



Establishing AI Literacy before Adopting AI

Fiona Hollands & Cynthia Breazeal

To cite this article: Fiona Hollands & Cynthia Breazeal (2024) Establishing AI Literacy before Adopting AI, The Science Teacher, 91:2, 35-42, DOI: [10.1080/00368555.2024.2308316](https://doi.org/10.1080/00368555.2024.2308316)

To link to this article: <https://doi.org/10.1080/00368555.2024.2308316>



© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC



[View supplementary material](#)



Published online: 19 Mar 2024.



[Submit your article to this journal](#)



Article views: 4636



[View related articles](#)



[View Crossmark data](#)



Citing articles: 11 [View citing articles](#)

Establishing AI Literacy before Adopting AI

FIONA HOLLANDS AND CYNTHIA BREAZEAL



ABSTRACT

With the recent explosion of AI applications in our everyday lives, it is critical for teachers and students to become AI literate, that is, to understand the role of AI in our lives, to evaluate its pros and cons, and to use it productively. We describe a set of short-format, modular AI literacy curricula developed by Massachusetts Institute of Technology in collaboration with an implementation partner, i2Learning, to help educators introduce their students to AI and its responsible and ethical use. We used an online questionnaire to collect data from 265 individuals across the globe on how the curricula were implemented in 2022–23, including 190 teachers who collectively implemented the curricula with almost 12,000 students. Teachers reported an increase in their knowledge of AI concepts, an increase in optimism about the potential benefits of AI to society, and greater confidence in their ability to contribute to the future of AI. Similar results were reported for students. We also conducted 17 virtual interviews with teachers to elicit feedback on the curricula and to better understand how they adapted the curricula for their own contexts.

Keywords: Generative artificial intelligence; AI; ChatGPT; AI literacy; AI literacy; curricula; engineering design; instructional materials

Many teachers across all disciplines have spent the last year grappling with whether and how to integrate newly available generative artificial intelligence (AI) tools such as ChatGPT into their instruction. Others have fretted about how to respond to student inquiries about how AI works or to alarm bells raised about “deepfakes” and other kinds of misinformation. For one upper school STEAM teacher and makerspace coordinator in Ohio, the day students stopped her in the hallway to complain that they were spooked by the recently-released My AI feature in Snapchat was when she realized the time was ripe to tackle AI literacy.

AI literacy is the ability to understand the role of AI in our lives, to evaluate its pros and cons, and to use it productively (see Klein 2023 for a fuller explanation of AI literacy). One of the students had snapped a picture in a classroom and My AI asked what was on the wall and commented that it looked like the student was with her friends. The students found this intrusive, were angry that they could not eliminate the feature, and wanted to understand how it worked.

The STEAM teacher set to work looking for instructional materials that could repair her students’ sense of powerlessness by helping them understand the basics of how AI works, how it is being used, and its potential benefits and harms. It did not take much searching to find a set of curricula, freely available online at <https://www.dayofai.org/> and expressly developed by Massachusetts Institute of Technology over the last 2 years to help educators introduce their students to AI and its responsible and ethical use. This article describes the curricula, how they were used by educators in 2022–23, and reports key findings about their impact based on surveys and interviews of these teachers.

Background

As applications of AI have proliferated, the call has grown for educating students about what AI is, how it works, and how

it can affect us (Miao et al. 2021; Miao and Shiohira 2022; U.S. Department of Education, Office of Educational Technology 2023). However, current standards and frameworks for science teaching pre-date the expansion of AI beyond computer science into all disciplines, leaving explicit guidance on how to incorporate it into science instruction undetermined. Touretzky et al. (2019) laid out five big ideas every K-12 student should know about AI and on which K-12 AI literacy curricula should be based:

- “Computers perceive the world using sensors.” (97)
- “Agents [AI systems] maintain models/representations of the world and use them for reasoning.” (97)
- “Computers can learn from data.” (97)
- “Making agents interact comfortably with humans is a substantial challenge for AI developers.” (97)
- “AI applications can impact society in both positive and negative ways.” (98).

The AI4K12 initiative, jointly sponsored by the Association for the Advancement of Artificial Intelligence and the Computer Science Teachers Association, has since developed national guidelines for K-12 AI education based on these ideas. Initial efforts to implement and evaluate AI literacy curricula suggest they can help students become more knowledgeable users and creators of AI (DiPaola, Payne, and Breazeal 2020; Lee et al. 2021). Williams et al. (2022) recommend that curricula on AI concepts should incorporate active learning and “unplugged” (3) activities, engage students in projects, and help students consider ethical implications of AI applications. They also highlight the need to “mind the digital gap” (41) and lower barriers to entry by limiting the amount of prerequisite knowledge and technology resources students need to engage in the curricula.

