

AI Book Club

An Innovative Professional Development Model for AI Education

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ABSTRACT

This paper describes an AI Book Club as an innovative 20-hour professional development (PD) model designed to prepare teachers with AI content knowledge and an understanding of the ethical issues posed by bias in AI that are foundational to developing AI-literate citizens. The design of the intervention was motivated by a desire to manage the cognitive load of AI learning by spreading the PD program over several weeks and a desire to form and maintain a community of teachers interested in AI education during the COVID-19 pandemic. Each week participants spent an hour independently reading selections from an AI book, reviewing AI activities, and viewing videos of other educators teaching the activities, then met online for 1 hour to discuss the materials and brainstorm how they might adapt the materials for their classrooms. The participants in the AI Book Club were 37 middle school educators from 3 US school districts and 5 youth-serving organizations. The teachers are from STEM disciplines as well as Social Studies and Art. Eighty-nine percent were from underrepresented groups in STEM and CS. In this paper we describe the design of the AI Book Club, its implementation, and preliminary findings on teachers' impressions of the AI Book Club as a form of PD, thoughts about teaching AI in classrooms, and interest in continuing the book club model in the upcoming year. We conclude with recommendations for others interested in implementing a book club PD format for AI learning.

CCS CONCEPTS

- *Computing methodologies* → *Machine learning*: *Learning paradigms*; *Learning settings*; *Machine learning approaches*;



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SIGCSE 2022, March 3–5, 2022, Providence, RI, USA.

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ACM ISBN 978-1-4503-9070-5/22/03.

<https://doi.org/10.1145/3478431.3499318>

- *Social and professional topics* → *Computing education*; *Adult education*; *Model curricula*.

KEYWORDS

Book club, Professional development, AI education, AI literacy, Teacher preparation.

ACM Reference format:

Irene Lee, Helen Zhang, Kate Moore, Xiaofei Zhou, Beatriz Perret, Yihong Cheng, Ruiying Zheng, and Grace Pu. 2022. AI Book Club: An Innovative Professional Development Model for AI Education. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2022), March 3–5, 2022, Providence, RI, USA*. ACM, New York, NY, USA. 7 pages. <https://doi.org/10.1145/3478431.3499318>

1 Introduction

With the rapid growth in the availability of enormous amounts of data and computation power, Artificial Intelligence (AI) is having unprecedented industrial and societal impact. The rapid expansion of AI across fields and industries necessitates developing a workforce with strong computational skills and specifically, the knowledge and capability to work with AI. To develop this human infrastructure, teachers will need age-appropriate materials for their students and professional development to offer AI education into their classrooms. Despite this need, little is known about how to prepare teachers to offer AI education and to increase their students' interest in preparing for the AI-intensive industries of the future. Thus, the development of a tested and refined approach to preparing teachers to offer AI activities in a wide range of settings is paramount to ensuring the Nation's prosperity, health, security, and competitiveness.

At the same time, broadening participation in AI is of utmost importance to ensure that the design and utilization of AI technologies are inclusive and not reinforcing inequities based on demographic variables, and to address the historical marginalization of women and persons of color in STEM and computing. Through their participation in developing the AI

technologies of the future, persons from underrepresented groups in STEM and computing and their allies can work together towards ensuring that the AI industries of the future are founded in principles of inclusivity, provide equitable access, include consideration of multiple stakeholders and potential users, and minimize the potential for bias.

The current interest in and call for AI education in K-12 echoes a more general demand for raising computational and scientific literacies [5, 15] among young people [7]. Yet K-12 teacher PD in AI is in its infancy and early findings on AI Literacy [4, 11, 12, 20] are just beginning to shed light on how youth gain an understanding of AI concepts and processes and the ability to incorporate AI processes within their own applications. Although various AI curricular initiatives have been launched for the K-12 population, this field still lacks high quality curricula and in-depth research to understand the age-appropriateness of AI concepts [13, 18]. An additional hurdle to developing K-12 teachers' capacity to offer AI education is adapting to the COVID-19 pandemic. The pandemic has taxed teachers' energy and potentially, their inclination to participate in traditional PD offerings.

