Using Artificial Intelligence (AI) Tools in Middle School Instruction and Its Impact

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Abstract

Artificial Intelligence (AI) has been praised and vilified across the human spectrum. Such extreme reviews can be confusing to young learners, such as at the middle school level. Students at the middle school are at critical growth phase, where habits of the mind start being formed. It is therefore important to create interest and establish confidence in AI use at an early age such as at the middle school level, by showing its benefits in learning and hence empowering the young to understand the realities and capacities of AI. Teachers at the middle school have the opportunity to grow this confidence in middle school students.

The paper presents how teachers applied AI technologies in their classrooms and its resulting impact. The AI workshops were held for three consecutive summers, beginning 2021. Different teachers and students were selected to participate in the workshops each year. Teachers learned how AI technologies could be used to enhance images and videos leading to the transformation of instruction and increase class engagement and learning. Three teachers share their experiences on the impact realized from introducing and incorporating AI tools in their subjects at the middle school. Some of the phrases used by teachers about this experience include “captured interest, increased class engagement, probed curiosity, and improved outcomes”. Implications from implementing AI in the initial courses is the motivation to continue the trend in more subjects to promote learning in an effective way. This qualitative study underscores the value of providing awareness of how AI could be used to confirm information or to mislead its users. The middle school AI is used to enhance learning. As the case studies indicate, AI offers a unique platform to simplify complex systems that allow middle school students to understand such complexities by visualization. The AI addition in instruction has helped to convey difficult aspects of learning to students and has improve engagements and outcomes.

Introduction

AI is increasingly permeating across all sectors of the designed world. From transportation to the classroom, from battle fields to hospitals, from product design to manufacturing, AI presence is felt. For this reason, it behooves a nation to provide awareness of AI capabilities from the early beginnings of education. A recent formation of the AI4K12 is a welcome for providing guidelines for teaching AI in schools [1]. It is worth noting that there is a variety of research interest in AI at the middle school, for example, Zhang et al. provides introduction to AI in their MIT DAILy curriculum [2]; while Akram et al. used the Snap programming environment to introduce teachers to AI search of Algorithms [3]. This paper presents three case studies that stem from AI workshops for middle school teachers. In each case study, the instructor’s background is given, reason for participating in the study, and adapting an AI tool to class instruction and its impact in learning.

A teacher professional development summer workshop titled ImageSTEAM was created to introduce middle school educators to AI focusing on visual computing. A total of 22 teachers in Georgia participated in the workshops run in three separate cohorts for 2021, 2022, and 2023. The case studies are teacher experiences and their transfer of knowledge to their classrooms. The teachers presented in this paper are for the 2022 and 2023 cohorts.

Method

After realizing the need for teacher professional development in AI, researchers wrote joint proposals for Arizona and Georgia which realized funding from National Science Foundation (NSF). In an effort to determine a suitable time to conduct the teacher and student workshops, the researchers reached out to local teachers for help and guidance. Suggestions from the local teachers overwhelmingly favored summer time during the months of June and July when schools are closed. This was the ideal time for workshops to be offered in a two to three week period. After determining the favorable time for the workshop, researchers developed a flyer to advertise the summer event. The flyers had information on the criteria of who would be considered a suitable participant for the workshop. The middle school STEM teacher was the target. In addition, the flyer also had information on what AI lessons would be covered in the workshops, the dates the workshops would take place, the start and end time of daily activities, expected outcomes from the participants, and how to apply including the contact information and application deadline. The flyers were digitally sent to local school districts with instructions that they be forwarded to middle school teachers. Teachers applied digitally, and the workshop review committee composed of the researchers examined the applications to determine if they met the criteria such as, being a middle school teacher preferably in STEAM area. In addition, an applicant's reason for participating in the program was a major consideration for being selected.

Range of teacher backgrounds

A diverse group of teachers, primarily from the North-Central Georgia and the Atlanta Metro area attended the workshops. A total of 22 teachers participated in the Georgia workshop. The distribution of teacher attendance was as follows: in 2021, 6 teachers, in 2022, 7 teachers, and in 2023, 9 teachers. They ranged from 5th grade teachers to 8th grade teacher. A range of the subjects taught by the teachers included Science, Social Science, Engineering and Technology Education, Mathematics, and Art. Six of the 22 teachers identified as male, and 16 identified as women.

