AI through Computational Cameras for K6-K8 Teachers and Students: Preliminary Results from Virtual Workshops

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Abstract

In the next 50 years, the rise of computing and artificial intelligence (AI) will transform our society and it is clear that students will be forced to engage with AI in their careers. Currently, the United States does not have the infrastructure or capacity in place to support the teaching of AI in the K-12 curriculum. To deal with the above challenges, we introduce the use of visual media as a key bridge technology to engage students in grades 6-8 with AI topics, through a recently NSF funded ITEST program, labeled *ImageSTEAM*. Specifically, we focus on the idea of a *computational camera,* which rethinks the sensing interface between the physical world and intelligent machines, and enables students to ponder how sensors and perception fundamentally will augment science and technology in the future. Our 1st set of workshops (summer 2021) with teachers and students were conducted virtually due to recent pandemic, and the results and experiences will be shared and discussed in the conference.

Keywords
Artificial Intelligence, STEAM, student engagement, teacher professional development, Middle Schoolers

Introduction

Currently, the United States does not have the infrastructure or capacity in place to support the teaching of AI in the K-12 curriculum [2,3]. AI requires an integrative body of knowledge from disciplines such as computer science, mathematics, data science, cognitive neuroscience and psychology. The aforementioned subject areas lie outside the traditional curriculum taught at the K-12 level. Teacher-preparation curriculums do not typically offer the integrated areas listed above, hence teachers have little to no experience with AI, and it remains an open challenge of how to train teachers in these fields [4,5].

Generally, interest in a STEM career expressed in middle school predicts a graduation with a college degree in STEM. This prediction is stronger than enrollment or performance in math and science courses in high school [1]. However, due to unavailability of courses that relate to computer science AI, in grades 6-8 [2,3], it becomes essential that any teaching of AI for these grades align with the NGSS standards as well as state standards within the existing science and math curriculum at those educational levels to be effective.

The specific goal of the funded NSF – ITEST project is to design, implement, and evaluate a technology-infused workshop experience that addresses the professional development of teachers' practice of STEM instruction and to improve underrepresented students' requisite knowledge, motivation and interest in STEM careers. We expect to improve STEM knowledge and motivation, particularly in the field of artificial intelligence, by engaging middle school students (grades 6-8) and teachers in our project. Through a variety

of activities the ImageSTEM experience engages students in both guided and independent active learning, and promotes critical thinking to address real world scenarios.

During summer 2021, we offered our 1st set of workshops with teachers and students that were conducted virtually due to recent pandemic. The results and experiences are briefly discussed in this paper and will be presented at the conference.

Workshop Structure and Deployment

The summer teacher/student workshop was created at both the University of Georgia (UGA) and Arizona State University (ASU). For both workshops, teaching materials related to AI topics and technology, such as image processing, computer vision, data, machine learning and applications were developed as lesson modules for each teacher to customize and present to students. Additionally, Google Colab notebooks with guidelines and specific AI-related activities were created to scaffold teachers/students' learning and knowledge related to specific lesson modules. These resources are evidence-based in that they employ active learning techniques and the associated AI technology tools. Also, the instructional resources include elements of interaction, visualization, and reflection, which also help to strengthen metacognitive skills related to AI technology experiences.

The developed teaching materials introduce AI technologies and tools, and provide several examples of how AI algorithms, data and predictions are used in modern society. Teachers and students learn about various AI techniques (e.g. data manipulation, image classification, object detection and recognition, neural networks, computational cameras) and tools (e.g. Teachable Machine; pixlr; NVIDIA GauGAN; Nearpod), as well as how the AI knowledge can be adopted for STEM subjects and ELA courses. To scaffold students in their application of AI technologies/tools, several examples are provided with accompanying learning activities. In the learning activities, students are walked through the background information on AI topics and provided with hands-on learning activities to reinforce the AI concepts and applications.

Pilot Studies

The AI technology infused workshop for middle school teachers/students were first piloted at ASU in June 2021 and from there deployed at UGA during July 2021. Each of the workshop details are presented below.

Selection of participants at ASU

Teachers were recruited from local Arizona schools which are considered Title I schools where a large population of students served come from low-income families. Teachers filled out an application and then were subsequently interviewed by the research team before selected. Student participants were selected from applications to the Digital Culture Summer Institute at ASU, a summer camp for media arts conducted every year in June.

