

RESEARCH

Engaging High School Teachers with Artificial Intelligence Concepts, Applications, and Developments

Nebojsa Jaksic¹[®], Bahaa Ansaf¹[®], Margie Massey¹ ¹ Engineering, Colorado State University Pueblo Keywords: AI, Workshops, K-12 https://doi.org/10.18260/B2B3-8F-80362

ASEE Computers in Education

Vol. 14, Issue 3, 2025

This work analyzes the effectiveness of an artificial intelligence (AI) communitybuilding workshop designed for high school teachers and it focuses on contemporary issues related to AI concepts and applications. A group of high school teachers from local education districts attended a one-day AI hands-on workshop at our university. The workshop included several AI-related topics and hands-on examples and exercises aiming to introduce AI concepts and tools relevant to pre-college education. The participating teachers were expected to become a part of a collaborative network created to design, develop, and implement novel AI learning modules for high school students. Initial and a post-training surveys have been used to measure the impact of this training and to obtain a better understanding of teachers'/students' readiness for additional hands-on AI experiences and further training. The surveys showed that the teachers gained valuable AI knowledge, AI tools, and attitudes that could help them when introducing AI concepts, applications, and AI ethics to their students. The teachers also explored various AI-based teaching tools that they could use to improve learning outcomes for their students. Based on the positive results of this work, one of the authors developed and implemented a three-credit graduate elective course ED 537 AI in K-12 Education at the School of Education at our university. This is an updated and improved version of the ASEE conference paper titled "Engaging High School Teachers in Artificial Intelligence Concepts and Applications."

I. Introduction

Artificial Intelligence (AI) applications have become an integral part of our lives, from social applications on smartphones to autonomous vehicles. However, as they remain in the domain of "computer magic," these new advancements of knowledge processing and reasoning using AI tools will not be of a great benefit to humanity, unless a complementary educational environment is created to enable students and communities become involved in this scientific revolution early, ethically, and systematically. Introducing and exploring AI concepts and applications earlier in the students' learning journey will help fulfill the future AI job market needs as well as address AI ethics issues and will prepare students for use of new innovative AI applications in all aspects of their lives. The long-term goal of this research is to create a pathway to AI-based learning environments for all. Today, AI leads the revolution in the social, economic, health, and technology areas. The rapid development of AI-based products is accompanied by huge investments from large companies and governments. For example, in the US, the Stargate initiative led by SoftBank, OpenAI, and Oracle is planning to invest \$500B in AI. Furthermore, both the previous and the current administration fully support AI research and development efforts. For example, on February 11, 2019, President Trump issued Executive Order 13859 to maintain American leadership in artificial intelligence¹ and there are strong indicators that he will continue with this support in his current term. With respect to the above executive order, France A. Córdova, Director, National Science Foundation (NSF), included the following statements.²

"NSF has a long and rich history of supporting transformative research in artificial intelligence and machine learning and is an essential contributor to growing the workforce needed to advance AI research and development" ... "Advances in AI are crucial for the U.S. science and engineering enterprise, and nearly all sectors of our 21st-century economy. Many of the transformative uses of AI that we are witnessing today are founded in federal government investments in fundamental AI research that reach back over decades. Building the foundations of tomorrow's AI innovations will require new interdisciplinary collaborations, resources, and strategic visions - principles that NSF has championed in its support of fundamental AI research" ... "The AI innovations that NSF has funded have helped the U.S. capitalize on the full potential of this critical research area, and we are eager to (continue to) strengthen our economy, advance job growth, and better our society."

At the beginning of 2021, Congress passed H.R. 6216, the National Artificial Intelligence Initiative Act of 2020.3 One of the purposes of this law is to "prepare the present and the future United States workforce for the integration of artificial intelligence systems across all sectors of the economy and society." Two initiative activities (Activity 3 and Activity 4) address AI education directly. Activity 3 calls for "support for educational programs at all levels, in both formal and informal learning environments, to prepare the American workforce and the general public to be able to use and interact with artificial intelligence systems, as well as adapt to the potentially transformative impact of artificial intelligence on society and the economy," while Activity 4 addresses "support for interdisciplinary research, education and training programs for students and researchers that promote learning in the methods and systems used in artificial intelligence ..." On June 10, 2021, NSF and the White House Office of Science and Technology Policy (OSTP) formed the National Artificial Intelligence Research Resource Task Force (NAIRR TF).⁴ Their task was to "write the road map for expanding access to critical resources and educational tools that will spur AI innovation and economic prosperity nationwide." In January 2023, NAIRR TF published their final report proposing \$2.6B government funding for a six-year period to establish a NAIRR Operating Entity.⁵

Here, a hands-on project-based AI workshop created to engage and educate high school teachers is designed, implemented, and assessed. Its major goal is to change teachers' perceptions of AI through increased knowledge of AI topics.

