BOARD # 394: Middle School Teachers Professional Development for AI instruction through ImageSTEAM Summer Workshops

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Middle School Teachers Professional Development for AI Instruction through ImageSTEAM Summer Workshops: The Georgia Experience

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Abstract

Through an NSF funded ITEST program, ImageSTEAM, summer workshops were conducted for the past four years with diverse middle school teachers in Georgia and Arizona. Specifically, we focused on introducing artificial intelligence (AI) concepts in the middle school curriculum through computer vision and AI tools that will substantially augment science and technology teaching and learning. We introduced computer vision, machine learning, and computational cameras as key AI tools to engage middle school students and to assist teachers with creating lesson plans as part of teacher professional development in the summer. After co-designing and developing the lesson module with the team, teachers implemented the lesson plans with their students at the workshop. Based on the feedback, teachers further improved the lesson modules to present to their classes. The results, including the experiences of the teachers as well as the impact on student learning through AI tools, were obtained through surveys. The results demonstrated teacher satisfaction with AI integration in classroom instruction and increased student engagement in AI-based activities in middle school classrooms.

Introduction

Professional development

Professional development is defined as "*... a catalyst for growth and change in the classroom"* [1]. In this paper, the view of professional development for teachers is based on the preceding statement. The teacher is the catalyst for growth in the classroom. The teacher creates an atmosphere where change occurs. The most valuable individual in the classroom is the teacher, and professional development is necessary to equip the instructor with current and valuable tools that will help in creating the identified changes and growth. In general, four items are identified as vital to the success of any professional development for a teacher, they are: content knowledge, best practices, assessment, and communication [1]. The workshops based their activities on the four aforementioned items . In planning and enactment of the professional development programs in AI in STEM, the following were deemed essential: adequate support for teacher change, opportunities for collaboration, a coherent program, and a focus on content knowledge [6]. With these factors in mind, a team of experts in content, practice, assessment, and communication, was assembled to provide the professional development experience to teachers. Additional details of the experts are provided in the methods section of the document.

Rapid AI Availability

The United States Office of Educational Technology has emphasized the fact that, Artificial Intelligence (AI) has permeated all aspects of life including in education [5]. It identifies parents, educators, and students as parties of interest in AI in educational settings. AI systems are built

using programming language and are intended to mimic humans in several ways. The AI, and many forms of technology, is developed to provide assistance to humans.

Topic selection

Learning technology capabilities at a young age provides confidence and discerning abilities of weighing what is helpful and what isn't. The workshop identified AI topic areas for the middle school that included computer vision, machine language, and computational camera. Ease of access and no cost of these technologies were a key motivation for their selection and use.

Age appropriateness

Scientific research indicates that computer language learning at about age 10 provides the best outcome in grasping the content, context and subject matter skills [2, 3]. Among the benefits that are cultivated at this early age are basic skills such as critical thinking, cause-effect relationship, love of learning, and digital literacy. It is observed that lessons that lend to student motivation are intentionally developed meaningful curriculums where student choice is considered as an important factor for engaging the middle-level learner [4]. Further, when young adolescents are actively engaged in learning they are more likely to achieve at higher levels [4]. The workshop design decisions were based on the aforementioned reasoning.

Method

The Team: An interdisciplinary team of researchers and educators collaborated to design and conduct the workshop. The team consisted of individuals with expertise in computational cameras, AI, visual media, multidisciplinary engineering, sociology, STEM education, and media arts and sciences. The collaborative work between the team of experts and teacher participants was instrumental in creating valuable content and management for the workshops. The team brought subject matter, and technology expertise, while selected teacher participants helped in guiding the standards and content that would be best learned using visual media. A summary of the Georgia summer workshops is briefly described in the sections below.

Selection of participants

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

Workshops: Four workshops were conducted in Georgia on the following dates: 1) July 6 to July 23, 2021; 2) July 11 to July 22, 2022; 3) May 30 to June 15, 2023; and 4) June 10 to June 13, 2024. Each workshop was unique. The first workshop was impacted by COVID-19 and the intended format changed from in-person to a virtual workshop. Meetings were held 3 days a week from 9 am to 12 noon. Students attended virtually on the third week. The second workshop used an in-person format for teacher participants. The meetings took place Monday through Friday from 9 am to 3 pm. Students attended virtually during the second week. The third workshop was an in-person meeting that lasted three weeks. It met four days a week from 9 am to 12 noon. Students attended virtually during the third week. The fourth meeting was in-person and met four days from 9 am to 3 pm. No students attended the fourth meeting. In addition to formal meeting hours indicated in Table 1 below, participants were expected to spend up to an additional twice the amount of time in their design of development of the lesson modules. Table 1 shows general workshop information in Georgia through the four years.

