Literacy and STEM Teachers Adapt AI Ethics Curriculum

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Abstract

This article examines the ways secondary computer science and English Language Arts teachers in urban, suburban, and semi-rural schools adapted a project-based AI ethics curriculum to make it better fit their local contexts. AI ethics is an urgent topic with tangible consequences for youths' current and future lives, but one that is rarely taught in schools. Few teachers have formal training in this area as it is an emerging field even at the university level. Exploring AI ethics involves examining biases related to race, gender, and social class, a challenging task for all teachers, and an unfamiliar one for most computer science teachers. It also requires teaching technical content which falls outside the comfort zone of most humanities teachers. Although none of our partner teachers had previously taught an AI ethics project, this study demonstrates that their expertise and experience in other domains played an essential role in providing high quality instruction. Teachers designed and redesigned tasks and incorporated texts and apps to ensure the AI ethics project would adhere to district and department level requirements; they led equity-focused inquiry in a way that both protected vulnerable students and accounted for local cultures and politics; and they adjusted technical content and developed hands-on computer science experiences to better challenge and engage their students. We use Mishra and Kohler's TPACK framework to highlight the ways teachers leveraged their own expertise in some areas, while relying on materials and support from our research team in others, to create stronger learning experiences.

Introduction

Artificial intelligence ethics is an urgent topic with tangible consequences for secondary students' current and future lives. Career opportunities in AI are expected to expand rapidly over the next decade, with AI playing a role in solving major social problems. But AI also has the potential to extend historical inequalities (Sherman 2022) and erode democratic institutions (Kamarck 2022, O'Neil 2016). Youth deserve to have a deep understanding of the ways in which AI may influence their lives, and a voice in ensuring that AI technologies are designed and used in ethical ways. AI ethics is making its way into K-12 schools, but the process is slow and uneven. Not only is AI ethics an emerging topic in which few teachers have had formal instruction, it is also an inherently interdisciplinary one that requires many teachers to work outside of their comfort zone. Teaching AI ethics involves technical knowledge that is unfamiliar to many experienced computer science teachers and requires delving into contentious topics related to race, gender, and social class, which are generally more closely associated with humanities classrooms.

One approach to solving this challenge would be to provide teachers with a set curriculum, with an emphasis on fidelity, to ensure skills and concepts are accurately taught. We believe, however, that this approach is not likely to develop students who are able to apply a critical, ethical stance toward the design, production and consumption of AI technologies. Teachers' knowledge of their students' interests and experiences is essential for ensuring that they are supported academically and emotionally, especially while exploring topics that can be technically challenging and politically sensitive (Ryoo and Tsui 2020).

Our interdisciplinary team of STEM and literacy researchers and educators has developed an open education, modular, project-based AI ethics curriculum for middle and high school students. These modules explore topics such as algorithmic bias, privacy vs security, and the ethics of AI-created art and self-driving cars. We combine original short stories, non-fiction texts, and hands-on AI experiences to help students develop nuanced understandings of AI ethics. We ask them to design and share digital products in which they take a stance on an AI ethical dilemma. In this study we examine the ways a 7th grade computer science (CS) teacher, two 9th grade English Language Arts (ELA) teachers and a 9th grade cybersecurity teacher

adapted and enacted our modular AI Ethics curriculum to fit their content areas and contexts. Our results suggest that even without previous formal training in AI ethics, teachers were able to leverage their pedagogical, content, and technical knowledge to develop customized versions of our curriculum that better met the needs of their students, adhered to school-level guidelines, and were responsive to the cultures of the local communities.

Related Work

There have been significant efforts in developing and testing new curricula for AI education for K-12 students (Tourestzky et al. 2019), including elementary school students (Kim et al. 2021), middle school students (Zhang et al. 2022), and high school students (Estevez, Garate, and Grana 2019). Projects take place in informal settings such as libraries, after-school programs, and summer camps (Cummings et al. 2021), as well as formal education settings. Some work at the state level, such as the AI4Georgia project. Some work at the district level. Most work with individual teachers in schools to pilot a wide range of innovative AI curriculums.

