Charting the Course: Decoding K-12 AI Education at a Youth-Led Multimodal Workshop

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Abstract. In an increasingly digitized world, the early acquisition of Artificial Intelligence (AI) fluency is imperative. While K-12 AI education has achieved initial momentum in the past years, most initiatives require a certain degree of coding background. Few resources include ethics as an integral component either. This mixed-method study examines a project-based and largely unplugged AI education initiative entitled "Charting the Course," led by a rising high school sophomore based in Durham, North Carolina. 18 students of Grade 5-9 attended the workshop. Pre- and post-surveys assess students' changes in knowledge levels and cognitive development before and after the program, while qualitative instruments such as participant observation, interviews, and open-ended questions provide additional insights into key design elements associated with the changes. Quantitative results demonstrate significantly deepened knowledge levels about AI, positive attitude shifts, strengthened tendency to learn, and enhanced job inclination in AI-related fields. Design components such as theme-based gamification, project-based learning, multimodal knowledge representation, and embedded ethics contribute to students' maximized agency and therefore meaningful outcomes. Notably, middle school students are able to grapple with the merits and risks of AI through critical reflections. The ethics-by-design lesson plan inspires students to harness the use of AI for societal and environmental betterment. The presence of a youth role model also stimulates students' continued interest in AI. Findings from this research could inform scholars and practitioners in facilitating, implementing, and assessing AI education initiatives led by youth and for youth.

Keywords: K-12 AI Education, Youth-Led Initiatives, Project-Based Learning, Ethics-by-Design.

1 Introduction

Artificial intelligence (AI) is rapidly transforming the world, reshaping industry and redefining education. As AI-driven technologies permeate every fabric of society, young learners ought to be prepared for a digitized era. The rapidly changing nature of AI technologies requires the school system to adapt to the digital transformation as well. It escapes no one that early acquisition of AI knowledge among young learners will soon become the top priority. The K-12 Computer Science Framework Steering

Committee (2016) provides a generalized structure for computer science education, emphasizing computational thinking, problem-solving, and ethical technology usage. This framework has established the foundation for building computational thinking and AI basics by teaching K-12 students about algorithms, automation, data-driven decision-making, and impacts of computing (K12CS, 2016).

Departing from said framework, practitioners have proposed specific guidelines for K-12 AI education, consisting of essential knowledge in machine learning, neural networks, and ethical considerations (Gardner-McCune et al., 2019; Touretzky et al., 2019). These core topics in AI equip students with knowledge in the definitions, mechanisms, and applications of this emerging technology. Furthermore, educators have also emphasized that K-12 AI education ought to go beyond technical knowledge, proactively addressing the ethical concerns and social issues raised by AI development and usage (Touretzky et al., 2019). Above all, this comprehensive approach to K-12 AI education prompts students to not only acquire 21st century skills of technical fluency, but also become critical thinkers who can thoughtfully deploy AI for social good and innovative problem-solving.

In the light of the rising demand for AI education in K-12 settings, this study probes into a local educational initiative in disseminating AI literacy for young learners. In this action research, we document the experience and evaluate the outcomes of 18 students from Grade 5-9 who participated in a youth-led project-based AI workshop entitled "Charting the Course." Through a comprehensive mixed-method paradigm, this study aims to examine the immediate impact of a weekend workshop on students' AI knowledge acquisition and attitude shift in continuous learning. Quantitative instruments through pre- and post-surveys gauge the overall measurable outcomes, while qualitative information from student interviews and participant observation yields in-depth and multidimensional narratives about the program experience. Centering the voice of youth, this program integrates embedded ethics and inclusive design principles to lower entry barriers and foster equitable AI education. Broadening participation in AI learning is essential to nurturing the next generation of innovators and changemakers. The program encourages diverse perspectives on the ethical development and application of AI technologies. This study not only evaluates the effectiveness of the workshop but also offers a point of reference for inclusive AI education, informing future curriculum development and youth initiatives in the field.

2 Literature Review

2.1 Current State of K-12 AI Education

K-12 AI education has seen rapid development over the past years (Casal-Otero et al., 2023; Su et al., 2023). Existing literature in inquiring about AI learning in K-12 education focuses on two major branches: learning experience of AI literacy and the implementation of AI tools in K-12 settings (Casal-Otero et al., 2023). The first branch focuses primarily on basic content knowledge, such as recognizing common AI applications and mechanisms. The second branch concerns more with design elements, including curriculum, pedagogies, and ethics (Casal-Otero et al., 2023).

Besides the growing scholarly interest, practitioners have contributed resources for teaching AI to young learners (Druga et al., 2022; Grover, 2024). Common types of such resources include demos, activities, tools, and curricula (Druga et al., 2022). Utilizing multiple modalities, instructional platforms, and digital capacities, these resources have all opened up pathways for educators of varying levels to start incorporating AI content in their subject areas (Druga et al., 2022). Notably, the AI4K12 initiative proposed a structured and scalable framework of curriculum and instructional design - known as the Five Big Ideas of AI - that caters specifically to the young audience (Touretzky et al., 2023; Grover, 2024). The Five Big Ideas framework sets up a preliminary guideline for resource development, as currently available teaching materials all to some extent cover one or more of the big ideas (Druga et al., 2022).

Nevertheless, challenges linger in terms of consistency and clarity in instructional guidance (Druga et al., 2022), teacher capacity, and assessments (Su et al., 2023; Grover, 2024). Empirical evidence remains sparse regarding the effectiveness of AI education for young students; further, current inquiries primarily revolve around coding- and robotics-driven lessons (Su et al., 2023). In other words, K-12 AI education is largely within the niche of computer science, potentially limiting its accessibility to non-STEM learners (Druga et al., 2022). Researchers also suggest the increasing need for teacher readiness in technical fluency and demystification of AI (Grover, 2024). Pedagogy-wise, teachers ought to deploy age-appropriate teaching materials along with project- and play-based learning methods (Su et al., 2023). Finally, Druga et al., (2022) called for a greater emphasis on AI's societal impact that existing course materials hardly address.

2.2 The Digital Divide

Digital divide describes the unequal access to digital technologies that could result in disproportionate levels of digital fluency (Warschauer et al., 2004; Hernandez, 2023). Socioeconomic status (SES) and geographic location are two of the definitive factors (Hernandez, 2023). Households of lower SES or in remote areas tend to lack the financial means to acquire digital devices, nor could they leverage adequate connectivity to obtain information about technological knowledge (Hernandez, 2023). When digital exposure is increasingly linked to AI literacy and computational thinking (Celik, 2023), bridging the digital gaps becomes ever more necessary. If resources are not promptly and adequately allocated, the digital divide could ultimately lead to limited academic opportunities and career pathways for underserved students (Hernandez, 2023).

Although broadening access through distribution of technological products is a common solution (Hernandez, 2023), closing the digital divide requires far more than expanding accessibility. Warschauer et al. (2004) pointed out that students from higher SES engaged in more sophisticated applications such as statistical analysis, whereas their lower SES counterparts primarily used it for basic internet searches. Of greater importance is leveling the playing field of advanced technological deployment. This calls for inclusive pedagogy and home support, as well as deepening technological use in education (Warschauer et al., 2004).