To meet these evolving needs, we have developed a year-long "Everyday AI" PD program which includes: 1) a 20-hour AI Book Club that builds a community of practice amongst AI educators, representatives of organizational partners, and researchers by reading AI book chapters, reviewing the "Developing AI Literacy" or DAILY curriculum [3, 11], and discussing pedagogies to teach AI activities; 2) a two-week Summer Practicum experience, hosted virtually at youth-serving organizational partners' sites, that provides teachers with hands-on experience teaching DAILY activities; and 3) webinars and teaching preparation meetings throughout the academic year to support teachers' classroom implementation of the DAILY curriculum. This paper reports the ongoing work of the PD program, focusing on the implementation and findings of the AI Book Club during the spring of 2021. Due to COVID-19 induced scheduling issues, the AI Book Club took place over a 7-week period in May and June 2021. A one-day 6-hour Saturday PD workshop was added to ensure educators received the planned 20-hours of PD.

2 Theoretical Foundations

Three frameworks informed the design of the AI Book Club: Sweller's cognitive load theory, Wenger's communities of practice, and Constanza-Chock's design justice. In cognitive load theory [16], Sweller posited that new information needs to be at a pace and level of difficulty appropriate to building comprehension and effectively transferring information into long-term memory. In designing a PD program for teachers (none of whom have prior knowledge of AI), cognitive load is relevant because AI concepts are dissimilar from core disciplinary concepts with which teachers are familiar - thus teachers lack a frame of reference to help with acquiring and transferring AI concepts into long-term memory [17]. Strategies to lower cognitive overload are known such as use of concise introductory explanations to limit the elements that must be processed simultaneously, reinforcing new information both verbally and visually (graphically), reducing extraneous

information (that does not contribute to the task at hand), and chunking content into segments to facilitate the transfer information from short-term to long-term memory [9].

Wenger's communities of practice framing provides a model for collaboration among teachers. Specifically, collaboration in a community of practice (CoP), wherein teachers share goals, their practice, and resources with fellow teachers, has been effective in enabling teachers' learning [1, 19]. Providing teachers with a forum and adequate time to discuss new information and to reflect on their learning is especially important in AI PD. Since the AI content addressed is not housed in any single department, teachers' learning and teaching of AI related content will not typically be supported from the existing CoPs available through departmental structures (i.e., department meetings) in K-12 settings. Teachers also need sustained collaborative efforts to learn and solve problems [8]. Thus, a sustained professional learning community is critical to the process of deep learning necessary for practitioners to make meaningful changes in their pedagogy and classrooms [10].

The design of the AI Book Club was also influenced by Constanza-Chock's design justice framework. Constanza-Chock [2] calls upon designers from various fields to work closely with community-based organizations and the communities they serve in order to explicitly challenge, rather than reproduce, structural inequalities. In our AI PD, we saw design justice emerged as teachers from historically marginalized groups as well as teachers of students from historically marginalized groups combined their experiences through discussions that ultimately led to their framing of bias in AI as an important social justice issue. As such, participating educators gained a commitment to AI education as a means of raising community awareness of the potential harms (and benefits) of AI. Bringing AI education to their communities was also seen as a way of challenging a structural inequity in education, whereby privileged students would typically get exposed to cutting edge technologies like AI first.

3 Developing Teachers' AI Literacy

3.1 Institutional Collaboration

The Everyday AI project strategically leveraged existing partnerships to support sustainability and scaling of the project beyond the period of grant funding. The lead institutions, MIT and Boston College, had successfully collaborated on the project that produced the free DAILY curriculum [3]. Through a prior project, PI Lee became connected with a network of school districts, youth-serving organizations, regional CS education organizations, and CS-savvy science educators nationally, many of whom were excited to join this new initiative to learn about AI and prepare to teach about AI. From this network three school districts were invited to collaborate on the project because of their existing CS education initiatives and infrastructure that could generate and support an AI teacher corps. Additionally, five youth-serving and regional CS education organizations from the network were invited to participate and host AI summer camps for youth in their respective communities that would serve as teacher practicum

sites. Each partner organization was empowered to recruit their team of local facilitators or coaches to participate in the PD to build the organization's capacity to offer AI education programs and camps beyond the period of grant funding.

Facilitators representing school district partners were experienced CS and STEM teachers who assisted with teacher recruitment and served as mentors to teachers from their districts. Facilitators representing youth-serving organizations were out-of-school time educators who recruited students for the summer camps and helped introduce teachers to the communities in which the summer camps / practicums were held. It is important to note that roughly half of the facilitators had participated in a pilot of the AI Book Club in Jan-Feb of 2020. Through the project's advisory board, the perspectives of stakeholders such as AI researchers, out-of-school time AI program directors, education researchers, and career counseling specialists were incorporated.