How workshops were conducted

Activities of the first week of the workshop included instruction about AI and its use, and the exploration of various AI platforms and programs. The extent to which AI has permeated society was examined during the first week, this in turn cemented interest in the teachers, and hence pursued mastery of the AI platforms and its application. In the second week, teachers together with the researchers co-created AI powered lessons to use in teacher classrooms and to be shared with the public. Reinforcement of mastery of the material was to be achieved at this stage.

During the third week, the teachers "tested" their lessons on students enrolled for the last week of the AI workshop. Transfer of knowledge takes place during this phase. It is known that, without an adequate level of initial learning, transfer cannot take place [4]. This is why teachers had two weeks to learn and become comfortable with the AI platform they chose to use. In his social learning theory, Bandura observes that time to learn is proportional to the amount of material being learned [5].

How the focal teachers were selected and how data was collected

The focal teachers were purposefully selected to represent the various fields presented by participants. The composition of the focal teachers included one from science, one from engineering and technology, and one from social science. The purposeful selection was to help understand how AI had impacted their teaching in the various fields. The researchers asked for volunteers from these categories and the case studies presented in the paper represent their experience. Therefore, the data collected was self-reported by the participants. Participants provided a narrative about their experience using AI as a tool in teaching in their classrooms and the impact they witnessed. Some participants submitted videos of class sessions they had created during their instruction activity. From the video, researchers reviewed for engagement and interaction among the students and their teachers.

Data analysis method

The narrative and videos from the teachers were reviewed by the researchers. Researchers looked for patterns that may have emerged across the different fields during the use of AI in classroom instruction. The results are presented as individual case studies; however, a conclusion that summarizes the teacher – student experience with the new AI tool in the classroom is presented.

Results – choice of presenting results as case studies

During the workshops, participating teachers had the opportunity to co-create lessons for their class instruction. They had the opportunity to teach these lessons to a set of students that participated in the last week of the summer workshops. Researchers challenged the teachers to try the new AI tools in their classrooms and document the impact they noticed, if any. The case studies presented offer a glimpse of each teacher unique experience. The three case studies are from Georgia.

Case study 1: The K-12 Engineering and Technology Education Challenge

In a county in north-central Georgia exists a teacher dedicated to help students understand and use the Universal Systems Design (USD) that graphically depicts processes. Graphical representation attempts to simplify complex systems. In a normal case, the USD has four parts to be considered which include input, process, output, and feedback mechanisms. In her effort to optimize her USD instruction at the middle school, she found an AI tool suitable to assist in student learning.

Teacher1 holds a bachelor degree in chemical engineering (CE), and a master's degree in supply chain and logistics. She is white and has taught for10 years in a title 1 school. She teaches Engineering and Technology classes at the middle school. Based on her background, she had a great deal of experience in computer science and engineering; however, she had no experience in AI. Her view on STEAM was "a field that is constantly evolving, and AI is the cutting edge of technology". She understood that cloud computing and IoT depend on AI. Therefore, when she found out about a workshop on AI for middle school teachers was being offered near her, she applied immediately. She state that "this program seemed like a great way to learn about AI and collaborate with other teachers to develop engaging lessons to bring back to the classroom." Her reason for participating in the workshop was "Teachers must always engage in continuous learning. This is especially true for teachers in STEM fields. I am excited to learn about AI and bring this knowledge back to my students." Her view on how AI would benefit her students was "I want to learn more about this field to bring the knowledge back to my students and hopefully encourage some to pursue a field in CE and AI."

With a specific mission to learn and find AI tools that would support her need to optimize USD instruction, she narrowed down her choices of tools during the 3 week workshop. She identified the GauGAN platform to fit her need. GauGAN is an AI image generation tool that turns words and drawings into lifelike images.