The Day of AI curricula

In 2022 and 2023, Massachusetts Institute of Technology, in collaboration with an implementation partner, i2Learning, developed 12 modular, short-format curricula for educators of students aged 5–18 years to use for developing AI literacy among students. Details of the curricula are shown in Table 1. The curricula incorporate the National Research Council's (2012) core ideas of engineering design. They introduce educators and students to AI vocabulary and concepts; help them understand the distinguishing characteristics of AI; engage them in hands-on activities to learn how AI works, is applied to everyday technologies, and can advance scientific knowledge; and provide opportunities to design and test solutions to problems faced by individuals and society, and communicate their results (see Boxes 1 and 2 for example activities). The curricula explore benefits of AI to individuals and society and potential harms, emphasizing the need for responsible, equitable, and ethical design and use of AI.

The curricular materials, including educator guides, teacher slides, student resources, and training videos, can be freely downloaded, used, adapted, and redistributed under a Creative Commons license. They were designed to be taught by educators with minimal experience teaching AI and with limited equipment beyond digital devices and high-speed internet access.

In 2022–23, over 7,500 individuals from 136 countries registered to access the curricula: 65 percent were teachers and 65 percent were based in the U.S. Two hundred and sixty-five of these registrants responded to a survey inquiring about

their use of the curricula and how the content affected their views of and knowledge level about AI. One hundred and ninety respondents who implemented one or more of the curricula with students (“implementers”) were asked a more extensive set of questions about the experience and its impact on their students. Seventeen implementers agreed to a follow-up interview, providing additional insights and feedback on the curricula.

Collectively, the 190 implementers taught the curricula to approximately 12,000 students. Two-thirds of the implementers taught in government-funded schools. Many teachers taught the curricula to students older or younger than the target age range, with all curricula being taught to high school students. No doubt this reflects the demand for knowledge about AI among both adults and students and the dearth of readily available content. The ability to adapt the materials allowed educators to tailor the content for learners of different ages, abilities, and cultures.

How the Day of AI curricula were implemented in schools

In most cases, the curricula were implemented during regular class hours but, in some instances, teachers had to fit the lessons into lunch time or students' free periods, before or after school, or as part of end-of-semester activities or summer school. On average, teachers reported spending four hours preparing to teach the curricula; for example, reading the



TABLE 1

Day of AI curriculum information and ages of students taught by 190 implementers.

Curriculum	Target grade level	Age range of students to whom curriculum was taught		Estimated no. of hrs to implement	No. of lessons	Topics addressed
		Youngest (Yrs)	Oldest (Yrs)			
What Can AI Do?	K-2	Under 5	22-30	4.0	4	Define AI; identify AI applications, capabilities and limitations; AI sensors; image recognition and sorting
Teachable Machines	G3-5	5-6	Over 50	3.0	5	Machine learning: collecting datasets, training an algorithm, predicting on new data, algorithmic bias
AI Blueprint Bill of Rights	G3-5	9-10	17-18	4.8	7	How human rights are impacted by the use of AI: non-discrimination, privacy, transparency, safety
Can Machines Be Creative?	G6-8	5-6	17-18	3.5	5	Machine learning: collecting datasets, training an algorithm, predicting on new data; algorithms; Generative Adversarial Networks (GANs); deepfakes and data manipulation; ethical and responsible use of AI
Game AI	G6-8	9-10	17-18	3.2	4	Introduction to Scratch, rule-based learning vs. reinforcement learning and ethical implications
AI in Social Media	G6-12	13-14	19-21	4.0	8	AI in recommendation systems, clustering algorithms and filter bubbles; how misinformation can spread; responsible use and regulation of social platforms
Data Science and Me (no coding version)	G9-12	15-16	17-18	4.3	6	Creating datasets, sharing data, data activism, bias in data, data visualizations, how identity and power can be expressed through data
Data Science and Me (coding version)	G9-12	15-16	15-16	5.8	8	Creating datasets, aggregating and cleaning data, combining data sources using Python, data visualizations, how data is captured about individuals by governmental and social technology systems, sharing data, how identity and power can be expressed through data
Intro to Voice AI	G9-12	Under 5	19-21	1.0	1	How voice AI works, program Alexa skills using voice AI, how Alexa uses AI to determine what user commands mean
Personal Image Classifier	G9-12	15-16	17-18	3.6	6	Image classification, using App Inventor to create a Personal Image Classification model, bias in machine learning systems, ethical implications of using AI in image recognition

(Continued)

TABLE 1 (CONTINUED)

Day of AI curriculum information and ages of students taught by 190 implementers.