3.2 Target Audience

The audience for the AI Book Club consisted of 37 educators: 18 middle school teachers from across the 3 partnering districts and 19 facilitators representing the 5 partnering youth-serving and CS education organizations, and 3 districts. The educators represented a variety of disciplines, some with experience from multiple subjects: 18 (49% of all educators) had prior experience teaching Computer Science, 14 (38%) Science, 10 (27%) Math, 7 (19%) English Language Arts, 6 (16%) Art, 5 (14%) Social Studies, and 5 (15%) were generalists who had experience teaching multiple subjects. The 18 teachers came from 3 school districts that served student populations from underrepresented groups in STEM and Computing (59%, 90% and 85% respectively). Thirty-three (89%) of the educators were from underrepresented groups in STEM and CS including 28 women (76%) and members of historically marginalized groups: 13 (35%) self-identified as Black/African American and 6 (16%) as Hispanic/Latinx.

3.3 The AI Book Club PD

The AI Book Club mimicked a traditional book club by offering a weekly communal experience of discussing selected readings assigned the week prior. The readings consisted of selections from Melanie Mitchell's book "Artificial Intelligence: A Guide for Thinking Humans," [14] and an assortment of articles presenting various viewpoints on AI. The progression of readings was chosen to match the progression within the DAILY Curriculum [3]. Mitchell's book was chosen because it presents a balanced view of AI, introduces AI concepts in laypersons' terms, and is driven by a historical narrative that sets the context for developments in AI. The book mirrors our philosophical stance that learners can decide for themselves the attitudes to take towards AI. Unlike a traditional book club, the AI Book Club included three other types of asynchronous activities: a) viewing videos selected to foster discussion of AI, b) discussing the material in an online forum on Slack, and c) previewing activities from the DAILY curriculum that aligned with the topic of the week. Through the readings and viewings we aimed to present a balanced perspective on AI (detailing both the beneficial and potentially harmful aspects of AI while also discerning between

reality and hype) and to encourage the learner to make sense of AI without promoting a single perspective or belief system.

Each synchronous book club meeting began with highlights from the prior week's asynchronous discussions, followed by a group discussion of the activities that were previewed led by a member of the development team. Teachers and facilitators discussed the relevant concepts, lessons and activities as part of a cycle of inquiry and reflections designed to reduce cognitive overload. Discussions opened with concise explanations designed to crystalize and reinforce key concepts from materials reviewed asynchronously, reducing extraneous information. These explanations were given with visual (graphic) aids and chunked reflection questions to facilitate information transfer. For complex hands-on activities, instructors and facilitators led a walkthrough of the lesson in breakout rooms (small groups of 3 or 4 teachers) offering teachers a student experience of the lesson. During the walkthrough, teachers could ask clarifying questions, identify potential misconceptions, and reflect on how they might bring this activity to their own classrooms. Next, teachers and facilitators returned to the main room for a synchronous discussion of the experience. The synchronous discussion was often prompted by viewing student work samples from the activity and responding to questions such as "What do students need to know to be successful in this activity?", "What are possible misconceptions students may form?" After the discussion of student learning, teams met in breakout rooms for pedagogy and equity discussions prompted by "How would you teach this lesson/activity?", "How can we make this activity more equitable?" and "Are we privileging some students over others?" Half of the time spent in these synchronous sessions was devoted to having teachers talk about their thoughts on AI and the DAILY activities.

Through weekly meetings, ongoing asynchronous discussion through Slack, and small weekly breakout group groups, Everyday AI PD is designed to create sustained CoP to facilitate fundamental changes in teacher AI learning and instruction, particularly for teachers who have little prior experience in the topic and who may struggle with misconceptions and a lack of self-efficacy. For example, in the PD, teachers are confronted with the realization that AI impacts them directly and as a result, their worldview may be changed profoundly. Some may experience cognitive dissonance [6] when they learn that some of their everyday actions are influenced by AI and their understanding of the world may be shaped by AI. For example, teachers learn that common internet searches provide different results to different users and that the results may be biased because the model was built using historically or culturally biased data sources. Through the process of sharing these realizations and experiences the teachers can avoid isolation, learn from each other, and have the opportunity to develop personally and professionally.