Table 1: Summary of program in Georgia

Year	Teacher participants	Formal hours	Teacher meeting	Student participants	Formal hours	Major topics/program	*Lessons co-created
2021	6 from GA 1 from AR	27	virtual	20	9	**Programs	0
2022	7	50	In-person	17	15	***Programs	5
2023	10	26	In-person	10	12	***Programs	7
2024	14	24	In-person	0	0	***Programs	1

*Lessons modules posted on ImageSTEAM for the public to access
**2021 Programs used: Neural networks, GANs, pixlr, Google colab notebooks, deepFake
***2022, 2023, and 2024 Programs used: Teachable Machine, Google Colab notebooks, NVIDIA GauGAN, and Pixlr

Participants: A total of 38 participants attended the workshops held in Georgia. Teacher participants came from the following counties: Barrow, Clarke, Greene, and Gwinnett. They represented a cross section of counties in the State. Demographics indicate that female participants comprised of one Asian, 12 African American/Black, one Hispanic, and 12 White. Male participants included three African American/Black, two Hispanic, and seven White.

Implementation of the Program

Workshops settings were intentionally selected over seminars or conferences because of two reasons. First, a workshop is a format conducive for learning new skills and practices the teachers were going to gain. Second, the format allows a cohort design whereby trained teacher participants are able to teach new participants, hence imparting confidence to both sets.

A typical first session was for the team leaders to introduce artificial intelligence broadly, then narrow the scope to the educational setting. Demonstrations of AI capabilities were made, followed by hands on activities to create an AI program for a specific task. This approach provided a platform for creating images that better presented a complex learning subject. In subsequent

sessions, participants practiced what they had learned and brainstormed programs to best suit the subjects they intended to apply the AI to enhance student learning.

The workshops were designed as phases with each phase having a unique goal. The first year, the goal was to explore and learn from middle school teachers on what extent AI was actively used in their schools and classrooms. Target participants in this phase were those that mainly taught STEM related classes. The workshop provided an opportunity to the teachers to learn AI based on various computational camera platforms. This learning platform was used throughout all the four phases of the program. The second phase built on the experiences from the first, and added teachers from the social sciences. The goal in year three was to evaluate the impact the first two phases had on middle school education. Also, the workshop was expanded to include additional school districts. The goal in phase four was to invite past participants to lead workshop sessions for new teachers, enabling the program to learn its impact.

Co-Created Lesson Modules

The imagesteam.org houses lesson modules created by both the Arizona and Georgia teachers. In Georgia, teachers could work in an individual capacity or as a team. A total of 13 lesson modules produced by Georgia participants are posted on the website. The lessons cover the following subject areas: Engineering and Integrated STEM (2); ELA and Social Studies (4); Math (2); and Science (5). Sample lesson module snapshots are shown in Figure 1 below.

Figure 1. Snapshots of sample lesson modules developed by teachers

Student Feedback and Perspective

In a pre-test/post-test design, students completed a computer-based survey during the first week of the workshop, prior to instruction (Time 1); and in the final week of the workshop, after receiving some instruction (Time 2). 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. 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.

Teacher Feedback and perspective

Thirteen lesson modules were developed during the workshops in Georgia, and each of these have been implemented in the respective schools by the teachers. Teachers voiced satisfaction in their deployment of the AI based instruction. A couple of teachers have made presentations at conferences showing their success in enhancing their instruction strategies. Two examples of lesson plans presented at conferences include: 1) The Cotton Gin and The Westward Expansion: AI Concepts in Middle School Social Studies; and 2) Create your 3D Eye: A Lesson Module for Grades 6-8 from ImageSTEAM Teacher's Workshop.

The cotton gin and the westward expansion module takes students through the journey from the east coast to the west coast. The teacher provided students with the following AI tools: 1) TinkerCAD to create a US map representing conditions in 1789 to 1840; and 2) Teachable Machines used to train the machine to recognize US territories (1789 -1840). Each territory had a specific color assigned. The exercise was a total success with increased student engagement. *Create your 3D Eye:* A Lesson Module for Grades 6-8 from ImageSTEAM Teacher's Workshop, was aimed to ease the complexity of the study of an eye by creating a 3D eye using TinkerCAD. Students liked the challenge and the 7th graders enjoyed their learning as it was very engaging.

Conclusion

The intellectual merit of the project included the design and use of computational camera technology modules in middle school science and math curriculum. This objective was met and exceeded the scope by expanding into the social sciences. Additionally, it showed students were both motivated and engaged in their learning activities. Thirteen lesson modules were created and are accessible at the imagesteam.org website. The lesson modules are tied to national and state standards that govern learning at the middle school level. The consistency/accuracy of the AI technology, its reliability and repeatability, and its speed in problem solving are characteristics that are needed in todays world and the future. The workshops have equipped teachers with basic skills in AI and content that they can use and grow as they help students and communities learn.

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