While the major emphasis of this work is on the content and organization of the workshop, an educational research question (To what degree the high school teachers engage with AI through a short, hands-on project-based workshop?) is also addressed. This question can be subdivided into three parts, (1) *loss of fear* caused by better understanding of AI concepts, practices, and applications, (2) *acceptance* caused by increased knowledge of AI and applied exercises, and (3) *implementation* of AI concepts and project-based exercises as course topics in teachers' classes enabled by workshop notes, slides, videos, and a list of URLs that offer additional training.

II. Review of Related Work

The "One Hundred Year Study on Artificial Intelligence" (AI100) from September 2021,⁶ claims that from 2016 to 2021, AI has gained increased attention from governments, public agencies, and organizations. More than 60 countries engaged in national AI initiatives. These efforts include a range of governance approaches and programs to ensure public safety, consumer trust, product reliability, accountability, and oversight of AI products. Littman *et al.*⁶ emphasized the importance of increasing governments' investments in AI research at universities to slow down the emigration of AI talent from academia to industry. The same study suggested that "the governments should support K-12 educational standards to help the next generation" of citizens live in a world of ubiquitous use of AI applications.

The sustainable future for humanity where AI applications are pervasive is based on the ability of nations, governments, and communities to establish the balance between AI developments and adaptations of the educational system at all levels (K-16) to follow these accelerated changes, as well as accepting AI as a tool for human advancement. The current K-12 educational system and other pre-college educational systems are mainly designed to accommodate the primary social and scientific learning objectives in accordance with the academic level of students as well as the knowledge of their instructors. Albeit the available AI learning resources are mainly designed for learners at college level.⁷ Even though pre-college students may be exposed to AI applications through games, text-to-image generators, natural language processors, and self-driving cars, it is hard for them to develop any depth in understanding of AI concepts and tools without proper learning environments. Two AI aspects can quickly describe AI's future potential; the first is the increasing demand for AI specialists with different backgrounds (not only computer scientists) which will help in exploring new AI applications, and the second is an increase in the acceptance of AI in the community as a valid scientific tool and not as a magic human replacement. These two aspects can be improved gradually by adopting and enforcing an educational system for high school students that will produce the seeds for the new AI job market. K-12 students are still in their early learning stages where they can increase their understanding of the role of moral values as applied to AI.

AI is a rapidly emerging field of research with broad and powerful applications. However, at this time, there are only a few curricular standards or educational guidelines for introducing pre-college students to fundamental principles and skills related to AI like the NSF-supported grant.⁸ There, the principal investigator (PI) developed specific guidelines for teaching and learning AI in K-12 school learning environments. Some of the AI learning modules as well as student learning outcomes (SLOs) are presented in.^{9,10} Internationally, there are many examples of AI implementations in education. For example, in Estonia, teacher perceptions of AI as a tool for supporting education¹¹ were positive. In China, students' (fourth to sixth graders) motivations to learn AI were influenced by students' gender.¹² In India, over a million children used AI tools to significantly increase their reading and comprehension skills.¹³

III. Context

One of the aims of this work is to provide an example of a successful collaborative AI educational environment consisting of university professors and high school teachers. A simple learning approach is constructed to help teachers understand AI-based solutions (e.g., fuzzy logic, neural networks, and evolutionary techniques) for the problems and procedures from their daily lives.