Two strategies were implemented to accommodate the large number of book club participants and the variety of time zones they lived in. First, we divided the participants into teams who met in breakout groups for walkthroughs of activities and pedagogy and equity discussions. Teams were assembled based on the summer practicum site at which they would be co-teaching. Second, we scheduled the book club meetings to repeat twice

weekly. The sessions took place on Wednesday evenings and participants could choose to attend either the 5pm or 6pm Eastern Time session. To ensure we were offering the same learning experiences at these two different times, sessions were identical in content and used the same presentation slides.

4 Method

This paper utilizes a mixed methods approach to explore teachers' experiences and perceptions of the AI Book Club. The analysis mainly focused on three types of data: a) session attendance, b) educators' posts to the community Slack channels, and c) focus group interviews with participating educators (total: 24 educators) after the conclusion of the AI Book Club.

Teachers and facilitators were interviewed separately by one of two interviewers who were members of the research team. The interviewers followed an identical interview protocol to ensure consistency. The protocol included the following questions: a) "Do you plan to bring the DAILY curriculum into your classroom(s)?", "If so, which activities?", "How and at what grade?", "What support do you anticipate needing?"; b) "Is there something you would have liked to do or learn about in the AI Book Club that you didn't?"; c) "How would you describe the AI Book Club experience to a colleague or friend?"; and d) "Would you like to continue participating in an AI Book Club?"

5 Implementation Experiences and Challenges

5.1 Teachers' Participation and Engagement

Overall, the implementation of the AI Book Club was successful with active participations of educators. On average, 33 (90%) of the educators attended each week of the AI Book Club. 81% of the educators also attended a full-day 6-hour Saturday PD workshop. Correspondence with absent teachers revealed that absences from weekly sessions were mainly due to technical issues and personal needs (such as illness or bereavement); while absences from the Saturday session stemmed from scheduling conflicts. All AI Book Club sessions were recorded and made available for educators who missed the session. Our observation notes showed that teachers actively participated in all activities during the synchronous sessions. They experienced DAILY curriculum activities together as students, helped each other troubleshoot, asked questions, talked about views and concerns about implementing these activities in classrooms, and reported out what has been discussed on Slack channels.

Prepare for the AI Book Club (1 hr) Attend the AI Book Club meeting (1 hr)	
Week 1	Welcome to the Everyday AI Project - Introductions, Review of the project & its goals.
Week 2	Topic: What is AI? - Examples of AI Read & discuss: Prologue - pages 1 - 15 Lesson review: What is AI? & AI or not?
Week 3	Topic: Algorithms as Opinions (Ethics in AI) Watch & discuss: "The truth about Algorithms" "The era of blind faith in big data must end" (Cathy O'Neil) Lesson review: Best PBJ & Ethical Matrix
Week 4	Topic: Logic Systems Read & discuss: Roots of AI - pages 16-24 Lesson review: Decision trees / PastaLand
Week 5	Topic: Ethics in AI / Investigating bias Read & discuss: Ethical AI pages 117-129 Watch & discuss: Gender Shades (Joy Boulamwini) Lesson review: Investigating Bias in ML
Week 6	Topic: Perceptrons & Machine Learning Read & discuss: pages 24-34 on Perceptrons Watch & discuss: AI4K12 Big Idea #3: Learning Lesson review: Teachable Machine
Week 7	Topic: Neural Networks and Deep Learning Read & discuss: pages 35-42 on Neural Networks & pages 67-80 on Deep learning. Watch & discuss: Long haul trucker and AI video. Lesson review: Neural Network game.
Wks 8-10 offered as a 1-day PD (6 hours)	Topic: Generative AI (as a 6-hour workshop) Read & discuss: Deepfakes and how to spot them. Lesson review: Classification vs. Generation; Classifier or Generator; Explore GANs; GANs or Not?: GANs Art!; Art or not?; Face Art; Spotting deepfakes. Review Career activities and career videos.

Figure 1: AI Book Club Syllabus

Educators were also active on the community Slack channels. For the first week, we seeded the Slack discussion with a prompt to post a personal introduction to the community resulting in a spike of initial posts. Each subsequent week, a team member volunteered as the question poser who posted questions they had from the readings or materials reviewed, and another team member volunteered as the reporter who shared highlights of the discussion. In total participants created 254 discussion posts with an average of 17.2 posts each week (excluding Week 1).