AI ethics has been recognized by researchers and educators as a critical topic to teach in addition to core AI knowledge and skills (Touretzky et al. 2019). Some of the most common AI ethics topics covered by K-12 AI curriculums are fairness, privacy, and safety. AI ethics is also beginning to be integrated into AI learning activities. For example, as a teacher teaches face recognition technology, they may also discuss the issue of bias in this technology (Zhang et al. 2022).

Although there is increasing recognition of the importance of teaching AI ethics, several challenges have been identified, including lack of adequate content knowledge, lack of time, lack of a common standard, and lack of administrative support (Touretzky et al. 2019).

Who teaches AI ethics?

In formal education, AI ethics is most often taught by CS teachers (Williams 2021). Outside of CS classrooms, there's growing evidence that discussions of AI ethics are happening (Sakulkueakulsuk et al. 2018, von Wangenheim et al. 2017), such as in an ELA classroom, where students learn to write essays about the topic "self-driving cars" or in a social studies classroom, where students learn about bias in AI used in the criminal justice system, as part of a broader discussion on social justice.

Most research has focused on pilots and single workshops led by researchers; in our study, secondary teachers took a lead role in teaching multi-week units adapted for their course and students. Further, most previous studies focused on computer science classrooms, with some in social studies classrooms (van Brummelen, and Lin, 2020). We collaborated with 4 teachers in STEM and literacy classrooms to learn similarities and differences in how they adapted our modules to fit their contexts. Finally, many studies situate ethics as subordinate to the main goal of developing AI technical knowledge (Williams, 2021). Our study investigated scenarios in which teaching AI ethics is the main goal.

Our work builds on previous studies of curriculum that explores social problems related to technology, as well as project-based approaches to technology learning that encourage student-driven inquiry, especially in interdisciplinary contexts (von Wangenheim, Marques, and Hauck 2020). Our work is also informed by studies that examine cybersecurity and computer science instruction that takes place in other subject area classes (Buchanan, Scarlatos and Telendii 2021).

Theoretical Framework

While some researchers examining curriculum implementations have focused on fidelity, we echo Gutiérrez and Penuel's (2014) assertion that local expertise plays a vital role in ensuring that learning is relevant and engaging for a group of students. During our partnerships with teachers we served as co-designers, assisting in selecting and modifying instructional materials to better meet the needs of their students. We use the Teachers' Integration of Knowledge of Technology, Content, and Pedagogy (TPACK) framework (Figure 1) to understand the ways teachers made modifications (Koehler and Mishra 2005). For us, the term 'technical' includes AI technology.

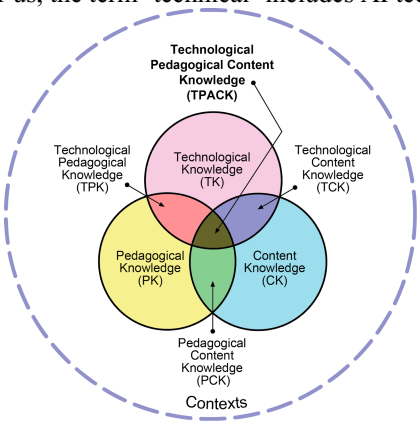

Figure 1: TPACK Framework (Koehler and Mishra 2005)

Topic	Introduction to AI Ethics	Understanding AI systems and their impact	The ethics of self-driving cars	Privacy vs. safety	Developing and presenting a final AI ethics product
Key concepts and questions	-What is AI? -What is ethics? -What is an algorithm?	-What is machine learning? -How can algorithms make our lives better? -What is Algorithmic Bias?	-What is computer vision? -How do self-driving cars work? -How should we design self-driving cars to be more ethical?	-How can AI keep us safe? -How can AI invade our privacy? -What is empathy? -Can machines be empathetic?	-What are your strongest convictions about AI ethics? -Which ethical stance do you *need* to share? -How can you convey your ethical stance in a compelling way?
AI Story	"Your Own Song"	"Undone"	"ZapCar"	"Code Orange"	N/A
Design experiences and student products	Draw AI (pen and paper or digital drawing) Quickdraw	Train Google's Teachable Machine to be less biased Create AI comic story (Pixton.com)	Design and evaluate MIT Moral Machine scenarios Create driverless car video ad or PSA	Create empathetic chatbot (juji.io)	Finish and present final product: comic, video, or chatbot that conveys an ethical stance on AI

Table 1. Overview of AI Camp Experiences

The TPACK framework emphasizes the interplay of three types of knowledge and beliefs that teachers draw upon as they implement technology-rich curriculum. We use this framework not to evaluate teacher expertise within different domains, but to identify the areas in which they leverage their expertise to improve student experiences, and areas where they make fewer modifications or request external help (such as a guest speaker). This helps us understand the ways teachers from different disciplines (computer science and English language arts), and from different communities (urban and semi-rural), adapted AI Ethics curriculum for their contexts.