Unplugged activities strive to tackle the disparity by developing computational thinking without the overreliance on digital infrastructure through "playful challenges, facilitated discussions, group problem-solving, accessibility to fundamental and generative concepts, and a high regard for participants' ability to conduct inquiry" (Huang & Looi, 2021, p. 96). The unique non-digital representation of knowledge to some extent removes the technical barriers and provides foundational cognitive skills before formally introducing learners to coding. The merits notwithstanding, unplugged activities have not yet been systematically integrated into routine teaching practices (Huang & Looi, 2021).

2.3 Youth Experience with AI Education

Youth engagement in technologies and AI has been of growing interest and importance. Young learners have become more than just passive users of digital technologies, but are active agents of innovative thinking (Bokil, 2024). Youth have started to deploy emerging technologies for problem-solving and community betterment (Bokil, 2024). One of the major roadblocks young people face in digital spaces is the inadequate training or support network. Guided learning experience through digital literacy acts as a crucial means to help young learners better navigate technologies (Bokil, 2024).

In this sense, AI education initiatives shall gradually adopt a youth-driven approach (Irgens et al., 2022). Young students' motivation to learn largely depends on instructional quality and curriculum design. Case studies from on-the-ground teaching evidenced the necessity of youth-centered courses through participatory frameworks (Irgens et al., 2022; Hamburg et al., 2024). In particular, students had better experience tinkering with digital tools when they could deliver their own technological implementation plans, under teachers' constructive guidance (Irgens et al., 2022). When students claimed their agency as co-creators of digital knowledge and applications, their learning experience became more meaningful and thus their understanding more enduring (Humburg et al., 2024).

Youth's encounter with AI could inform practitioners about best practices in AI literacy. In general, young students can articulate basic knowledge about AI (Humburg et al., 2024; Greenwald et al., 2021). They are able to enumerate specific AI applications such as generative AI and automation (Humburg et al., 2024). That being said, AI may still present to most young students as a "black box"; even for those with some coding background, the mechanisms of AI may be difficult to internalize at the beginning stage of instruction (Greenwald et al., 2021). Representation of mathematical and computational knowledge also matters. Young learners prefer concrete examples and immersive learning with real-world or personal relevance (Irgens et al., 2022; Humburg et al., 2024), as opposed to abstract concepts (Greenwald et al., 2021). Above all, youth are keen observers of AI's complex societal impacts. Within an open space for discussion, young students often contribute their unique perspectives on AI ethics, such as identity-based data biases, data safety, and algorithmic fairness (Irgens et al., 2022; Hamburg et al., 2024). Taken together, teaching AI to young students starts with the demystification of the technology, along with cultivating a supportive environment for practical training and empathetic conversations.

Within the domain of K-12 AI education, this study ties itself to the growing trend in scholarly inquiry and in-class practices, aiming to contribute another piece of evidence to the necessity and effectiveness of age-appropriate and student-centered initiatives. Comprehensive documentation of how youth participants navigate AI education spaces will also open up new possibilities of innovative practices in real-world learning environments. The current study also addresses two major gaps in existing literature. Firstly, case studies regarding youth's encounters with AI rarely involve youth-led programs, as most courses were designed and conducted by adult faculties. Second, ethics-by-design resources are generally lacking in K-12 AI literacy. Therefore, this study may add insights to the K-12 AI education discourse by examining a project-based workshop spearheaded by a high-school youth.

3 Purpose & Research Questions

Premised upon the opportunities and challenges in the field of K-12 AI education, this study aims to broaden the participation of AI literacy programs among elementary and middle school students with limited to no coding backgrounds; explore the role of youth-led initiatives in spearheading early acquisition of digital skills and AI ethics; provide empirical evidence for the K-12 AI education field in terms of curricular resources, classroom practices, and organizational frameworks; and inform educators and decision-makers about innovative and interactive course design that caters best to young learners of AI and computational thinking.

We ask two research questions (RQs) to guide our inquiries:

RQ1: Does "Charting the Course" affect students' knowledge level, interest, attitudes, tendency to learn, and job inclination regarding AI?

RQ2: What design components in "Charting the Course" are applied to affect students' learning outcomes and attitudes?

4 Program Synopsis

4.1 Context

"Charting the Course" is a dynamic program designed and implemented by a rising high school sophomore based in North Carolina. In collaboration with education technology companies and local non-profit organizations, this weekend extracurricular workshop brings middle school students (Grade 5-9) together to explore the possibilities of AI technologies. Offering an interactive and project-based experience, "Charting the Course" incorporates a series of hands-on activities that aim to deepen students' knowledge about AI, as well as their willingness for continued learning. The course content revolves around the AI4K12 Five Big Ideas of AI (Touretzky et al., 2023) (see Figure 1). Each activity addresses at least one big idea, with a particular focus on ethics and societal impact – the fifth Big Idea positioned at the center of all AI-related content knowledge (Touretzkey et al., 2023). The course content not only demystifies AI to young learners through age-appropriate and structured progression, but it also aims to cultivate students' critical evaluation of the AI tool, leveraging AI for social and environmental wellbeing.

Fig. 1. Five Big Ideas of AI Poster (AI4K12)

The program consists of 3 incremental phases: introductory, exploratory, and application. The session began with an introduction of AI's definition and basic mechanisms. Students also learned to distinguish between AI and non-AI technologies. This introductory phase established a general understanding of AI which paved the way for the deep dive into the Five Big ideas. Onto the exploratory phase, students worked individually or in groups on hands-on, unplugged activities that simulated AI functions in an intuitive and approachable manner. Through role plays and journal reflections, students enhanced their conceptualization of the Five Big Ideas before progressing to more complex discussions about AI's ethical implications. Finally, in the application phase, students applied their acquired knowledge to address real-world issues, namely, deploying AI tools to identify and prevent wildfires. This final stage underscored problem-solving and tech criticality, in order to equip students with the transferable skills and psychological assets necessary for continuous endeavors in AI learning. The sample lesson plan with each activity is presented in Appendix A.

4.2 Theoretical Framework

Project-Based Learning (PBL)

"Charting the Course" embodies the PBL paradigm. The class journeyed through the 4 steps in a PBL course (Boston University, n.d.). Under the theme of AI for problem-solving, students identified a problem or a challenge, from which they designed an action plan to reach solutions. Using worksheets, simulations, and iterations, students continued testing and refining their machine learning prototypes. Instructors and peers would offer feedback that further guided students through their project development (Boston University, n.d.). PBL particularly highlights students' creativity in a collaborative environment (Boston University, n.d.). This fits into the course structure of "Charting the Course," as the instructor deliberately engaged learners in groupwork settings and left adequate room for self-driven inquiries.