Since the end of the workshop, she has used her AI knowledge for both personal and instructional purposes. For personal use she has used AI "to predict other videos one may want to watch on YouTube." She values this aspect of AI because "one gets ideas for additional videos to see on that topic or related topics." An example of how this works is "The AI algorithm uses my viewing history (watch history, search history, age, location, time of day, etc.) and viewing metrics (views, likes, and shares) to recommend videos you may like to watch." She shares another example as "Online shopping stores could use your shopping history to suggest additional items you may want to add to your cart."

Likewise, AI tools have helped her to generally garner additional online instructional resources. As earlier stated, Teacher 1 has selected and used the GauGAN to enhance the instruction of Universal System Design. She has used GauGAN to engage students in engineering related lessons that incorporate input, process, output, and feedback. An example lesson plan aligned with Georgia standard MS-ENGR-TS-3 is given . The lesson is found here: https://docs.google.com/document/d/1YdD24XDFRItQPckJDSn0L0l7OH6AiWL-aRIats-JA9U/edit

Her lessons depict the richness of the GauGAN's NVIDIA Canvas where by it can be used to sketch and customize an image. The customizing aspect is very important because each student can highlight their input and make it visible to others. This aspect is critical in engineering and technology because visualization adds a sense of the design details. Students seem to benefit by interactive environment where they can modify or manipulate variable to attain their interested goals. This is more engaging than only viewing displayed images.

Four different examples are presented on how to engage students in such a lesson. The student worksheets for the lessons are found here: https://docs.google.com/document/d/1c9QqL1rZ8EhDILWkolzQz_ni2wUlF8v2/edit

One example of the lesson is scenario #1, as follows:

A company in Castledale, Utah, buys cocoa beans from Columbia and sugar from Hawaii to make chocolate candy bars. They make the bars in a manufacturing plant and ship them to stores all across the United States. People love them so much and have bought enough candy bars that soon the company will start selling in Canada and Mexico, too.

Identify the:

Input(s)_____

Process(es) _____

Output(s) _____

Feedback _____

Using information in scenario above, students are allowed to sketch their input in the GauGAN's NVIDIA Canvas and create unique chocolate candy bars. Fun learning!

Figure 1 shows a generic topography sketch on the left, and its equivalent GauGAN image.

Figure 1: Customized drawing: https://www.nvidia.com/en-us/studio/canvas/

"My students are thrilled to generate such designs", she added.

Case study 2: Historical Experiences and Facts Become Live!

In a large metropolitan area in north-central Georgia, history lessons have gained life with the aid of AI. A teacher at the middle school level has livened her classes by engaging students to creating historical events using Teachable Machines and TinkerCAD. It's no longer a passive sit and listen, but act and do class.

Teacher 2 holds a bachelor degree in social studies. She identifies as black or African American. She has taught for 8 years in a Christian private non-profit school. She teaches social studies for the middle school. Teacher 2 has no experience in computer science or engineering. In her application to the ImageSTEM workshop, she stated, "I am interested in AI so I can get the professional experience with technology, better understand how it works and implement it in my classroom." Her view on how AI would benefit her and her instruction in the classroom was "Learning about AI would benefit me by helping to refine my teaching practices over time." She envisioned teaching using AI would benefit her "students in their critical thinking skills. It would help them solve certain challenges and ignite learning."

Her testimony follows: "After my training, I felt confident enough to introduce AI into my Social Studies classes at school. While studying about the movement of settlers in the 19th century, we came across terms like manifest destiny and the territorial expansion that were involved during this critical time in history. AI played a new role in my instruction on the expansion experience. As a teacher, I was able to introduce two AI tools that helped the students with hands-on learning. One of the tools introduced was teachable machine learning. With this tool, the students were given a map of the territories and asked to use specific colors for each territory. After completing that activity, the students then trained their machines to identify any of the territories by a specific color. The students successfully trained their machines to identify each territory by color." See figure 2. She adds, "students were totally engaged in this activity and wanted to stay longer even after class was over." She employed more than one AI tool. "Another tool used was TinkerCAD. After learning how to use TinkerCAD, the students were instructed to create the territories using the TinkerCAD tool and use specific colors to identify each territory. The kids enjoy using TinkerCAD because they were able to create and be creative. I found that using TinkerCAD brought out the kids creativity sides. This type of interaction in teaching never used to take place, "I now teach AI as an elective on Fridays for 60 minutes."