ASU Workshop (June 2 - June 25, 2021)

Four teachers from Arizona along with 27 middle school students participated in the workshop. During the 1st week, teachers were introduced the AI concepts (data, AI, algorithms, neural networks, deep learning), and technology experiences with tools such as Teachable Machine, pixlr, Google Colab notebooks, NVIDIA GauGAN, …). In the second week, both teachers and students were grouped together to observe and learn AI topics and technology/tools taught by the research team. In week #3, teachers in consultation with the project team, each developed a lesson module that was delivered to students along with some specific topics/examples provided by the project team. All students were involved in experiential learning activities in using the AI tools/techniques. Some students participated in a single week while others attend additional weeks. Based on initial feedback, students are eager to learn and experiment AI topics and activities.

Selection of participants at UGA

Teacher selection was conducted as follows. A decision initially was made to reach three counties with different "economies" yet close enough to our workshop site to ease their teachers and student to travel during the sessions for in-person activities. This decision was not changed even when unexpectedly COVID-19 hit before the workshops. The three counties represented were somewhat different with the first county having a 52-75% reduced lunch; 80% white; 1% black; 9% other; the second county had 100% reduced lunch; 53% white; 45% black,2% other; and third county had 70% reduced lunch; 36% white; 29% black, 22% Latino; 12% Asian; 1% other. Notification about the application for the workshops were sent to school districts. We asked the school districts to help recruit math and science teachers considering minority and underrepresented as priority. Two teachers from each county were recommended. Each teacher had to show interest, and was to participate in the entire workshop and develop an AI lesson that they would adapt and use in their class.

Student participants were selected as follows. We asked the selected teachers to help recruit students from their schools who fit the underrepresented or minority categories when possible.

UGA Workshop (July 6 - July 23, 2021)

Six teachers from Georgia and one teacher from Arizona along with 20 middle school students participated in the workshop. During the 1st week, teachers were introduced the AI concepts (data, AI, Algorithms, neural networks, GANs), and technology experiences with teaching machines, pixlr, colab note books, deepFake, …). In second week, both teachers and students were grouped together to observe and learn AI topics and technology/tools. In week #3, teachers in consultation with the project team, each developed a lesson module that was delivered to students along with some specific topics/examples provided by the project team. All students were involved in the two week experiential learning activities, as a cohort, in using the AI tools/techniques. Based on initial feedback, students were eager to learn and experiment AI topics and activities.

Significance Results

Fourteen lesson modules were developed during the workshops ASU and UGA, and each of these will be refined and iterated upon during next academic year. The lesson modules spans a variety of STEM subjects as well as ELA, and these illustrate the impact and significance of AI-infused technologies in the middle school curriculum.

Educational Research Survey Results

In a pre-test/post-test design, students completed a computer-based survey during the first week of the workshop, prior to instruction; and in the final week of the workshop, after receiving some instruction. The student survey contained several measures related to student science identity, perceptions of science concepts, and intention to pursue STEM education and employment in the future. Twenty-nine students participated at Time 1 and seventeen of these same students participated at Time 2. Results of two-tailed T-tests showed that students' perceptions of themselves became significantly ($p < .05$) more active at Time 2. Students also perceived that their teachers thought of them as more powerful or strong at time 2 in comparison to when they started the workshop. Students' perceptions of *Artists* became significantly ($p < .05$) more active, and their perceptions of *Coders* and *Engineers* became significantly ($p < .05$) more powerful and active. Other concepts saw marginal ($p < .10$) upward trends in evaluation, potency, and activity. Students saw no significant change in the salience, prominence, or centrality of their science identities. There was also no change in intent to pursue STEM education or careers. However, preliminary analyses show marginal decreases in the distance between students' self-identity ratings and some science identity ratings suggesting that students may be more likely to see themselves as similar to scientists after workshop participation.

Project Assessment and Evaluation Results

The evaluation team used a mixed methods approach to assess the following outcomes in participating teachers and students: 1) perceived gain in knowledge and skills and 2) perceived satisfaction with the program. The intent mostly was to provide feedback to the program in efforts to improve future programming. It is important to note that the survey findings do not represent the majority of teachers and students who participated in the program and therefore should be interpreted with caution. Future iterations of this summer programming will enhance efforts to increase the response rates.