Playful Learning

Besides PBL, "Charting the Course" also integrates playful learning techniques to enhance young learners' attentiveness (Samuelsson, 2024; Hughes, 2013). This learning design principle caters to the behavioral features of young students' distinct learning habits, such as entertainment and games, to tailor in-class instruction to their needs. "Charting the Course" immersed students' in a camping-themed scenario, where students role-played in gamified activities as in Campfire S'mores Chef and Campsite Cruisers. These techniques espouse fantasy play (i.e. using AI in simulative contexts) and exploratory play (i.e. exploring AI functions in given instances and testing it through trials and errors) (Hughes, 2013; Samuelsson, 2024). Playful learning in AI education enables students to explore an imagined future with cutting-edge technologies through entertaining and educational processes (Samuelsson, 2024).

Universal Design for Learning (UDL)

Last but not least, UDL principles inform the program's multimodal instruction for greater accessibility for students of all knowledge levels. UDL aims to cultivate dynamic and agential learners who proactively pursue knowledge and opportunities (CAST, 2024). UDL principles underpin the diversification of knowledge representation, in the key areas of engagement, representation, and action and expression (CAST, 2024). At the core of its design, "Charting the Course" engages learners in various ways, combining small lectures, demos, and hands-on activities. Each activity is highly interactive between peers and instructors, allowing students to formulate strong communication skills (CAST, 2024; Ecker, 2023). Above all, the theme-based and unplugged course design presents AI knowledge that students might not be familiar with in an accessible and relatable manner (Ecker, 2023). This element enables students of different knowledge levels to equally engage in the AI learning process, as UDL principles ensure all students have the capability and agency to learn and excel (CAST, 2024).

4.3 Main Events

The workshop took place at a community workspace of a non-profit organization based in Durham, NC. The organization's core missions include distributing digital devices and hosting AI and computing workshops to individuals experiencing the digital divide. Students came from local neighborhoods and nearby areas. All students sat around the table, facing the youth instructor who set up the laptop and projector at the center-front of the classroom. Students sat in small groups of 2 or 3. After self-introductions and icebreakers, the instructor played a short video about explaining AI definitions to elementary learners. The first warm-up activity, "AI or Not," led students to identify key characteristics of AI using the 5 guiding questions from MIT Day of AI (MIT RAISE, n.d.). The instructor presented a series of artifacts on the slideshow, after which students went around the room to discuss or debate if the artifact was considered an AI. The introductory session concluded with a "Human Bingo" game, bringing students closer together as a cohort.

The cohort moved to the lab for the Campfire S'mores Chef activity. Students began the activity by learning about the big ideas of Representation and Reasoning along with Machine Learning. In an imagined camping scenario, students were tasked with a "cookout" mission to customize their s'mores sandwiches. This activity simulated the reasoning and supervised learning mechanisms where AI follows specific instructions to complete a task. Each group worked with a different set of "ingredients" paper cutouts to start with (see Appendix B.2.). The cutouts contained items that belonged in a s'more (e.g. crackers, chocolate, fruit, and marshmallows) and items that did not (e.g. vegetables, pizza, and eggs). One member of each group took on the role as an AI agent to assemble the s'mores. The groups then trained their "AI" person with various combinations to show them the features or "distinguishing points" of a s'more. Students learned about predictions, and the "AI" person made predictions based on the group's training instead of prior knowledge. The group proceeded to retrain their AI through feedback loops, documenting the success and challenges during the process. Campfire S'mores Chef taught students about the mechanisms of supervised learning. This section ended with students reflecting on the real-world applications of AI algorithms and feedback loops by examining the case study of Netflix personalization.

For the next activity, Campsite Cruiser, the whole class relocated to a new classroom with a U-shaped conference room setup. The center space was left open for simulations, and the surrounding space for workstations. The instructor delivered a mini-lecture on the big idea of Perception, after which students filled out a worksheet comparing AI sensors to human sensory organs. Once students grasped the basics of perception, the instructor brought the class to a panoramic Waymo self-driving car experience. Students familiarized themselves with the essential components of an autonomous vehicle and its function in real life. Using written worksheets "ML Journal" (see Appendix B.1.), students reinforced the technique of machine learning through training data. This interval activity prepared students for the main task of Campsite Cruiser. In another simulative setting, students logged onto an online meeting to communicate with a fictional character named "Sasha," who acted as the director of Camp Woodstock. Dubbed in an AI voice agent, Sasha presented the problem statement and assigned tasks to the students — designing a self-driving car that could transport campers around the forest. Students formed into teams and spent approximately 5 minutes ideating their prototype. They documented the different aspects of their car, what obstacles to avoid, and how to train their machine learning models. The groups created their own detailed flowchart (see Appendix B.1.) delineating how their cars would respond to environmental changes and obstacles using sensors and reasoning. Students then ran their flowchart on a foldable-fabric map sheet (see Appendix B.2.), where they placed different obstacles like animals, trees, and rocks along the way to represent changing road conditions. Upon concluding, students presented their flowcharts and outcomes to the class, reflecting on what went well and what could be improved upon.

The workshop culminated at the LA Wildfire project, as students departed from simulations to real-world events. Following the theme of nature and environmental awareness, students watched a brief video about the dire consequences of the Los Angeles wildfires. This contextualized the problem statement that guided students in the subsequent problem-solving activities with AI. Each group would pick two of the three main aspects of wildfire combat: Prevent (i.e. precautionary methods to stop wildfires from happening in the first place), Protect (i.e. actions taken to protect structures, people, and nature from the fires), and Persist (i.e. fighting the fires or aiding emergency personnel). During the final two hours of the workshop, students self-selected into groups, collaborating at their designated workstations with laptops, design materials, and a TV screen. The project emphasized student autonomy, requiring minimal instructor intervention to encourage leadership and accountability. Each group built their models around the Big Ideas of Natural Interaction and Societal Impact pivoting ethical considerations. Students conducted brief research on three existing AI technologies for wildfire interventions, analyzing how each aligned with the Five Big Ideas of AI. Students then moved on to a structured brainstorming session using an "ideation station" of sticky notes. These processes enabled students to collaboratively generate, organize, and refine their ideas. Students then transferred their concepts onto a virtual design board, detailing their designs through graphics and drawings. Integrating the Five Big Ideas of AI, each group walked through their thought processes, pitched their demos, and evaluated the foreseeable benefits as well as unintended consequences of their AI models. The group presentations were delivered in a gallery-walk format, as students circulated among stations to interact with and provide feedback on each other's projects.

5 Methodology

5.1 Research Design

This study adopts a mixed-methods approach to reach a comprehensive understanding of the design, experience, outcomes, and impact of the program. Quantitative instruments consist of pre- and post-surveys using a Likert scale from 1-5, with 1 being "Strongly Disagree" and 5 being "Strongly Agree," which measure students' interest, attitudes, tendency to learn, and goal-setting. Besides, a questionnaire of 7 questions (6 multiple choice questions and one true/false question) assesses students' knowledge level in AI concepts. We perform repeated measures ANOVA to measure the change in these constructs. Quantitative measures aim to answer RQ1. Appendix C presents the pre-post surveys.