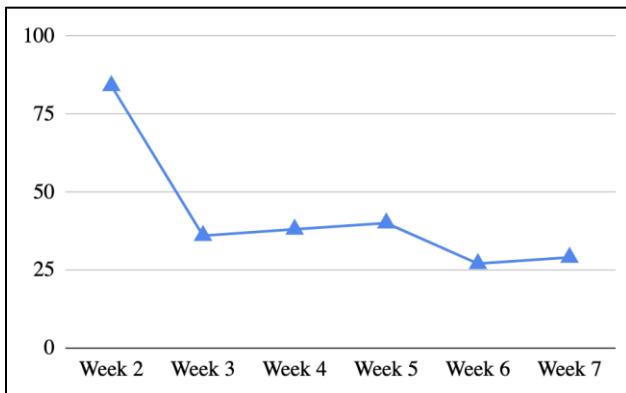


Figure 2: Number of weekly posts created by educators on community Slack channels.

A closer examination of the posts made by educators revealed that they shared...

- Thoughts on the readings and DAILY curriculum activities. For example, in Week 2 some teachers posted their feelings of AI, “*I don’t think we should be terrified [about AI], all great technologies change the way we are used to interacting with each other....*”, whereas others expressed their concerns, e.g., “*I am a bit concerned with the ways the AI is used and how some people have been negatively affected as a result of AI*”
- Discussion of how to prepare students for the AI era. They discussed how important it is to prepare students for being flexible in their future jobs, “*I think the best way to prepare our students is to make sure they have the kinds of skills that are indispensable and not easily replicated by a computer, specifically related to observation, critical thinking, and analysis. Our students will need to have a great flexibility of mind to suit the modern world.*”
- Resources that educators think might be helpful to others. They posted videos and articles they found that are interesting and relevant to AI, e.g., a New York Times article around Google’s use of AI algorithms to filter harmful content.

5.2 Teachers’ Experiences with Activities

All interviewees reported that the multiple-week format was effective. Teachers felt spacing the PD over several weeks allowed them time to reflect, experiment, make mistakes, and to ask questions more so than in a more intense, time limited teacher workshop. A majority of participating educators made comments like, “*It helped for us to kinda like build relationships, familiarize ourselves with the content, where we were not pressed, it wasn’t like a waterfall of the content. So I think making it longer helped.*” Teachers also appreciated the blending of synchronous and asynchronous sessions because it provided dynamic ways of participating. One teacher reflected, “*I would say that it was a unique type of professional development that combined reading a book to launching into activities, it was a very rich kind of professional development that took some of the findings based on*

research people in that field, and then brought it into real-life activities we can utilize with our students.”

Further all interviewees listed ethics and bias as an important topic that must be taught in AI education and addressed in the AI field, e.g., “*People need to be aware that because of those limitations of the data sets, the decisions that are output based on that algorithm could impact them or people that they know.*” The participants’ mutual reinforcement of the framing may also have helped many educators recognize that AI ethics can be taught across disciplines. For instance, a teacher shared his plan to teach AI in his civics class, “*I’m going to implement the bias, using some of the tools to show the students bias, because I teach civics... and I do think that they will benefit from it...like learning about misinformation because it affects the news, and social media.*”

Interviews also revealed that the book club model sparked interest from educators and school district leaders in sustained involvement. All interviewees expressed enthusiasm of continuing the book club PD in the school year and suggested ways to improve, including setting up a Facebook page, weekly or monthly gatherings to exchange resources and plans, and effective (and ineffective) teaching practices, and continuing the Slack discussion. A participating school district facilitator planned to implement the book club model within the district, “[we will] have them [our teachers] read a chapter and then report out and maybe bring an activity that helped illustrate that concept or share an article that went along with it. So that’s something we’d like to do with our teachers...I think we would definitely continue it.”

5.2.1 Asynchronous elements. Participants felt the readings were helpful in building content knowledge, as a teacher explained, “[reading the book] put us in a cool mindset [so that later he could] envision in my head when we were getting into the lessons.” The short length of the reading assignments (10-15 pages) for each book club session was appreciated by all participants. Some asked for more explicit connections between the readings and the DAILY activities so the readings could “*have given a firmer grasp of the DAILY material*”.