Curriculum	Target grade level	Age range of students to whom curriculum was taught		Estimated no. of hrs to implement	No. of lessons	Topics addressed
		Youngest (Yrs)	Oldest (Yrs)			
Data Science and Decision Making	G9-12	No response	No response	6.3	9	AI in college admissions decisions, biased AI and Algorithmic Decision Making, analyzing and visualizing data, implications of using and not using affirmative action policies
ChatGPT in School	G3-12	9-10	Over 50	3.5	4	AI and the creative process, how large language models work, chatbots vs. search engines, benefits and limitations of large language models, how they should be used in schools

BOX 1

Example of developing an AI-based solution to a real world problem in the Teachable Machines curriculum.

This excerpt is from an interview with the teacher based in a Title I magnet school in North Carolina who taught *Teachable Machines* as part of an Emerging Technologies course.

They have to use Teachable Machine to... design some sort of AI solution that can help people with disabilities. And then they have to make a prototype of that using Teachable Machine. . . They do really well. . . I had a student. . . where his idea was that if somebody is color blind then it might be more difficult for them to be able to pick out produce without being able to touch it. And so he trained Teachable Machine on red delicious apples. And so we found lots of pictures on the Internet of apples that were underripe and overripe and just right. And so he was able to train it. And then we showed it some other pictures and it worked really well. He was very excited, like jumped out of his chair. He was like "I'm going to make this happen!"

Then. . . we extend that a little bit further . . . with so now. . . you've got something on your phone you can hold up to the display of apples and have it pick one for you that's your desired level of ripeness. . . In my mind, I was like maybe you could come up with something that actually picks produce, like a robot that can pick produce off the tree in an agricultural setting that is the desired amount of ripeness. But his thought process actually went to having robots do the grocery shopping for us. . . If the AI could tell how ripe the apple is, then you could say 'I want 5 ripe apples' and now the robot could actually pick them out at the stand at the grocery store.

educator guide; watching tutorial videos; attending optional, free training webinars; reviewing or editing slides; planning adaptations; translating content; and gathering materials and equipment. Some teachers spent little to no time preparing, while others spent up to 20 hours adapting the content and integrating other resources.

The most common adaptation was omitting or condensing content or modifying activities to fit into the available time or to avoid difficult content. Some implementers created their own

slides, notes, guides, or worksheets for students while others added more opportunities for interaction including additional hands-on activities, challenges, quests, questions, quizzes, and discussion topics. Several teachers suggested that integrating tools such as Pear Deck, Curipod, or Padlet would help facilitate interaction. Seventy implementers named a variety of resources used to supplement the curricula. These are listed in Box 3 (see Supplementary Files) and include teacher-developed activities and materials, videos, articles, books, EdTech tools and

BOX 2

Example of student recommendation for a school policy on ChatGPT use

One of the activities in the ChatGPT in School curriculum involved students working collaboratively to devise recommendations for a school policy on student use of ChatGPT for school-related work. The policy was required to meet the following criteria and constraints:

Criteria	Constraints
Understandable by school stakeholders (students, teachers, principals, etc.)	Needs to be written down and clearly communicated
Concrete – make it clear what will happen in the policy	Does not need to focus on ChatGPT specifically, but should have an impact on ChatGPT usage
One at a time – a policy should not do multiple things at once if possible	

Survey respondents were invited to share examples of their students' recommendations. The following unedited example of a student response was provided by a teacher of 15-16-year-old students (9th grade) in Maryland:

Based on the limitations and advantages of AI generated tools such as ChatGPT, I believe that it would be beneficial to add a policy on said tools to our schools Acceptable Use Policy. I think that AI generated tools should be acceptable to use for instances such as outlines, feedback/comparisons on one's previous work, and if one is stuck and needs inspiration for an assignment. However, there should also be restrictions. For example, it should not be used to write a whole essay and students should not be allowed to copy AI ideas that are not their own.

platforms, and online games. The average amount of time students spent engaging with the curricula ranged from 2.3 hours for *Personal Image Classifier* to 8.5 hours for *AI Blueprint Bill of Rights*.

Teachers reported that a favorite activity among the students was "AI or Not" in which the teacher shows slides of various items such as a toaster, a revolving door, a face filter, and a self-driving car, and asks students to apply a set of five questions to determine whether each item is artificially intelligent. An example slide is shown in Figure 1.

FIGURE 1

Example slide from activity "AI or not."

AI or Not?