The content of the workshop is designed based on authors' extensive experience in teaching and in AI research including AI applications like optimization, decision making, classification, and recognition. Also, the authors' multidisciplinary scholarly backgrounds shaped the decisions on how to introduce AI concepts and ethics to the teachers through simple, stand-alone, learning modules that teachers can use effectively when introducing AI topics.¹⁴⁻¹⁶

Approximately 20-40% of teachers' tasks could be automated.¹⁷ Teachers come with a preconceived notion that AI will replace them; instead, the workshop described here illustrated how AI can be helpful. Awareness that AI can complement their teaching methods and create an efficient way of assessing students is a benefit to teachers and their students. In education, AI applications affect four major areas: content, teaching methods, assessment,

and communication. When teachers accept AI, the above framework may create an overarching effect on the educational environment. The described workshop includes three stages: development, planning and implementation, and assessment.

IV. Workshop Development

New AI learning modules are developed. They can be used for teacher workshops or as online resources for future training. The AI module topics are:

- 1. Intelligent behaviors and systems
- 2. Ethics
- 3. Applications and examples:

a. AI as a classification tool (e.g., email spam filters, categorizing emails into primary, social, and promotion inboxes, as well as labeling emails as important)

b. AI as a recognition tool (e.g., smartphone face recognition app and check deposits app)

c. AI as a memory tool (e.g., online shopping personalization and targeting)

d. AI as a decision-making tool (e.g., AI autopilot for commercial flights, fuzzy logic system for optimizing parameters in the washing machine)

e. AI as an optimization tool (e.g., ridesharing apps (Uber and Lyft), Google Maps for optimizing traveling time or distance, and AI scheduling for commercial fights)

f. AI as a prediction tool (credit scores decisions and prediction of fraudulent transactions)

4. Tools for education and classroom activity support (analytic AI that assists with customizing plans for ELL, IEP, 504c; interactive AI like Siri or Alexa that assists with open learning for students; functional AI that assists students with special needs to calm, motivate, and stimulate them and visual AI that "sees" for visually impaired students and narrates the content for them)

Artificial intelligence in K-12 education touches four main areas, *instructivist, constructivist, teacher support, and system support.* What teachers fail to realize is the focus of each of those areas. *Instructivist* approaches students' teaching in a manner which automates and adapts all forms of computerbased support for K-12 students. *Constructivist* refers to variables such as the points of learning where the data deals with visual, auditory, and kinesthetic stimuli. *Teacher support* relates to specific applications or materials that enhance the learning for students. *System support* relates to the impact of AI on teaching and learning in K-12.

Each learning module is designed to include all the required definitions and concepts related to the module topic. Due to time limitations, one of the goals is to provide face-to-face training and discuss a maximum number of AI applications.

V. Workshop Planning and Implementation

Local high school teachers interested in AI (not only STEM teachers) are introduced to basic AI concepts through a one-day workshop at our university. These AI workshops are developed for the first time using professional and scientific approach.

This research was implemented by our faculty members (School of Engineering and School of Education) partnering with local high school teachers from two districts. In average, schools in both districts have more than 44% Hispanic and marginalized students. So, this was an excellent opportunity to involve the maximum number of minoritized and marginalized students in this research to learn more about AI and contribute to future work. This is consistent with our university's mission to serve the local Hispanic minority community and the region. Nine high school teachers from two school districts participated in this workshop. An initial and a post-training survey were used to measure the impact of the training and obtain a better understanding of teachers'/students' readiness to further engage in hands-on AI experiences and training.

A workshop agenda was compiled based on the developed AI learning modules and the initial survey results. Invitations with workshop agendas shown in <u>Table 1</u> were sent out to nine high school teachers which all attended the Artificial Intelligence Workshop.

Prior to the workshop, participants received and completed an initial survey shown in <u>Figure 1</u> so the organizers could assess teachers' prior knowledge of AI.

Our participant pool included active high school teachers. The initial survey was necessary to develop the learning modules appropriate to the teachers' prior knowledge. The initial survey also gathered data on how the participants wanted to use AI in their classrooms. Part of the workshop described specific