Perceived Gain in Knowledge and Skills

Teachers were asked the extent to which they agreed or disagreed with the following survey items: 1) I gained valuable skills in AI that will improve my teaching skills, and 2) The skills and knowledge I gained will be beneficial to my students. The results indicated that 67% of the teachers who completed the survey "strongly agreed" that they gained valuable skills and knowledge that will be beneficial to their students and to their overall teaching skills. Interview data with three teachers also revealed the extent to which teachers feel they learned about AI. Each of the three interviewees felt their AI skills and knowledge had been impacted by the summer workshop series. One felt they only learned a little to get a basic grasp of AI but did not feel they achieved a level of mastery. Two others stated the information on AI was new to them and that their understanding of AI was very limited prior to the program. Due to this, these participants acquired some foundational level of knowledge of AI use in everyday life. The following illustrative quotes below highlight these themes and reinforce themes from the open-ended survey questions:

I thought through the experience I was able to get some fundamental basic knowledge of at least what AI is having a better understanding of all the different areas in our life that AI is already incorporated into. So, definitely, I knew nothing before.

At the beginning I knew a little bit about it, I didn't know how much it was incorporated into what we do today, what the different tools they showed us, how easy it is to access free tools online that can show you AI working, and all of that. I had really not a lot of knowledge on that. So when I took the workshop, I was a little lost in the beginning because it was really new to me.

I learned a little bit. … like knowledge plateaued at a certain point. I got a grasp of it, and then that's all I was really able to grasp, and then I watched them implement that three times with the kids, and there was never really a mastery for me because it was the same thing over and over and over.

Teacher interviewees were also asked about the extent to which they feel prepared to implement AI lessons in their classrooms. Importantly, none of the three interviewees expressed that they feel fully prepared to implement AI lessons into their classrooms. Two of the three interviewees brought up concerns with meeting state standards when trying to implement AI lessons in their classrooms. Both of these teachers suggested it would be easier to implement AI lessons as extracurricular or enrichment activities. To better illustrate these concerns with implementation, quotes from each of the three interviews are provided below.

I can see it incorporating them like telling the students about the tool, telling them how it applies to AI. But because we're so tied with the standards and how we are teaching things and the testing and all these different things that we have on our deadlines, I told them it would be better suited like for an enrichment class.

It seemed like some of the things they were doing would work better as maybe an extracurricular program or some type of club like outside of school, just because we are on, at least with the STEM in the Arizona state standards we are already pretty like locked in what we're allowed to teach and there's not

that much leeway. … I can incorporate this really easily and then there was some things I learned that I thought were really cool, but I'm like I don't know if I'm gonna be able to get this by my admin.

Students were asked the extent to which they agreed or disagreed with the following survey items: 1) I gained valuable skills from this program, and 2) I am motivated to learn more about AI after being in this program. As shown below, more than three-quarters of the students who responded to the survey agreed or strongly agreed that they gained valuable skills from this program (77%). Slightly more than two-thirds of the student respondents reported being motivated to learn more about AI after being in this program at that same level (69%).

Perceived Satisfaction with the Program

The teachers who completed the survey were satisfied with their experience in the summer workshop series. Taken together, all three teachers (100%) agreed or strongly agreed that they would recommend the ImageSTEAM program to someone like them and would apply to be in the program again.

Interviews with teachers reaffirm the satisfaction results in the survey of teachers. One commented, "It was a very, very exciting experience for me more than anything because I was able to see all the different things that you can do … and how just how AI is tied to everything, it was very, very exciting. …I really did appreciate being involved in a part of this, it's exciting and it's new." In another interview, a teacher commented that the most beneficial aspect for them was seeing how AI fit into standards. This is important because this interviewee along with another expressed concerns about their ability to implement AI lessons that meet state science standards. Finally, and related to state standards, the third interviewee said the most beneficial aspect of the program for them was finding AI tools that match the curriculum and developing a mini lesson.

Similarly, the majority of students who took the survey were also satisfied with the program as indicated by the 77% of survey respondents who agreed or strongly agreed that they would apply to be in the ImageSTEAM program again (see below). More than half of the students agreed or strongly agreed they would recommend someone like them to attend the ImageSTEAM program (62%).

Concluding Remarks

The NSF funded ITEST project addresses the need for middle school teachers and students training in Artificial intelligence (AI) technology by developing and implementing technology-infused summer workshops in the areas of computer vision and machine learning through a program called ImageSTEAM. This paper presented the findings and experiences of our 1st summer workshop for teachers/students conducted at both UGA and ASU. Based on initial feedback, students are eager to learn and experiment AI topics and activities. Also, the teachers are excited about learning the AI topics and integration of these topics to the subjects they teach in middle school curriculum.

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