide helpful student data and ease some of the teacher's requirements with lesson plans, assigned tasks, and assessments. Data collection will also help teachers create opportunities for more personalized learning to meet the needs of each individual. A few teachers have tried to differentiate as much as possible, but consistency is complicated. Each subject area also has curriculum requirements and common core standards. The Science and Math courses do have online textbooks but I did observe these being used in the classroom. A participant said, "AI sounds interesting to use in the classroom but no idea where to start." A language arts educator is concerned about AI possibly taking away form student thinking and would like to know more about how AI could further discussion and thinking along with pushing student writing." One participant of all twelve does not like to use any technology in the classroom and that was for a math classroom.

Student Engagement:

Students' lack of critical thinking, problem-solving skills, and motivation could be interrelated, possibly stemming from teaching methods that need to engage or challenge them sufficiently. When asked if students are critical thinkers, one participant replied, "No, because everything is spoon-fed to kids; kids do not see the point in why they need to learn something; they do not see the value." Four of the educators made a comment, "critical thinking skills are hard for kids, and these skills need to be taught." Another participant mentioned that the science curriculum has built in critical thinking questions but it is a struggle as well as a concern being able to get students engaged and pushing their thinking." Prior knowledge on the topic needs to be available for students to access. Also prior knowledge needs to be built on from learned concepts and if students do not have the interest level or the motivation this causes a loss connection from the material.

While observing a few of the participants' classrooms, the teachers did try to push students' thinking, but the academic conversations especially needed more guidance provided to push students in expanding their thinking. It was observed that students were challenged with context; however, due to a lack of knowledge or motivation, higher-level thinking was not noticed when students were answering questions. A connection could also be made

between a lack of connection to prior knowledge and disinterest and lack of prior knowledge to build on. Teacher participants did incorporate some prior knowledge into the learning process, but it was a whole group, and it was observed that not all students were engaged with what was being taught.

Diversity and Personalization:
The challenges in personalizing learning are exacerbated by the diverse student population and the varying levels of skill and prior knowledge, highlighting the complexity of modern classrooms. Four of the twelve participants mentioned in their interview that students need more personalization in their learning and more choices. Participants are concerned with the number of students who are more than two grade levels behind and how they catch up with over two years of learning, and this if is even an interest to the student/s. One participant mentioned that in the Science class, "when students know something about the topic, they are engaged, ask questions, and when the opposite is true, that is where the student either acts out or shuts down." The education system does continue to push along students to the next grade at least at the middle school level even if they are not academically prepared.

Limitations
The limitations of the case study included only a middle school setting being used for the collection of data. There was no collection of data from other schools to compare if AI is being used in the classroom and if critical thinking skills are extended with students and the advancement of technology.

Future Research Recommendations
Future research recommendations include studying AI and the implementation of AI in the classroom. The case study needed more data on teachers using AI to push critical thinking and problem-solving skills in the classroom. AI is still relatively new to the implementation of AI in the classroom, especially in middle school. Additional research should be conducted to include best practices for AI in the classroom to push student thinking and to create further opportunities for students to learn from prior knowledge.

Conclusion
The purpose of the case study was to understand the use of technology, particularly AI, for public middle school teachers in Michigan for critical thinking and problem-solving skills among students. The problem is that students lack the critical thinking and problem-solving skills needed to engage in learning effectively and struggle to apply what they know to practical situations. The significance of the case study is to understand how to implement instructional material to various learners, keep learners engaged and challenged within their learning capabilities, and use critical thinking skills. Pushing students to their full capability continues to be something that educators are committed to when entering the profession. With the amount of students that continue to behind in learning and the pressure on the schools and the teacher to maintain high growth rates amongst students it is a time to look at what is missing. Students today are being brought up in a technical society. Many are introduced to technology as a toddler. Students need to learn how to use technology, AI as an academic tool. Students need to be able to work when work gets challenging and push their critical thinking skills. Many educators are exhausted and they need resource to ensure that learners have the right tools to exist in ever changing society.

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