Qualitative instruments include interviews before, during, and after the program with student participants; students' write-in responses to the open-ended questions before and after the program; participation observation of classroom setups and interpersonal dynamics during each activity; and instructor feedback from on-premise faculties.

Qualitative instruments offer additional insights and explanations to quantitative findings, responding to RQ2. In essence, the quantitative results aim to provide an overview of the program's measurable outcomes, as well as descriptive data visualizing students' profiles. Qualitative information gives voice to youth participants, as their own narratives indicate resourceful implications for the program design. Appendix D lists the semi-structured interview questions.

The rationale for employing a mixed-method framework is trifold. First, the relatively small and focused sample size of 18 students and one youth facilitator necessitates a multidimensional research design to maximize the depth and breadth of insights (Dawadi et al., 2021). Second, one of the primary objectives of this research is to explore not only the outcomes of the intervention program but also the mechanisms underlying its impact, addressing the "how" and "why" of AI education effectiveness (Dawadi et al., 2021). Third, many key cognitive and affective dimensions of AI education are not fully quantifiable (Dawadi et al., 2021), such as students' attitudes, motivations, and tendencies to engage with AI learning. Simply put, the choice of a mixed-method design allows both quantitative and qualitative instruments to complement each other (Dawadi et al., 2021). This helps paint a more holistic picture of youth's encounter with AI under the guidance of a young instructor.

5.2 Participants

18 students participated in the program in 2 cohorts (10 in the first cohort, 8 in the second cohort). Table 1 indicates the number and percentage of student participants based on grade levels.

Table 1. Distribution of Students' Grade Levels

Grade Level	Frequency (n)	Percentage (%)
5	5	27.7
6	3	16.7
7	6	33.3
8	3	16.7
9	1	5.6
Total	**18**	**100.0**

Students were selected via convenience sampling on a voluntary basis. The program organizer distributed the online registration portal to local schools and emailed relevant faculty members to promote the event. This approach leveraged existing school networks to recruit additional students who self-selected into the program.

5.3 Ethical Considerations

This research observes human participants, especially minors in middle schools. Therefore, we strictly adhere to ethical standards following the Institutional Review Board

(IRB) guidelines to uphold integrity and dignity. This study considered the 3 principles according to the Belmont Report: Respect for Persons, Beneficence, and Justice (Department of Health, Education, and Welfare, 2014).

Students agreed to take part in the workshop and enter the research process upon informed consent. Researchers obtained formal approval from students along with their parents or guardians. Accommodation measures such as rest periods and complimentary refreshments supported students' physical and psychological wellness. Strong confidentiality and anonymity protocols were followed to protect students' identities and personal information. The study environment was also designed to be a safe space, with clearly outlined housekeeping rules and on-site supervision. Additionally, students and their guardians received a clear and non-deceptive debriefing regarding the research objectives prior to the study. Committed to respect and beneficence (Department of Health, Education, and Welfare, 2014). These actions respected students as autonomous and sentient individuals, as well as safeguarding them during the workshop. The recruitment process and research design considered equitable participant selection and the fair distribution of benefits (Resnik, 2020). Accordingly, participant recruitment was conducted on a voluntary basis, ensuring that all interested students had equal access to participate without coercion or discrimination. Notably, this study did not include a control group, as intentionally excluding students from an educational opportunity would be deemed as unethical. In this sense, the study maintains the principle of justice throughout the program lifecycle.

6 Findings

6.1 Quantitative Measures

16 of the 18 students responded to the pre- and post-surveys (response rate of 88.9%). Table 2 displays the descriptive statistics of the mean and standard deviation for each of the 5 constructs.

Table 2. Descriptive Statistics for Pre- and Post-Measures

Measure	Mean	Standard Deviation	n
Interest (pre)	8.94	1.063	16
Interest (post)	9.44	0.964	16
Attitude (pre)	12.88	2.209	16
Attitude (post)	13.94	1.436	16
Tendency (pre)	8.38	1.204	16
Tendency (post)	9.38	0.885	16
Job Inclination (pre)	11.94	2.380	16
Job Inclination (post)	13.38	2.062	16
AI Knowledge (pre)	4.00	1.826	16
AI Knowledge (post)	5.37	1.500	16

The pie chart (Figure 2) visualizes the distribution of the background knowledge level of the students.

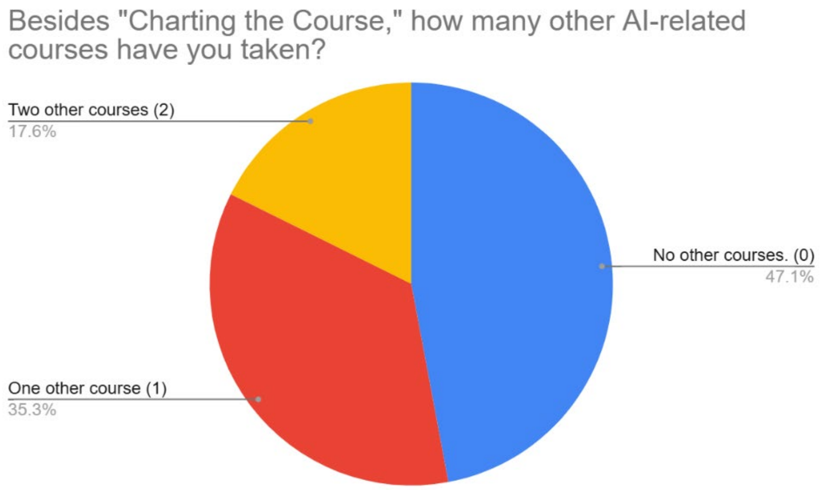

Fig. 2. Student Knowledge Background Pie Chart

A majority of the participants (47.1%) had not participated in AI-related courses prior to the workshop. A smaller percentage of participants (35.3%) had limited experience with AI training, having taken one lesson outside of the program. Students with continuous AI learning experience made up less than 18% of the cohorts. Although this could be attributed to their low grade levels when AI education was not as accessible to them at the time, the composition of past experience implies the limited background knowledge of AI among most students.

The repeated measures ANOVA results are presented in Table 3 and visualized in Figure 3.