Table 1. Workshop agenda

Time	Activity
9:00 am-9:05 am	Self-introduction
9:05 am-9:20 am	Introduction of the Research and Detailing the Purpose of the Workshop
9:20 am- 9:50 am	Part one: Artificial Intelligence's Types, Applications, and Future
9:50 am-10:00 am	Hands-on Example: Machine Learning Research (Object Recognition)
10:00 am-10:10 am	Part one Discussions
10:10 am-10:30	Why AI4K12? D. Touretzky of AI4K12 Presentation
10:30 am-10:40 am	Free Time
10:40 am-11:10 am	Part two: Artificial Intelligence's Applications to Support Education
11:10 am-11:20 am	Discussion of Applications and their use in the Classroom
11:20 am-11:30 am	Free Time
11:30 am-12:00 pm	Wrap up/Conclusion/Closing Thoughts/synthesis/ Future Collaborations/ Completing Exit Survey

	How much do you know about AI?			
	Select one answer that best describes what you know about AI:			
	I know nothing about AI I know little about AI I am not sure I know much about AI Are you aware of any applications that you currently use that are AI?			
	Yes No			
	 What barriers do you perceive in using AI in the classroom? (Select all that apply) I don't have AI tools in the classroom I am not familiar with using AI tools in the classroom The school does not have funds for AI tools in the classroom The students will not buy in to using AI N/A What would you like to know about AI? Rank what you would like to know about AI? (1 most wanted 4 least wanted) 1 24 			
a.	AI tools to support education			
b.	Al general applications			
C.	concepts and techniques			
a.	Do you believe that AI can be a threat? Yes Not sure N	No		

Figure 1. Initial AI workshop survey

applications that teachers could implement into their curriculum immediately. Understanding teachers' needs and desires also influenced the types of applications that were introduced.

Exiting this workshop, I learned something new about AI concepts, applications, and ethics (1 - strongly disagree to 5 - strongly agree).

I have a better understanding of AI and how to integrate it into Education as a result of today's session (1 - strongly disagree to 5 - strongly agree).

I feel that the workshop met my expectations as a teacher (1 - strongly disagree to 5 - strongly agree).

The workshop provided useful material/ideas that I can use as a teacher (1 - strongly disagree to 5 - strongly agree).

Would you be willing to participate in a new AI project (1 - no, 2 - maybe, 3 - yes)?

Overall, I would rate the workshop (1 - poor to 5 - excellent).

What did you enjoy about today's workshop?

Figure 2. Exit AI workshop survey

At the end of the workshop, the participants completed an eight-question post-training survey depicted in Figure 2. The survey consisted of six quantitative questions on a five point or a three-point Likert scale as well as two qualitative questions. The two qualitative questions were also used as pedagogical tools based on experiential learning best practices. Question 7's goal was to elicit a positive self-reflection while Question 8 reinforced learning through internalization and summarization.

VI. Discussion of Results

6.1. Assessment of the Initial AI Workshop Survey

From teachers' responses to the initial survey questions, it was determined that teachers' knowledge varied substantially (Question 1), as was the nature of how they envisioned to use AI in class. Question 2 responses determined teachers' awareness of the everyday use of AI (60% Yes and 40% No). Question 5 addresses teachers' fears of AI. Here, 40% of teachers believed that AI can be a threat, 20% did not, while 40% were undecided. Question 6 addressed teachers' beliefs about their students' knowledge of AI. Twenty percent of teachers believed that their students have some knowledge of AI, 20% believed that they do not, while 60% were not sure. While teachers' responses were not surprising, still they provided a great insight when designing the content of the workshop.

6.2. Assessment of the Exit AI Workshop Survey

At the end of the AI workshop, the teachers answered questions in the exit survey of Figure 2. All results of the first four questions were positive (Question 2: 62.5% Strongly agree and 37.5% Agree; Question 3: 75% Strongly agree and 25% Agree, and Question 4: 62.5% Strongly agree and 37.5% Agree). For emphasis, Question 1 results are presented in Figure 3

Exiting this workshop, I learned something new about AI concepts, applications, and ethics



Would you be willing to participate in a new AI project?



Figure 4. Willingness to participate in a new AI project

showing that all teachers learned something new about AI. While the answers seem obvious, one can infer that there were no teachers that already knew all the material presented. Also, Question 6 responses were all positive (62.5% Excellent and 37.5% Very good). However, Question 5 responses, shown in Figure 4, were puzzling. While most teachers expressed a willingness to participate in new AI projects, 12.5% did not. Upon further inquiry, we leaned that the teacher not willing to participate in a new AI project just accepted an administrative position and would not have time for further involvement.