1. Does it perceive its environment?
2. Can it learn over time?
3. Does it make plans on its own?
4. Does it interact with the environment?
5. Is it intelligent or is it following its programming?



Self-Driving Car

Reported impacts of the Day of AI curricula on teachers and students

AI-related concepts teachers and students learned as a result of engaging with the curricula

Survey respondents were asked to indicate on a scale of 0–10 their level of knowledge about AI before and after engaging with the Day of AI curricula (where 0 indicates no knowledge and 10 indicates expert knowledge). The average score rose from 3.8 to 6.0 (See Figure 2). Implementers were similarly asked to rate their students' level of knowledge about AI before and after implementing the curricula. The weighted average score across curricula increased from 2.4 to 4.3. Implementers were also asked to rate the extent to which the curricula improved specific aspects of their students' AI literacy. Over 70 percent of implementers indicated that the curricula helped students a lot or to some extent in:

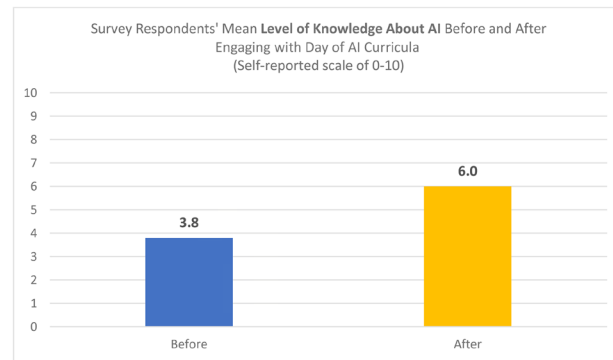
- understanding how AI is currently being used
- the mechanics of how AI works
- the potential for AI to benefit people and society.

Between 50 percent and 65 percent of implementers indicated that the curricula helped students a lot or to some extent in:

- understanding the potential dangers of AI to people and society
- applying AI concepts to complete a task

FIGURE 2

Increase in survey respondents' level of knowledge about AI before and after engaging with Day of AI curricula.



- understanding how and why AI applications may be biased
- understanding ethical implications of AI
- understanding how AI applications may use data in ways that raise concerns about privacy
- understanding how they themselves can contribute to shaping the future of AI
- understanding why AI applications may raise concerns about equity
- using AI to solve problems creatively.

Impact of the Day of AI content on teacher and student perceptions of AI and their sense of agency in determining its place in their future

Survey respondents were also asked to indicate on a scale of 0–10 their level of optimism about the potential benefits of AI to society before and after engaging with the Day of AI curricula (a score of 0 indicates not at all optimistic and a score of 10 indicates very optimistic). These scores rose from 5.6 to 7.1 (See Figure 3). Respondents noted that it was helpful to see practical examples of AI being used to facilitate tasks and to learn how AI is helping to advance scientific pursuits such as medicine and climate study. The focus on ethical use of AI helped alleviate concerns about misuse of AI.

For almost two-thirds of the survey respondents, learning more about AI gave them greater confidence in their ability to contribute to its future. The majority of these respondents felt they could exert influence by teaching their students about AI. For example, a teacher in a district school in Alabama wrote: “As an educator, I feel that exposing the students to AI, teaching them the basics of AI and addressing the social concerns is a

vital part of shaping the future of AI. These students will be the ones to be the main contributors to the growth and expansion of AI.” Respondents were generally more positive about their ability to contribute to shaping the future of AI literacy than about their ability to shape the future of AI itself: 77 percent felt that they could contribute to the future of AI literacy a lot or to some extent.

Implementers were asked to rate their *students’* level of optimism about the potential benefits of AI to society before and after they had implemented the Day of AI curricula. The weighted average score across curricula increased from 5.0 to 6.7.

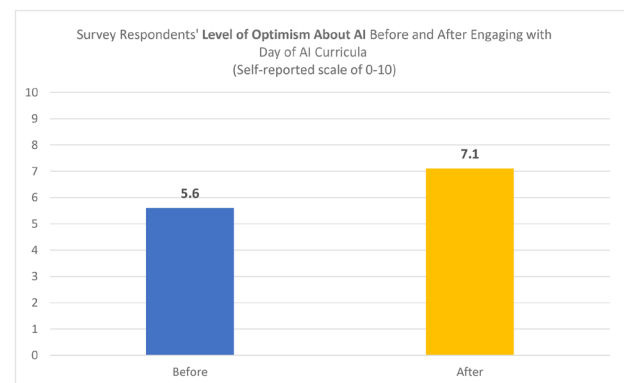
Sixty-one percent of implementers reported that their students felt they can contribute a lot or to some extent to shaping the future of AI and 77 percent reported that this sentiment increased as students learned more about AI. Some explained that students had begun to understand how their own data are being used in AI models and that their use of AI applications might contribute to training the models. For example, one teacher commented that: “. . . I think their eyes are opened to the fact that their data is the primary driving factor, over which they have at least some control.” Another teacher observed that: “Students are understanding how AI is being used and created and they are understanding that they can become programmers and creators of this technology and not just passive users of it.”