Methods

Curriculum Co-Design

Previously, we designed and piloted our curriculum in two remote one-week summer workshops for secondary students. Participants reported increased interest and understanding of AI and AI ethics (Forsyth et al. 2021). Table 1 provides an overview of the camp curriculum, which combined original short stories, non-fiction texts, hands-on AI experiences, and digital media design tasks in which students expressed their own ethical stances.

The camp curriculum was the starting point for the curriculum we shared with teachers, with several small changes including improved sequencing, supplemental texts, and increased time and support for design tasks. We then used a collaborative co-design process to further modify the curriculum to better fit in each teacher's context. Partner teachers took the lead role in enacting the curriculum, with pedagogical and technical support from Author 1. This support ranged from co-teaching sessions to sharing additional digital tools and resources.

Each implementation culminated with presentations to an outside audience chosen by the teacher (although COVID-19 prevented this in two classes (Abbott and Hunter). We consider all these implementations to be project-based, reflecting PBL criteria, such as being problem driven, authentic to students and society, using real tools and practices, involving iterative product development, and being collaborative and reflective.

Teacher	Ms. Juno	Mr. Abbot	Ms. Stiller	Ms. Hunter
Grade/subject	9 ELA	9 ELA	8 CS	9 Cybersecurity
Setting	Semi-rural, online	Urban, in person	Suburban, in person	Suburban, in person
# classes/students	2/39	2/44	2/49	1/17
#sessions/minutes	18/80	16/60	20/55	25/45
Project	Elaboration of camp curriculum – ELA emphasis	AI, Monsters, and Shelley's Frankenstein – humanities emphasis	Physical computing emphasis	Cybersecurity and app design emphasis
Student Products	Digital comic, driverless car video, empathetic chat bot, teaching MS students AI lesson	Teachable machine, Socratic Seminar	Digital comic, Scratch w/ AI, mask detection w/ Teachable Machine	Teachable machine, ethical app design with App Inventor

Table 2: Participants and class projects

Teachers had the freedom to expand or omit curriculum subtopics as they saw fit. For example, the cybersecurity teacher included additional focus on cybersecurity implications. One ELA teacher used all the modules, while the other dropped the self-driving car module which was not relevant to the class novel, "Frankenstein."

Data Collection

For all teachers, we collected original and modified classroom curriculum materials, notes from project planning sessions, and session observation field notes. We conducted 45-minute individual teacher interviews. Table 2 details each teacher's context.

Teacher Interviews

We used a previously developed semi-structured teacher interview protocol. Upon completion of the project, two researchers interviewed each teacher to gain their perspectives on the project and views on adaptations for their students, content, and context, as well as their sense of the feasibility of teaching the unit and usability of materials.

Initial PD, planning and debriefing meetings

We held two meetings with each teacher. School STEM coordinators also participated in the first meeting with Ms. Stiller and Ms. Hunter. Curriculum was shared with teachers and administrators prior to the initial meeting. Teachers came to the meetings with questions and goals. PD focused on the overall instructional approach (described above) and hands-on time with key moments in the curriculum that touched on topics and tools with which they were unfamiliar. Planning began with brainstorming ways of modifying the curriculum to better meet teachers' goals and contexts, including decisions on students' interim and final products. Teachers and researchers each took responsibility for finding, developing, and testing resources to meet those goals. During the second planning meeting these new resources were assembled and instructional materials were modified. We also met after some class sessions to debrief and plan adjustments for future sessions. These processes differed for each teacher and are described in the findings section.