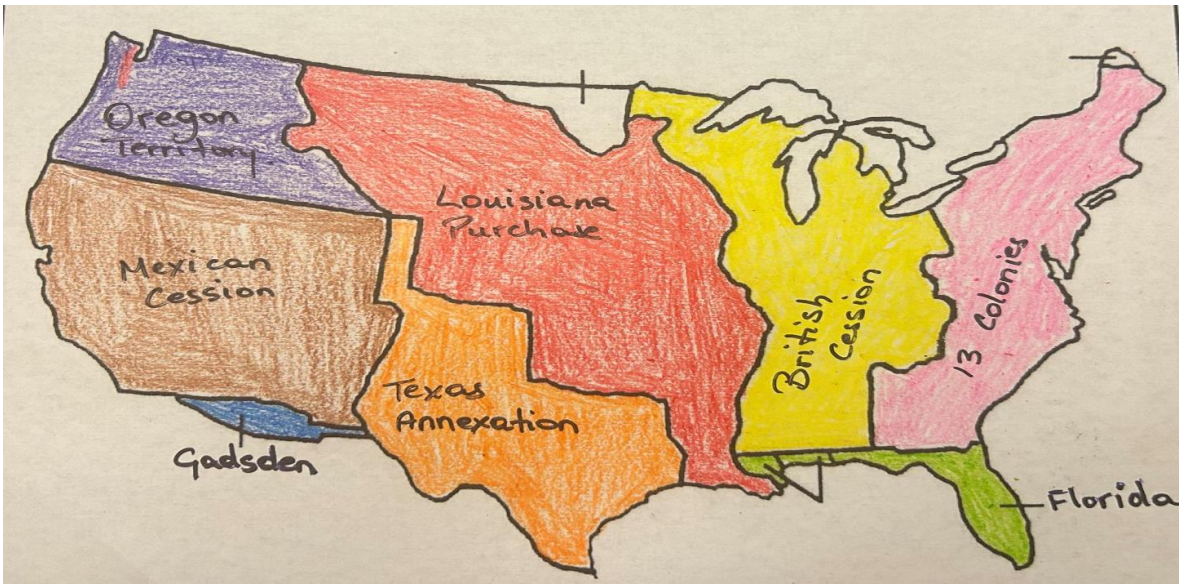

Figure 2: Sketch of US Territories 1789-1840

A lesson that aligns with Georgia's standard SS8H4 explains significant factors that affected westward expansion in Georgia between 1789 and 1840. The lesson is presented here: https://docs.google.com/document/d/1Yv3p-wVTw6uzU1hjOesCofytE_o8Jchn/edit

Figure 3 is a slide in the lesson showing the order of interaction of processing the lesson.

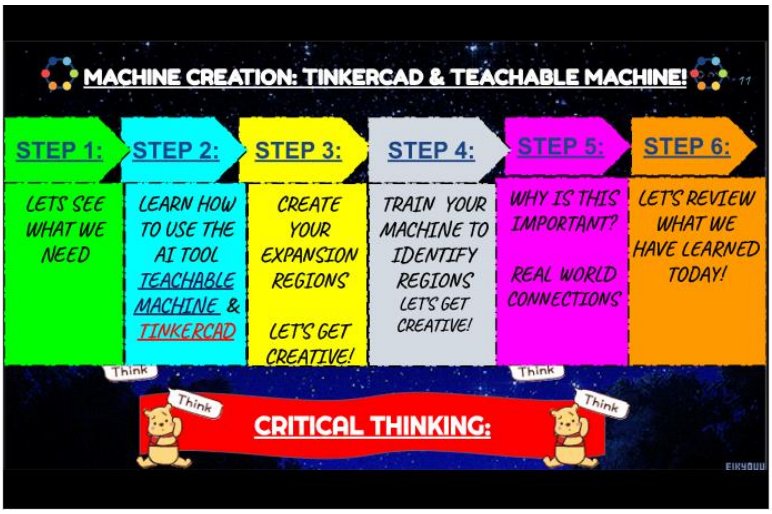

Figure 3: Slide # 11 at The Cotton Gin and The Westward Expansion

https://www.imagesteam.org/arts-and-design

Students benefited by interactive environment where they could modify or manipulate variable to attain their interested goals, for this specific one the westward expansion and the cotton gin lesson became very interactive. Engagement in learning was evident.