To summarize, the quantitative questions' responses implied that the teachers improved their understanding of AI concepts and AI applications that can be used in the classroom. They believed that the workshop was useful and provided an excellent set of resources to bring back to their colleagues. All responses to the two qualitative questions were positive. Here are two responses on what teachers enjoyed with respect to the workshop.

(1) I really enjoyed seeing the AI aspects of daily life.

(2) I just am glad I get to bring this information back to my supervisor and collaborate... This was exciting; Dr. Massey always provided me the greatest lesson material, so this was nothing short of awesome, as was expected.

From the teachers' perspectives (Question 8), major benefits from the workshop were the knowledge of how to search for specific resources and whom to contact to collaborate. The workshop resources used (websites, tutorials, and applications) were all free and can be used in education. Teachers expected that all AI tools would be expensive and hadn't considered that there could be ones that are free. As certain aspects of AI have been emphasized, the participants have been realizing that there are many AI applications all around them affecting their daily lives; that AI ethical issues concern them; that some of the teaching/assessment tools they are using are in fact AI apps; that their students can access these free AI tools for their own out-of-class education and that the help will be provided, if needed.

One K-12 teacher integrated AI content into a course that he is currently teaching. The course focuses on coding and AI.

Loss of fear, the first part of the research question, was addressed in the initial survey to establish a pre-workshop state, and then after the workshop through individual interviews. After demystifying AI, all teachers perceived AI just as a set of tools for their use, not as a monster that will take their jobs and possibly end humanity. Through lectures on AI topics, small projects and exercises with AI applications (some specifically developed for education) teachers increased their acceptance of AI. While the implementation of AI topics in high schools was limited, the development and offering of a graduate level course ED 537 AI in K-12 Education within the School of Education was a positive consequence of the workshop. The course addresses the following topics: problem spaces and search, classification and clustering, image classification, natural language, robotics, and fairness in AI. Students gain knowledge and skills through reading assigned text, watching assigned videos, and writing papers and delivering presentations to answer assigned questions. For example, one assignment instructs students to write an opinion paper (based on existing literature) on the use of AI in K-12.

VII. Summary and Future Work

The myth that artificial intelligence will replace teachers was dispelled. The barriers of an environment of mistrust versus lack of knowledge can be overcome by educating the educators via workshops. While there are still threats from AI misuse, a set of ethical rules should be able to minimize the risks. The workshop participants quickly realized that there is a learning curve to AI implementations in the class environment. The desire to integrate learning simulations supporting hands-on activities to enhance student learning is a good motivator for teachers to learn AI. Also, budget considerations for implementing AI in education are not problematic due to many free AI tools for education. In addition, there should be an understanding of the role of the teacher , i.e., how to gain parental acceptance, and how to promote the overall acceptance of AI in education.

The authors believe that the engagement of high school teachers in this and similar AI workshops is important in changing teachers' perspectives on AI and enabling them to include AI topics in high school curricula. While this work describes the design and implementation of a small AI workshop it is hoped that this can be scaled up so that many citizens can be educated in AI so to make informed decisions on AI aspects directly influencing their lives. This is especially important now, since the world is amid many controversies dealing with AI, from biased data sets for training of neural networks, ChatGPT unfair uses, to calls for a moratorium on all AI developments because the improvements in AI are occurring too fast.

In part and as a consequence of this work, one of the authors developed and implemented a three-credit one semester graduate level course, Artificial Intelligence in K12 Education. The course prepares future teachers to accept, teach, and use AI, as well as to critically evaluate AI progress, products, and events. To further promote and implement AI in the K-12 curriculum, a collaborative network including local schoolteachers and AI-active university professors will be investigated.

Submitted: November 07, 2021 EDT. Accepted: February 25, 2025 EDT. Published: March 31, 2025 EDT.



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-4.0). View this license's legal deed at http://creativecommons.org/licenses/ by/4.0 and legal code at http://creativecommons.org/licenses/by/4.0/legalcode for more information.