5.2.2 Synchronous elements. Participants felt learning the DAILY activities and key concepts as a whole group was engaging and helped them become familiar with the tools used in these activities, e.g., “*The most efficient use of time that we had was ... when we can go and use tools, I learned a lot from that and then discussing how the tool works as a team.*” They felt that experiencing the activities as learners enabled them to witness the challenges their students might have and made them feel comfortable with teaching the DAILY activities, “*Hopefully, you still remember, what glitches or challenges you had, so when you’re explaining it to the student you wanna make sure they don’t do the same thing, so that also was meaningful in the book club.*” Over half of the interviewees also described that learning together helped them start building supportive relationships with each other because “*you know that you’re not the only one that’s struggling and to have some help troubleshooting to fix those struggles.*”

Teachers also expressed that the ensuing pedagogical discussion was fruitful. Our observation notes revealed that teachers discussed how the activities can be enacted in middle school classrooms (e.g., adjusting the pacing, increasing the

emphasis on beneficial uses of AI) and where the activities would fit into their existing curricula. For instance, one teacher remarked, “*In my own classroom ... obviously, I would just slow it down a bit so that I’m not cramming all this information on the students.*” One complaint from teachers was that almost all of them felt rushed during the pedagogical discussions. Teachers suggested we allocate more time for in-depth conversations to develop pedagogy to teach AI in classrooms.

6 Conclusion

Bringing AI into classrooms is not easy due to reasons such as teachers’ lack of content knowledge and lack of developed connections between AI and traditional STEM coursework. This paper reports the design and implementation of a PD model that extends learning over time with the goal of reducing cognitive load and developing a community of practice to support teachers in integrating AI into the disciplines they teach. Specifically, the book club model was implemented with asynchronous tasks of reading selected text and participating in online discussions; and synchronous sessions wherein teachers spent time learning key activities together as students and discussing pedagogical and curricular customizations needed to teach the activities in classrooms.

Our results suggest the PD model was highly effective as a method for engaging and sustaining teachers’ interest in PD on AI literacy and building a community of practice wherein teachers felt comfortable learning challenging new concepts. The synchronous discussions created a social learning space that interviewees described as efficient and supportive when the discussion centered on how to use the AI tools included in the DAILY curriculum. Learning to use the tools together proved to be a meaningful opportunity for educators to not only to practice applying newly learned concepts, but also to experience the struggle of learning something new in a supportive community. Teachers’ frustration was eased by seeing others like themselves struggling to learn the new concepts. The sharing of information and reflection through discussion supported the developing of CoP. Beginning to emerge from the PD experience and the CoP was a sense of how AI and bias in AI systems can impact participants’ everyday lives and communities.

We are aware that the sample size of this study is moderate (37 educators); therefore, all the conclusions are based on this implementation of the AI Book Club with the target population. This study is designed specifically to inform other researchers and practitioners of a PD design for AI education. Implementing this book club model in other settings with other teacher populations may reveal different insights.

7 Recommendations

We provide the following recommendations on the design and implementation of the AI Book Club based on our experience:

- Carefully select the materials (readings and videos) to provide a balanced perspective on AI for educators and detail both the

beneficial and potentially harmful aspects of AI while also discerning between reality and hype.

- Provide time for educators to reflect on and share their learning about AI, change in understanding of AI, and reasons for wanting to teach AI.
- Utilize multiple types of tasks to provide educators opportunities to interact and develop a sense of community.
- Allocate time for discussions of pedagogy. Consider expanding the 1-hour synchronous session to 1.5 hours.
- Recruit teachers from the same area or district and maintain a dedicated communication sub-channel for them to use throughout the AI Book Club to develop the local CoP in addition to the full group CoP.

8 Future work

Our next steps are to refine the AI Book Club based on participants’ feedback, including allowing for deeper discussions of the content and pedagogy associated with the AI activities and strengthening the connections between the readings and the DAILY activities. The revised version of the AI Book Club will be implemented with the next cohort of teacher and facilitator participants in spring 2022. We also plan to further examine the discussions that occurred in the breakout rooms to investigate how teachers learned from each other and how the discussions helped them develop a sense of community and a commitment to implementing the curriculum in their classrooms.

ACKNOWLEDGEMENTS

This work was funded by the National Science Foundation award DRL-2048746. We thank our district, youth serving organization and CS education partners, and the participating teachers and facilitators who made this work possible.

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