Table 3. Pairwise Comparisons of Measures Over Time

Measure	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference
						Lower Bound
Interest	1	2	-0.500	0.242	.056	-1.015
	2	1	0.500	0.242	.056	-0.015
Attitude	1	2	-1.063*	0.433	.027	-1.985

	2	1	1.063*	0.433	.027	0.140
Tendency to Learn	1	2	-1.000*	0.274	.002	-1.584
	2	1	1.000*	0.274	.002	0.416
Job Inclination	1	2	-1.438*	0.540	.018	-2.588
	2	1	1.438*	0.540	.018	0.287
AI Knowledge	1	2	-1.375*	0.473	.011	-2.384
	2	1	1.375*	0.473	.011	0.366

Note. Based on estimated marginal means.
** The mean difference is significant at the p < .05 level.*

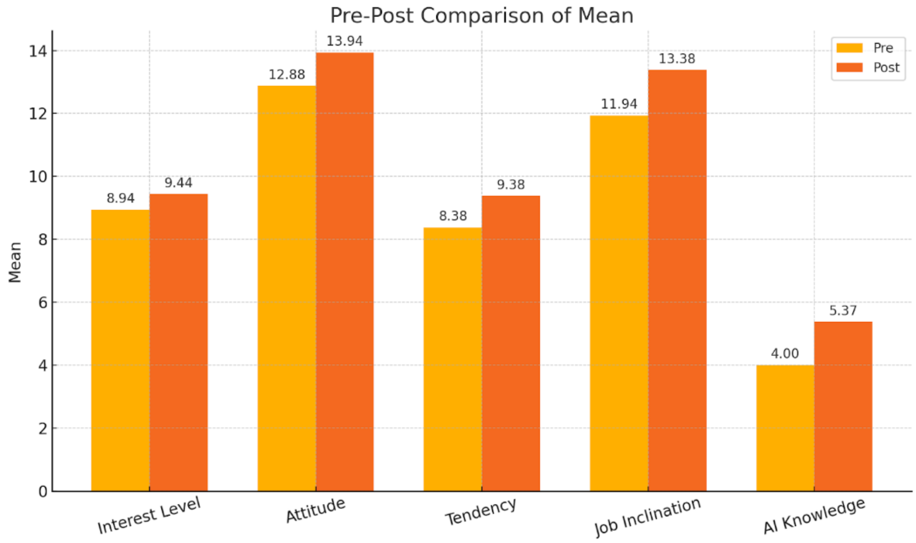

Fig. 3. Pre-Post Comparison of Means across All Measures

The ANOVA results show that the 16 respondents have experienced statistically significant increases ($p < .05$) in attitudes towards AI, tendency to learn, job inclination, and overall AI knowledge level. That being said, the increase in interest level is non-significant, which could be due to the high base level in the pre-survey (M = 8.94, sd = 1.063). Nevertheless, students have become more motivated to pursue AI knowledge after the course. They have started realizing AI's presence in jobs and everyday life, and planned to use AI on a regular basis for positive intents. Overall, the quantitative findings revealed the program's immediate benefits regarding students' knowledge acquisition and cognitive development in AI education. This could imply the preliminary effectiveness of a youth-led AI education initiative.

6.2 Qualitative Evaluation

Participant observations, interviews, and students' write-in answers provide additional qualitative insights into their overall experience and program effectiveness. Qualitative information was triangulated from 3 different observers. Interview answers and student responses were transcribed in a consolidated document for thematic color-coding. Three recurring themes emerged from the texts: AI through Youth Narratives, Multimodal Learning Experiences and Personal & Societal Factors. Under each of the three main themes, we identified the following subthemes: AI Understanding, AI Ethics; Agency to Learn, Learning through Play; Parental and Peer Influence, Academic Background. The sections below will discuss each theme and its relevant subthemes in detail.

Theme 1: AI through Youth Narratives

Before the workshop, students had varying perceptions on AI. Many students expressed curiosity about how AI works and acknowledged its capabilities in problem-solving. Most of them were able to enumerate commonly used AI applications, such as ChatGPT:

> *JG (G6): "AI is a short term for Artificial Intelligence. Some examples are ChatGPT and Gemini."*
> *VT (G8): "An artificial replicate [sic.] of human intelligence which is capable of learning or solving problems by itself. Copilot or ChatGPT."*
> *JR (G7): "AI is a tool used to do things more efficiently and there are many types of AI, such as generative AI."*
> *KB (G6): "Artificial intelligence is where AI is used for PowerPoint and you can use it in work."*

These comments indicate that students were largely familiar with AI, as they might have encountered these applications at school or in their daily lives. Still, students' understanding of AI did not go beyond acronyms or specific application names. They primarily viewed AI as a tool or a platform for efficiency and assistance. They rarely elaborated much on how AI achieved these functions or how generative AI engaged in natural language processing. Simply put, before the program, students still confronted the "black box" phenomenon of AI.

Although in-depth knowledge was lacking, students generally expressed optimism about AI. Many students described AI as a helper to humans, such as offloading hard work and making lives more convenient. A few students also addressed AI as the future, given its increasing presence in society. Some students drew on their personal experiences with AI agents to illustrate how AI could benefit them personally:

> *JP (G8): "The [one experience] I've had] with [AI] is the [Amazon refund] [and] I think that [it is going well]."*
> *RB (G7): "AI's positive social impacts are helping society with things that some people find hard or to do them more efficiently."*

TP (G9): "It can be your friend, make you feel comfortable if you don't have anyone to play and it can also make some impact on your studies too."

Other students concurred with these sentiments. They frequently used words like "help," "assist," "easier" and "convenient" to indicate AI's potential merits.

On the other hand, some students did recognize the potential harm AI could create. They brought up the concerns about misinformation or inaccuracy in the AI-generated results:

SN (G8): "...A challenge is it isn't the most reliable and sometimes gives wrong answers and is confident with that answer."
JB (G7): "...and some challenges may be not getting the correct information from the AI."

Generally, these students thought that AI might not be perfect, that it could "make mistakes" or "mess up." While the languages were vague, they nevertheless showed their conceptual grasp on AI's imperfections. Even though these attitudes might not be based on a systemic understanding of AI, a handful of students demonstrated rudimentary tech criticality.

As the workshop progressed, students' perspectives evolved. They began to recognize AI's capabilities beyond mere automation, identifying its problem-solving and decision-making capabilities. They also incorporated concepts of the Five Big Ideas into their definitions:

JH (G7): "AI is something that can learn off of every piece of information it is given to the best of its ability."
VT (G8): "[AI is] an artificial form of intelligence that can solve problems, reason, perceive, and learn."

These reflections indicated a shift towards understanding AI as an adaptive entity rather than a static tool. Other students told the interviewers about their understanding of feedback loops where AI could improve itself through trials and errors and additional data. Expressions like "learn and adapt," "improve," and "get better over time" implicate students' dynamic views on machine learning techniques.

Post-program, students' narratives about AI started to complicate. They demonstrated a more critical view on AI's role in society. More students recognized AI's possibility of job displacement and its influences on human decision-making, albeit upholding their initial positive conception that AI would engender generally positive outcomes:

SK (G7): "AI can improve human life and do things for human but it can also get rid of job [opportunities]."
TP (G9) "AI lessens the burden of people, and the challenges of AI are less jobs, and jobs being taken away."
VW (G5): "It could solve tasks that humans can't solve. Not always AI is reliable, though."

These statements illustrate an increased awareness of AI's dual nature, that is, its ability to enhance efficiency and innovation while simultaneously imposing challenges on industries. Some students also told the interviewers that they would like to explore

AI's "negative impacts" (JG, G6) and how AI could "not make mistakes" (JH, G7). Indeed, students' ethical considerations remained constrained to simple dichotomy, but these early concerns underscored their societal awareness, which is central to safe and responsible deployment.