Conclusion

The Day of AI initiative and associated curricula represent a timely response to recent developments in AI, preparing teachers and students to engage in thoughtful explorations and deliberations about the role of AI in our lives, in our schools, and in

FIGURE 3

Increase in survey respondents' level of optimism about AI before and after engaging with Day of AI curricula.



the advancement of science. It is impressive that after only a few hours of engagement with the content, teachers reported that they and their students learned AI concepts, how AI works and is currently being used, and about potential benefits and harms to society. Learning more about AI increased their levels of optimism about the potential benefits of AI to society and about their own abilities to contribute to shaping the future of AI. The last finding is perhaps the most critical: in the face of concerns about AI's potential to wrest control from humans, improving teachers' and students' sense of agency is a worthy achievement.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

SUPPLEMENTAL MATERIAL

Supplemental data for this article can be accessed online at <http://dx.doi.org/10.1080/00368555.2024.2308316>.

REFERENCES

DiPaola, D., B. H. Payne, and C. Breazeal. 2020. "Decoding Design Agendas: An Ethical Design Activity for Middle School Students." In *Proceedings of the Interaction Design and Children Conference*, 1–10. <https://dspace.mit.edu/bitstream/handle/1721.1/146207/3392063.3394396.pdf?sequence=1&isAllowed=y>.

Klein, A. 2023. "AI Literacy, Explained." *Education Week*. <https://www.edweek.org/technology/ai-literacy-explained/2023/05>

Lee, I., S. Ali, H. Zhang, D. DiPaola, and C. Breazeal. 2021. "Developing Middle School Students' AI Literacy." In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, 191–197. <https://dl.acm.org/doi/pdf/10.1145/3408877.3432513>.

Miao, F., W. Holmes, R. Huang, and H. Zhang. 2021. *AI and Education: Guidance for Policymakers*. Paris, France: United Nations Educational, Scientific and Cultural Organization. <https://doi.org/10.54675/PCSP7350>.

Miao, F., and K. Shiohira. 2022. "K-12 AI Curricula. A Mapping of Government-Endorsed AI Curricula." UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000380602>

National Research Council (NRC). 2012. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, D.C.: The National Academies Press.

Touretzky, D., C. Gardner-McCune, F. Martin, and D. Seehorn. 2019. "Envisioning AI for K-12: What Should Every Child Know about AI?" *Proceedings of the AAAI Conference on Artificial Intelligence* 33 (01): 9795–9799.

U.S. Department of Education, Office of Educational Technology. 2023. "Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations." Washington, DC, 2023. <https://tech.ed.gov/ai-future-of-teaching-and-learning/>

Williams, R., S. Ali, N. Devasia, D. DiPaola, J. Hong, S. P. Kaputsos, B. Jordan, and C. Breazeal. 2022. "AI + Ethics Curricula for Middle School Youth: Lessons Learned from Three Project-Based Curricula." *International Journal of Artificial Intelligence in Education*: 33 (2): 325–383. <https://doi.org/10.1007/s40593-022-00298-y>.

© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

Fiona Hollands (email: fiona_hollands@edresearcher.net | X: @EdResearcher | LinkedIn: <https://www.linkedin.com/in/fiona-hollands-4731037b/> | ORCID: 0000-0002-1172-9310) is the Founder and Managing Director of EdResearcher, an independent research, evaluation, and R&D organization. Previously, she was a senior researcher at Teachers College, Columbia University where she worked with the Center for Technology and School Change and the Center for Benefit-Cost Studies of Education. **Cynthia Breazeal** (X: @cynthiabreazeal | LinkedIn: <https://www.linkedin.com/in/cynthia-breazeal-1792317/>) is a professor of media arts and sciences at Massachusetts Institute of Technology (MIT), where she founded and directs the Personal Robots group at the Media Lab. She is the MIT dean for digital learning and the Director of the MIT-wide Initiative on Responsible AI for Social Empowerment and Education (raise.mit.edu). MIT RAISE is a research and outreach effort that advances access and inclusivity in AI education to people of all ages and backgrounds with a focus on K12 and the workforce.