Analysis

We employed qualitative data analysis methods to examine each teacher's design and adaptation (Corbin and Strauss 2014). We began by comparing each teacher's modified curriculum materials to the original materials. We wrote analytic memos for each, noting the types of changes they made, describing consequential changes in detail. Next, we compared the contents of the memos for each teacher to the notes from our project planning meetings and field observation notes. We attended especially to areas where teachers made modifications to meet the goals they expressed in the initial meeting and wrote an additional memo for each teacher. Finally, we examined the post-project interviews and wrote a third memo for each teacher, focusing on areas where they discussed their goals for the project, the modifications they made and the rationales behind them, and their experience teaching the various domains and pedagogies relative to the project. This gave us three memos for each teacher, which provided a rich look at how they modified the curriculum. The larger category of curriculum included sub-categories expanding on how , modifications and design related to teachers' pedagogical, technical, and content knowledge, and the relative contribution of the teacher and research team to the design process. Major themes emerged focusing on teachers' leveraging of their own situated, subject content and pedagogical knowledge to improve the project, in conjunction with strategic integration of the research team's AI modules and technical and pedagogical expertise. Two

researchers reviewed each case and cross-case comparison, reconciling differences in relation to individual teachers and cross-teacher comparisons. The full research team discussed and refined the findings.

Each of the participating teachers modified the curriculum in order to better meet the needs of their students. This included disciplinary learning needs as well as social and emotional needs. Teachers also modified the curriculum so it would fit into their own classroom contexts. They made these modifications in response to school culture and departmental requirements as well as the larger communities they served. When we look across all the teachers' modifications, we see that nearly all of them come in areas where the teachers have notable experience or expertise. Referencing the TPACK framework, teachers with more technical knowledge made changes to the technical components of the project. Teachers with more advanced pedagogical knowledge (project-based learning, in this case) made more substantive changes to the project's structures and tasks. When teachers made content related modifications they tended to occur within sub-domains aligned with their experience and expertise. In the following we highlight modifications from each teacher that exemplify these findings.

Findings

Ms. Juno, 9th Grade ELA

Ms. Juno is an experienced ELA teacher who has been using a project-based curriculum for the last 7 years. This was her first year teaching in a predominantly White online high school in a semi-rural community. She characterized her students as having either left the local high school because they did not fit in, or because of the COVID 19 pandemic. Her goal for partnering with us was to bring a challenging and engaging project to a modality (online learning) in which keeping students focused and motivated can be challenging. We co-designed an expanded version of AI ethics curriculum developed for our summer camps, providing more time for AI story discussion and creation of multimedia student projects, both important ELA goals and standards, as well as areas of teacher expertise. For the AI technology components, she used the modules as originally designed since this was new to her. She also expanded the curriculum to include structures and norms for her online classes, including strategies for using the chat function and breakout rooms in Google Meets to build community, share work, get feedback, get help, and post resources (manuscript in process).

Ms. Juno took the lead in designing the culminating task, which was for small teams to teach an AI ethics lesson to middle school students. She had used middle and elementary school classes as audiences for presentations during previous projects. She designed the student-facing documents, including a set of guidelines for what should be included and reflection prompts, and the Socratic Seminar.

This was our first school-based implementation. Ms. Juno's contributions help us understand the importance of leveraging teacher expertise in future implementations while supporting the teacher in new or less developed areas. Ms. Juno relied on the AI modules to teach AI and ethics, while deepening the application in the ELA multimodal composition projects and culminating presentations. The project helped demonstrate the natural connection between AI tools and composing multimedia compositions in ELA.

Ms. Stiller: 7th grade Computer Science Teacher

Ms. Stiller was in her first year as a middle school teacher. She was previously a high school librarian. In this role she ran a Maker Space and taught AP Computer Science. This experience helped her build considerable technical knowledge associated with coding and physical computing, but she described working with middle school students to be a challenging yet enjoyable adjustment. One of her goals in partnering with us was to get support from our team in challenging and engaging a diverse group of middle school learners (80% of the student body is Hispanic/Latinx and 75% qualify for free and reduced lunch).