A majority of the students had memorable experiences with the Wildfire activity. The problem statement tied closely to an imminent environmental topic that aligned with students' main concerns. In their interview responses, students exhibited willingness to apply AI and the Five Big Ideas to solving real-world problems. One student (VT, G8) shared that they wanted to learn more about Representation & Reasoning, because "it is interesting how [AI models] can reason and solve problems." Another student (SK, G7) expressed curiosity about "how [they] can use AI in [their] daily life." Other students provided a few more concrete examples of AI for problem-solving:

> *JG (G6): "If I was designing an AI bot I would basically try programing it to answer all the problems in a human's brain."*
> *JR (G7) "I want to solve the problem of wasting paper especially in schools, (workbooks)."*
> *TP (G9): "I want it to solve and get rid of human's social anxiety."*

In these responses, students demonstrated empathy for psychological wellness and environmental awareness. This suggests a step forward from the pre-program narrative about self-benefiting use of AI, to a more altruistic application. Imaginative as their answers were, these narratives nevertheless revealed young students' motivation to leverage AI for good and minimize its harm.

Theme 2: Multimodal Learning Experiences

"Charting the Course" diversifies the forms of activities to convey AI-related knowledge to young learners. Students demonstrated positive feedback on Campsite Cruiser, Campfire S'mores Chef, and the Wildfire activities. These projects comprised different forms of tasks, including writing, prototyping, and graphic design. Multimodal learning gives rise to two main components of positive experiences: agency and playfulness.

Students generally found the hands-on activities both enjoyable and educational. Students frequently used words like "fun," "creative," and "interesting" to describe their overall experience. They also expressed enjoyment of the Campsite Cruiser and Campfire S'mores Chef activities. Although students did not elaborate much beyond exclamations of excitement, these emotional cues accentuated the affective soundness of gamified learning processes. In particular, the organization of these activities played a decisive role in shaping the positive feedback:

> *SA (G7): "[I like] Wildfires activity because it was fun collaborating and working independently…"*
> *RV (G7): "Wildfires… [I was able to] apply what I learned and interact with others."*
> *KB (G6): "I really enjoyed making our own product because it helped us understand AI and apply. It was really fun and something I would love to do again."*
> *TP (G9): "- Interacting with others, and making new friends - I think my overall experience was amazing."*

Another way students obtained adequate agency is through the lenient problem space. One student (SK, G7) mentioned the benefits of working on their projects at their own pace. We could infer that the activities provided a balance between independent and collaborative work. This not only gave students ample freedom to develop their respective work plans, but also brought them together with their peers to foster friendship and a sense of belonging. Interpersonal contacts and augmented agency allowed students to comfortably navigate the workshop.

Besides, several students expressed appreciation for the final presentation:

TP (G5): "[The] activity [I] liked the most is [the] presentation we did on a real world problem like a wildfire and how we made our own app which can help out other people too!"
KB (G6): "Activity [I enjoyed was] presenting in front of people…"
VT (G8): "I enjoyed the presentations because we were able to come up with a practical application of AI."

Following the merits of agency, where students were able to create their own artifacts, the presentation gave voice to young students. They showcased their ideas with their peers, deepening their mutual support and fostering a sense of achievement. The practical nature of their final deliverables validated their creativity by connecting their designs to real-world significance.

Challenges occurred from time to time, as one student (SK, G7) found the writing too dense for the worksheet exercises. The on-site faculty also noted that the presentation slides were text-heavy, potentially hindering students' attention to the course content. Another student (SA, G7) conceded that timing could be a potential challenge, for according to the instructor's reflection, some activities might require more time than initially planned. Despite the challenges, the instructor took initiative to manage the pacing and incorporated small interactions throughout the course to keep students engaged.

Theme 3: Personal & Societal Factors

Prior to the workshop, students were asked about their favorite subject(s) at school, as well as their motivation for participation. A decent number of students demonstrated interest in STEM-related subjects. 4 of the 18 students talked about their fondness of the general Science subjects, while one student specified Physics and another Maths. In open-ended questions about AI's mechanisms, 3 students mentioned coding as an integral part of designing an AI system, indicating familiarity with the connection between programming and AI. 2 students told the interviewers that they wanted to learn coding, one of whom already equipped with basic coding knowledge. These responses could imply that pre-existing conceptualization of computing and AI might motivate young students to pursue learning opportunities like "Charting the Course."

In addition to most students' intrinsic academic readiness, external factors from families and peers could also shape youth experience with AI education. When asked about the reason behind their attendance, 5 students mentioned that their parents (mother) signed up for them. One student whose mother was a software engineer was also driven by her friend's recommendation. Another student had attended a similar class in a different state with her cousins. Family support could serve as an intangible factor shaping students' tendency to learn about AI. It is also worth noting that one student showed specific appreciation to the instructor by complimenting his personable teaching style. Youth leadership could establish an approachable environment, assuring students of a supportive workshop experience.

7 Discussion

Both the quantitative and qualitative findings provide answers to the two aforementioned RQs. Regarding RQ1, we observed statistically significant improvements in students' AI knowledge level, attitudes towards AI, tendency to learn, and job inclination, in terms of using AI for work and for community betterment. The noticeable increase in knowledge level supports the immediate effectiveness of "Charting the Course." Recent studies that adopted similar activities — such as design challenges and simulations — all yielded positive outcomes in students' mastery of AI and machine learning (Dai, 2024; Zhang et al., 2022). The practical aspects in using AI for real-world settings could also contribute to students' career interest (Zhang et al., 2022). This is also reflected in their narratives about AI's impact on the job market, demonstrating young students' early consideration of vocational pathways. Positive attitude shifts are also commensurate with existing case studies in similar topics, where interactive and participatory methods were used (Mavromihales et al., 2019; Trifonova et al., 2024; DiPaola et al., 2020). Although the increase in interest level was non-significant, one possible explanation for this result would be the ceiling effect (Staus et al., 2021). In other words, students may have already had a high level of interest in AI, leaving little room for further measurable growth. This is in line with the qualitative findings from student interviews and reflections. Most of them came to the workshop with an initial curiosity in computing or AI. Students' interest level might also be stable over time, influenced by pre-existing personal preferences (Bognár & Khine, 2025).

Interviews, observations, and open-ended questions unveiled fruitful insights into the particular design elements contributing to the positive changes in students' knowledge acquisition and socioemotional development. Most directly, the findings consolidate the pedagogical soundness of PBL, playful learning, and UDL. In "Charting the Course," the instructor deliberately organized the course around multiple modalities, using videos, music, texts, and practical exercises to deliver AI knowledge. This method was proven to be effective from the case study by Abu-Boateng & Goodnough (2022), where students had the freedom to choose their preferred formats of assessments and deliverables. Collaborative hands-on activities centered students' agency and interest, thus stimulating their cognitive development via learning by doing (Trifonova et al., 2024). Gamification also contributed to students' stronger satisfaction with the learning experience that augments their internationalization of knowledge (Mavromihales et al., 2019). The combination of student-centered and humanistic design frameworks laid out the theoretical foundations for learners' success (Trifonova et al., 2024; Mehrotra & Sinha, 2024).