REFERENCES

1. White House. "Executive Order 13859, Maintaining American Leadership in Artificial Intelligence," Presidential Documents. *Federal Register*. 2019;84(31). Accessed January 27, 2025. https://www.federalregister.gov/documents/2019/02/14/2019-02544/maintaining-american-leadership-in-artificial-intelligence

2. NSF Press. NSF Press Statement 19-001. Statement on executive order to maintain American leadership in artificial intelligence. 2019. Accessed January 27, 2025. <u>https://nsf.gov/news/news_summ.jsp?cntn_id=297658&org=NSF&from=news</u>

3. U.S. Congress. U.S. Congress H.R. 6216. The National Artificial Intelligence Initiative Act of 2020. 2021. Accessed January 27, 2025. <u>https://science.house.gov/bills?ID=34889C3E-C675-4EAF-B50F-880C05EB753B</u>

4. NSF News. NSF News Release 21-006. The Biden administration launches the National Artificial Intelligence Research Resource Task Force. 2021. Accessed January 27, 2025. <u>https://www.nsf.gov/news/news_summ.jsp?cntn_id=302882&org=NSF&from=news</u>

5. National Artificial Intelligence Research Resource Task Force. Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem An Implementation Plan for a National Artificial Intelligence Research Resource. January 2023. Accessed January 27, 2025. <u>https://nsf-gov-resources.nsf.gov/2023-10/NAIRR-TF-Final-</u>

Report-2023.pdf?VersionId=2RqgASgtGLzEI6QKsMIL.MWITnjgtmh_

6. Littman LL, Ajunwa I, Berger G, et al. *Gathering Strength, Gathering Storms: The One Hundred Year Study on Artificial Intelligence (AI100) 2021 Study Panel Report.* Stanford University; 2021. Accessed January 27, 2025. <u>http://ai100.stanford.edu/2021-report</u>

7. Russell S, Norvig P. Artificial Intelligence: A Modern Approach. Pearson; 2019.

8. Touretzky D. Developing K-12 Educational Guidelines for Artificial Intelligence. NSF Award Number 1846073. 2019. Accessed January 27, 2025. <u>https://www.nsf.gov/awardsearch/ showAward?AWD_ID=1846073</u>

9. Gardner-McCune C, Touretzky D, Martin F, Seehorn D. AI for K-12: Making Room for AI in K-12 CS Curricula. Published online February 2019. doi:<u>10.1145/3287324.3293729</u>

10. Touretzky D, Gardner-McCune C, Martin F. Envisioning AI for K-12: What Should Every Child Know about AI? *AAAI Proceedings*. 2019;33(01):9795-9799. doi:10.1609/ aaai.v33i01.33019795

11. Chounta IA, Bardone E, Raudsep A, Pedaste M. Exploring Teachers' Perceptions of Artificial Intelligence as a Tool to Support their Practice in Estonian K-12 Education. *International Journal of Artificial Intelligence in Education*. Published online June 2021. doi:10.1007/ s40593-021-00243-5

12. Lin PY, Chai CS, Jong MSY, Dai Y, Guo Y, Qin J. Modeling the structural relationship among primary students' motivation to learn artificial intelligence. *Computers and Education: Artificial Intelligence*. 2021;2:100006. doi:<u>10.1016/j.caeai.2020.100006</u>

13. Srinivasan V, Murthy H. Improving reading and comprehension in K-12: Evidence from a large-scale AI technology intervention in India. *Computers and Education: Artificial Intelligence*. 2021;2:100019. doi:10.1016/j.caeai.2021.100019

14. Ansaf B, Jaksic N. Teaching Mechanical Design for Mechatronics Engineering Students Using a Project-based Sequential Learning Approach. In: *Proceedings of the 2018 ASEE Annual Conference and Exposition*. ; 2018. 15. Ansaf B, Jaksic N. Teaching Undergraduate Manufacturing Course using a Design-based Teaching Approach. In: *Proceedings of the 2019 ASEE Annual Conference & Exposition*. ; 2019.
16. Sarper H, Jaksic NI. Simulation of the stochastic one-dimensional cutting stock problem to minimize the total inventory cost. *Procedia Manufacturing*. 2019;38:916-923. doi:<u>10.1016/j.promfg.2020.01.174</u>

17. Bryant J, Heitz C, Sanghvi S, Wagle D. How artificial intelligence will impact K-12 teachers. McKinsey & Company report. January 14, 2020. Accessed January 27, 2025. <u>https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers#/</u>