Ms. Stiller, Author 1, and the STEM coach had a 90-minute initial meeting in which they mapped the AI ethics curriculum onto the school's project planning document and began brainstorming ways of incorporating coding and physical computing into a new culminating task for the project. Following the meeting, Ms. Stiller and Author 1 separately explored ways of incorporating AI into micro:bit (an affordable microcontroller designed for young learners) and Scratch (a widely used block-based programming language), both of which students had used earlier in the school year. During a subsequent 60-minute meeting Ms. Stiller and Author 1 developed a design task in which students would use a micro:bit and/or Scratch to either make a statement about or design a solution to an AI ethics issue. The vision for this final design task came primarily from Ms. Stiller: it would be accessible and challenging for students with a range of CS experiences and skills, and students would build on their learning from earlier in the semester while taking an ethical stance on an issue they cared about. Author 1's primary role was finding and testing resources (such as Scratch extensions that can utilize

Google's Teachable Machine) that would make the final design task possible.

Ms. Stiller took the lead in designing the culminating task because, apart from the AI tools utilized, it fell within her experience and it allowed her to ensure that she met departmental guidelines. She invited Author 1 to be a guest speaker four times and relied on the research team's project slides with minimal modifications because of their AI ethics knowledge and experience teaching and designing curriculum for diverse, multilingual learners.

Ms. Hunter, 9th grade Cybersecurity

Ms. Hunter had 15 years of experience teaching high school science and a master's degree in Science Education. She teaches in a suburban district where 80% of the students are Hispanic/Latinx. Two years earlier she had begun teaching a 9th grade cybersecurity class for students in an accelerated CS pathway. Students in the pathway graduated with a high school diploma and an associate degree in Computer Information Systems from the local community college. During her first year teaching the class she relied heavily on a packaged curriculum as the topic was a new one for her. This curriculum focused on the sequential development of cybersecurity related skills and concepts. However, it did not address her need to teach a range of technical content that would challenge her students with more advanced CS knowledge. It also did not, in her opinion, pay sufficient attention to the social implications of cybersecurity. In her second year teaching cybersecurity she supplemented this packaged curriculum with discussion of articles about how cybersecurity technologies were impacting society, noting that the more she engaged students with this content the more they cared about cybersecurity in general.

Her goal in partnering with our project was thus to introduce her students to AI topics related to cybersecurity and dive deeply into related ethical concerns. We had an initial planning meeting that included Ms. Hunter, the high school's STEM coordinator, and two members of our research team. Both educators had familiarized themselves with our curriculum before the meeting. Ms. Hunter had three primary ideas for modifying the curriculum. First, she felt that the cybersecurity concerns related to artificial intelligence (such as the Cambridge Analytica's use of social media data to influence elections) should be further emphasized. Second, she thought her students would benefit from a deeper exploration of some technical content (such as the advantages and disadvantages of different approaches to designing autonomous vehicles). Third, because the class would be participating in the Congressional App Challenge in the spring, she wanted the final design task in her project to be the design of an ethical app that incorporated AI. Students could continue developing their ethical AI for the app design challenge if they wished.

Following this meeting the research team created modified AI slide decks based on the meeting notes. As she conducted the project Ms. Stiller made additional modifications to the new slide deck, often based on how students reacted to a previous lesson. For example, after her students expressed a great deal of interest and concern when they were introduced to the topic of algorithmic bias, she decided to devote an additional class period to the topic, reading and discussing a New York Times article about false arrest based on facial recognition and an additional, more technical video about how biased data sets can result in flawed machine learning tools. She identified topics of high interest for her students and developed ways in which they could explore those topics more deeply. In her context, the integration of AI and ethics into cybersecurity content and skills with real world applications made the work more relevant to students' lives. She elaborated and deepened both the AI technology and ethics components to better address students' interests and needs, flexibly adapting the AI modules.

Mr. Abbot, 9th grade ELA.

Mr. Abbot made the most drastic modifications to the AI ethics curriculum, integrating a graphic novel version of Mary Shelly's "Frankenstein" into his project. He has a Ph.D. in Literacy Studies, as well as extensive experience designing project-based curriculum. He teaches in an urban school with a diverse population: 39% Hispanic/Latinx, 27% African American, 20% White, and 6% Asian and Pacific Islander. His classes contained a high percentage of recent immigrants who were multilingual. He described the school as having an explicit social-justice focus, but also tendency to retain aspects of traditional instruction that could interfere with that social justice mission. This included an over-reliance on classic literature with White authors, which he believed students were less likely to find personally or culturally relevant. He also wanted to avoid a too-narrow focus on developing standard Academic English and language arts skills among students whose other languages and literacies are too often overlooked and undervalued in schools. He also told us that he had heard from students of color that they were tired of learning about racism from their mostly White teachers. As such he developed the following goals:

- Examine structural inequality in a context (artificial intelligence) that is novel and interesting to students.
- Read a work of classic literature (Frankenstein graphic novel) that students would find interesting and accessible.