Contexts and course formats account for the positive outcomes. Anchoring itself in the local community, "Charting the Course" opened up additional learning opportunities for students who might not have previous exposure to similar initiatives. As Mehrotra & Sinha (2024) observed, a non-formal learning environment would be suitable for young learners to learn about AI through culturally responsive and resourceful ways. Extracurricular activities reach beyond brick-and-mortar classrooms, expanding "the inclusive ecosystem at an early stage when attitudes and aspirations are being shaped" (Mehrotra & Sinha, 2024, p.506). Furthermore, "Charting the Course" extensively deployed unplugged activities throughout the course. The projects required minimal digital capacity or coding backgrounds. Done largely through written worksheets and physical-model games, these projects translated AI knowledge into accessible and age-appropriate formats without the prerequisites of programming (Bell et al., 2009; DiPaola et al., 2020). Similar studies (Lim et al., 2024) have also shown promising results of using role plays and gamified group projects to teach the Five Big Ideas of AI. Whereas some unplugged classrooms relied solely on seminar-style discussions (DiPaola et al., 2020), "Charting the Course" synthesized both discussions and practical prototyping, thereby forging a holistic and enduring understanding of AI beyond abstract concepts. More importantly, this initiative further bolstered the use of unplugged activities to broaden the participation of AI education among young learners, especially catering to those with limited digital access or exposure (Bell et al., 2009).

Thanks to the ethics-by-design approach in the lesson plan, students demonstrated incremental changes in the depth of their AI literacy. "Charting the Course" threads societal impacts and ethical principles throughout each activity, espousing the technique of embedded ethics in K-12 AI education (Williams et al., 2023). The Wildfires activity not only guided students to apply AI principles to tangible situations, but also developed their environmental stewardship and compassion. Embedded ethics could inspire students to develop AI systems in personally meaningful ways, cultivate empathy that informs responsible AI design, and critically examine AI's complex influences on society (Williams et al., 2023). Previous inquiries have proven young students' sensitivity to AI's profound disruptions to society and everyday life (Ali et al., 2021). With proper intervention programs on AI and its ethical implications, students could better articulate their concerns and enumerate potential stakeholders for accountability (Ali et al., 2021). In "Charting the Course," students evolved from simply enlisting AI applications to deliberately pointing out specific risks AI might create, for instance, misinformation or hallucination as well as job displacement. Although young students in this cohort have yet to engage in highly sophisticated ethical conversations — as their discourse remains dichotomous (Morales-Navarro et al., 2023; Dai., 2024), they nevertheless conveyed their preliminary grappling with AI's promises and problematics through critical reflections (Zhang et al., 2022). Students' willingness to address the ethical issues post-program also proves that, to young learners, the challenges of AI are imminent but not insurmountable (Morales-Navarro et al., 2023). In this regard, "Charting the Course" has inspired youth to partake in dialectical evaluation of AI, thereby preparing them for subsequent inquiries with greater nuance.

Learner agency is a salient feature in "Charting the Course." The course left open the possibility to utilize creativity and showcase the end results. This amplifies and validates students' own narratives (Williams et al., 2023). Students were able to think outside of the box in open and creative processes, developing multiple ways of innovative solutions (Martin et al., 2024). In the Campsite Cruisers activity, the instructor devised a highly customizable roadmap and several figurines to simulate various road conditions. The flexible design space provides students with ample resources and room for creativity to tinker with their designs, optimizing and coordinating in role-based group work (Martin et al., 2024). It is worth noting that in some cases of AI education, learner agency may not yield positive outcomes, such as overestimating AI's reliability and developing dependency (Lee et al., 2024). This was also partially observed in students' reflections: some students thought AI's capability would exceed that of humans. Nevertheless, under instructors' proper guidance (Lee et al., 2024) and consistent exposure to ethics-related content, the overly optimistic sentiment started to compromise, as students started adopting a more cautious view on AI. Put alternatively, "Charting the Course" meticulously manages the adequate freedom to explore AI while offering necessary support for optimal learning.

Finally, what sets "Charting the Course" apart from existing case studies is its youth leadership. A high school student dedicated his efforts to the entire lifecycle of the program, from ideation to instruction and to implementation. The presence of a peer instructor could create a role model effect on young learners (van Dijk & Noorda, 2019; Atif et al., 2022). Youth between Grade 5-9 are in the process of identity-building and self-exploration; peer mentorship could have lasting ripple effects on their personal development later in their academic and professional pursuits (Atif et al., 2022). Working alongside a peer mentor who can empathize with youth's experiences would strengthen their efficacy and sense of responsibility (van Dijk & Noorda, 2019), which is implicated through students' seamless cooperation and mutual support during the activities. Given that young people's encounters with AI have become more frequent, it is imperative to amplify youth's voices in AI education (Bouziane, 2025). In a co-created interactive space, both the youth instructor and young students forge computational thinking, design responsible AI, and narrate their unique stories as Campsite Cruisers.

8 Conclusion

This mixed-method study probes into a youth-led project-based AI workshop, "Charting the Course." Pre- and post-surveys assess the immediate impact of the course on 16 respondents out of 18 students, revealing significant increase in knowledge levels and socio-psychological development. We could thus infer that "Charting the Course" has demonstrated preliminary success in cultivating young students' computational thinking skills and AI fluency, particularly in terms of the internalization of the Five Big Ideas. Indeed, the increase in interest level is not as significant, but since the baseline level is already high, this could imply that AI workshops like "Charting the Course" could pique great interest among young learners. Simply put, young learners are eager to seek out opportunities to learn about AI. Therefore, quantitative results point to the necessity and imperativeness of expanding impactful and inclusive AI initiatives to a wider student body.

Qualitative instruments were used to identify particular design elements in the course that contributed to students' knowledge acquisition and attitude shifts. Amplifying youth's voices, insights from their narratives affirm the pedagogical soundness of PBL, learning through play, and multimodal representation of knowledge. The extensive use of unplugged activities and gamification has lowered the entry barrier of AI education, making digital literacy more accessible to students with limited prior knowledge in relevant fields. "Charting the Course" has maximized learner's agency, centered young people's narratives, and established a youth role model to encourage continuous pursuit of AI learning. The ethics-by-design lesson plan has deepened students' awareness of AI's societal impact, at the same time channeling them to leverage AI for environmental good. These design elements could account for the increasing complexity in learners' articulation about AI upon commencement.

This study could contribute to K-12 AI education in scholarly and practical ways. For researchers, this study unveils empirical evidence for youth-led AI initiatives, an oft-overlooked area in the current discourse. Subsequent research in this area can shed light on the unique ways youth leadership or mentorship strengthens middle school learners' AI literacy, comparing its differences of in-class dynamics and teaching methods from adult-led courses. Attentiveness to youth's perspectives can inform innovative pedagogical frameworks of AI for K-12 audiences. More than AI-related content structures, new frameworks shall pivot cultural and socioemotional responsiveness according to youth's distinct learning styles and interests. For practitioners, such as teachers and instructional designers, vignettes from "Charting the Course" can inspire similar course designs and practices. Curriculum designers can adopt gamification and theme-based activities based on students' academic preferences, extracurricular interests, and cultural backgrounds. Teachers may consider youth co-teaching in facilitating hands-on lessons focusing on real-world problem-solving and self-exploration. Creating a youth-centered classroom setting is crucial for AI education. Adult and youth instructors alike can proactively foster supportive and empathetic classroom conditions where meaningful, sophisticated conversations about AI ethics emerge. Above all, this study demonstrates the potential of youth-led AI initiatives as a catalyst for community empowerment, strengthening a constructive ecosystem of peer-to-peer learning. Towards a future driven by ethics, empathy, and innovation, "Charting the Course" has blazed a new trail in decoding AI education by dismantling entry barriers and sparking curiosity.