Case study 3: Wow, is it clear?

Science lessons become very interesting and engaging when the scenario discussed can be created and is visible. This is exactly what has been happening in a rural county in north-central Georgia where a teacher has used AI to provide vivid instruction in translucent, transparent, and opaque qualities of visibility.

Teacher 3 holds a bachelor degree in Science Education. She is white, and has taught for 10 years. She teaches in a Title 1 school. She has no experience in computer science or engineering. Prior to participating in the workshop she had no experience in AI. She summarized her interest in participating in the workshop as " I love the opportunity to explore new ideas/concepts that I could bring into my teaching of physical science. I am always up for a new challenge or idea to complete with my students." She observed that, learning AI would help her and her teaching as follows "I would love to incorporate AI teaching into a few of our projects/lessons (making those connects between science and technology). It gives students a new perspective and opportunity to do 'non-traditional' lessons." She notes that her students would benefit by her teaching and

applying AI concepts by “gaining computer knowledge/skills, building up collaboration skills, improving on their communication skills, and using/developing critical thinking skills. It opens the door to deeper thinking, problem solving, and making real world connections.”

She engages her students to take part in lab where they change clear water to colored water by adding milk and/or juice and compare their outcome with the computer AI Teachable Machines results. Slides to her lesson are found here: https://docs.google.com/presentation/d/1Hh_zd76PB7sfcbubayb7vNhKOFyLFnIaCn5ptEAWA30/edit#slide=id.g13d95aebe0c_0_8

Her student worksheet that gives step by step instructions in setting up, experimenting, and reviewing results is presented here: https://docs.google.com/document/d/1SQkg_cumHlVlSi3YGAX7lWojlgbIj7H_t6Uq5v9SIsA/edit A comparison between clear and opaque is shown in figure 4.

Figure 4: Left is glass with clear water; Right is opaque glass once milk was added to water

She adds, “the experimental vs machine learning comparison have enhanced participation in class by discussing the differences seen by the machine when less milk is added to the water versus lots of milk.”

Lessons Learned

A love to enhance teaching emerged as the common theme transcending across the three teachers as to why the participated in the workshops. The teachers in the case studies had the willingness to put students first in learning. AI seemed to satisfy teacher needs to reach high level of engagement in class. From the teachers views, they were successful to get students in sustainable engagement and staying on task. Their goals were met and impactful learning took place in the classroom using a variety of AI tools.

Conclusion

The paper presents the experiences and lessons learned from 3 summer workshops on how teachers were trained and how they applied AI technologies in their classrooms and the resulting impact on students as well as themselves. Twenty two teachers from different backgrounds and expertise participated in the AI workshops and expressed a positive experience in gaining a new tool to use in class instruction. All teachers were excited to learn techniques and the spectrum of the AI tool and Computer Vision and apply them to topics they teach in middle school standards. All three teachers reported that incorporating AI tools led to a more engaging learning environment for their students. We recommend scholars reading this article to visit our

ImageSTEAM website, and explore the various fields that AI tools were used at middle school instruction.

Future Research

The three case studies presented offer a glimpse of a short engagement and follow up of implementations of AI in the classroom. In order to gain a greater understanding about the impact of using AI as a tool in instruction, additional studies need to be carefully crafted and purposefully planned and administered. For example, specific AI tools need to be identified and used for a number of lessons. A record of learning outcome before the use of AI intervention is to be collected and compared to results after the intervention to examine any changes, if any. Analysis of the data would yield an informative conclusion of effects of the AI intervention in engagement and learning.

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