- Help students make connections between AI Ethics, Frankenstein and their lived experiences in a way that built traditional academic literacies and extended the other literacies students bring with them to school.

Mr. Abbot retained, with minor changes, the parts of our curriculum that introduced students to AI and machine learning. Students designed image recognition tools with Google's Teachable Machine and read two of our AI ethics stories to develop their understanding of algorithmic bias. Beyond this, the project was largely of his own creation, including a Socratic seminar in which students collected evidence to discuss questions such as "What is a monster?," "Is AI monstrous?," and "What is power and who has it?" Mr. Abbot's understanding of literacy learning and of his own students, as well departmental guidelines, led him to make more drastic changes while retaining materials related to AI, a topic with which he had no formal background. He deepened his usual approach to teaching literature by embedding it in a project that leveraged AI knowledge and skills.

Trends across teachers

When we asked teachers about the curriculum modifications they made, they consistently offered nuanced explanations for those modifications, often citing the needs of specific students in their classes. These included social and emotional needs, as well as needs related to content and accessibility. All teachers tended to modify the curriculum more heavily in areas associated with their own experiences and expertise and make fewer changes in areas that were less familiar, using the module or learning experience as originally designed. Mr. Abbot, who has the most curriculum design experience, made the most changes to our curriculum. Ms. Stiller, who had only just begun teaching middle school, made the fewest changes to the original modules. The co-design process for each teacher was different, taking shape organically to reflect their strengths, needs and schedules.

Teachers found the customized co-design process and AI modules to be very helpful and thought that selectively integrating modules improved the quality of the students' learning experience and met academic standards. The teachers also reported that it was important that they could call on the first author for teaching assistance when the module was unfamiliar and request assistance in finding the right resources and tools to fit their students' needs. Co-teaching a course or teaching an interdisciplinary project across two courses might help provide some of this kind of support to teachers who are tackling complex topics like AI and AI ethics.

Implications

AI ethics deals with pressing social and political concerns. It is vital that youth understand the ways that AI technologies can both solve problems and extend and amplify old ones. It is a difficult topic to bring to schools in part because so few teachers have the ideal breadth of experience and knowledge for teaching the topics. CS teachers, who may have some background in topics such as machine learning and algorithms, are less likely to have experience engaging students in discussion around race, gender, social class, law, and government. Humanities teachers face the opposite challenge as they consider whether they are comfortable introducing AI concepts and tools that lie well outside their expertise.

While it would be possible to offer teachers a more scripted, "teacher proof" AI ethics curriculum, we believe this is an insufficient solution. There is no one-size-fits-all approach for teaching AI ethics. On the one hand, teachers will encounter students with a wide range of CS backgrounds. On the other, they teach in different communities and settings where views on contentious social issues can differ dramatically. We believe that widespread racial bias in our criminal justice system, including in some predictive algorithms and facial recognition systems, is a matter of fact, not opinion. But we also recognize that discussing this and other topics with students needs to account for the beliefs, cultures, and experiences that students bring to school. Both Ms. Juno, who taught in a more conservative community, and Mr. Abbot, who taught in a more progressive one, successfully tackled controversial issues in their respective contexts, drawing on their in-depth understanding of their students and their primary content expertise. As curriculum designers, we can offer multiple texts and strategies for educators, but teachers are the ultimate designers in how they adapt curriculum and make choices about texts, rhetoric, subtopics, and products that will be most effective.

This study suggests that skilled STEM and literacy teachers, including those with little background in AI or AI ethics, play a vital role in customizing curriculum for their students to help them develop critical, nuanced perspectives on AI ethics. We strongly suspect this holds true for other interdisciplinary topics that combine CS, literacy, and humanities.

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