A few limitations need to be acknowledged in this study. The relatively small cohort would hinder the generalizability of our quantitative findings. Subsequent iterations shall enlarge the number of participants to reveal more representative results. Since the participants enrolled on a voluntary basis, self-selection bias might be present, which could also explain the insignificance in interest level changes. Assessments of long-term retention of AI knowledge are also needed, which calls for a longitudinal study and follow-up surveys. Expanding the scope of this research, further endeavors could look into the effects of extrinsic factors like parental influence. A more refined assessment for unplugged activities is needed to fully capture the degree of enduring understanding among learned. Finally, subsequent lessons will deepen the sophistication of ethical conversations that transcend simple dichotomies.

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Appendix

A. Sample Lesson Plan

Activity 1: Introduction

Objectives:

- Objective 1: Students become familiar with each other and the program layout
- Objective 2: Students become familiar with what the word "AI" means and its characteristics
- Objective 3: Students are able to distinguish whether a technology is AI or Not

Instructions:

- (5 minutes) Welcome session and name tag distribution
- (5 minutes) Instructor share with students the schedule and rules for the day
- (5 minutes) Students watch an introductory video on AI
- (5 minutes) Play the around-the-room debate activity "AI or Not"
- (5 minutes) Play "Human Bingo" with their peers and instructor as an ice-breaker activity

Activity 2: Campfire S'mores Chef

Objectives:

- Objective 1: Students understand the Big Ideas of Machine Learning and Representation & Reasoning
- Objective 2: Students learn the process of how AI learns through data and feedback loops through the process of building s'mores

Instructions:

- (8-10 minutes) Introduction to the Big Ideas of Representation & Reasoning and Machine Learning
- (3 minutes) Divide students into groups and each group chooses an individual to act as the "AI".
- (5 minutes) Instructor explains the activity: to simulate how AI learns and reasons through the process of building a s'more.
- (5 minutes) Each group is provided with a different set of ingredients, including:
  - Ingredients that belong in a s'more (e.g., crackers, chocolate, fruit, marshmallows).
  - Ingredients that do not belong in a s'more (e.g., vegetables, pizza, eggs).
- (10 minutes) Groups train their "AI" person by using different combinations of s'mores to find the distinguishing features of a s'more.
- (10 minutes) Instructor introduces the idea of prediction.

  - Ask the groups to have the "AI" person make predictions based on the group's training, without using prior knowledge.
- (10 minutes) Students learn about feedback loops and their significance. Each group retrains their "AI"
- (5 minutes) Discussions about how the "AI" can improve with feedback loops
- (5 minutes) Conclude the activity by discussing real-world applications of the learned concepts, with a focus on the use of AI in the Netflix application.

Activity 3: Campsite Cruiser

Objectives:

- Objective 1: Students deepen their knowledge about ML models and Representation & Reasoning
- Objective 2: Students explore the big idea of Perception, relate it to the human body, and learn about perception sensors
- Objective 3: Students learn about self-driving cars, their role in today's world, and how they work

Instructions:

- (3 minutes) Introduction to Perception.
- (2 minutes) Students fill out a chart comparing perception sensors to human body sensory organs.
- (5 minutes) Students view a 360-degree self-driving car experience featuring the San Francisco-based Waymo self-driving car:
  - Learn about the many components that go into an autonomous vehicle.
  - Learn about how a self-driving car operates in a real city.
  - Reiterate the idea of how AI continuously learns.
- (5 minutes) Reviewed the concept of Training Data via ML Journal
- (5 minutes) Campsite Cruiser activity starts. Students enter a simulated online meeting to speak with a virtual client named "Sasha," the director of Camp Woodstock.
  - "Sasha" informs students she needs help designing an ML model for a self-driving car to transport students around the forest.
- (5 minutes) Small-group discussion of adapting the concept of self-driving cars in cities to a unique environment with its own challenges to overcome.
  - Students form into teams and learn about different types of sensors in self-driving cars.
- (5 minutes) Completed a brainstorming activity in their journals:
  - Highlight aspects of their car.
  - Identify obstacles to avoid.
  - Detail how to train the model.
- (5 minutes) Brief introduction of algorithms and flowcharts.
- (5 minutes) Students work on a detailed flowchart describing the process their AI car would use to maneuver through the forest using its sensors.
- (5-7 minutes) Each group simulates their flowchart on a large map poster

  - Students place obstacles like animals, trees, and rocks along the map to test the flowchart.
- (10 minutes) Students present their flowcharts and simulation outcomes to the class

Activity 4: Real-World Application - AI and the LA Wildfires

Objectives:

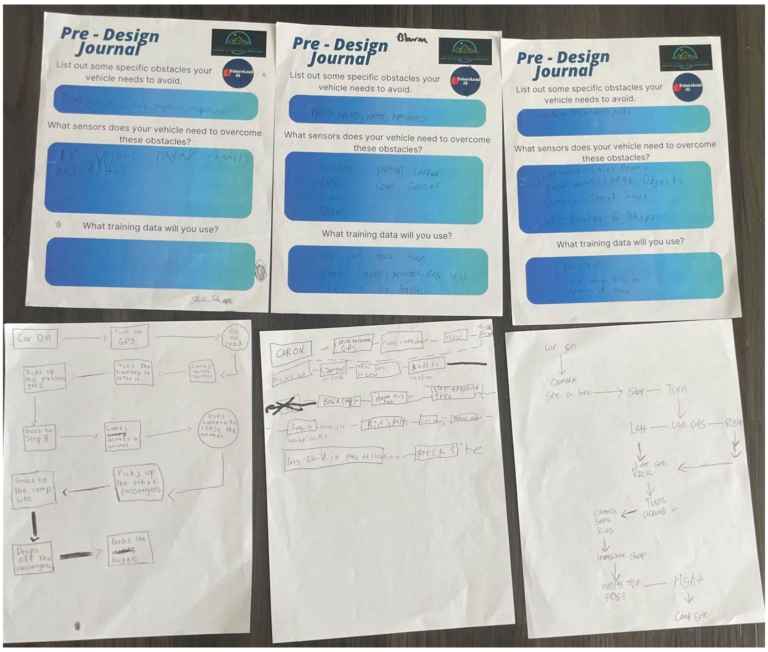
- Objective 1: Students learn workplace skills such as team-work, time management, project management, and the design process.
- Objective 2: Students learn about the big ideas of Natural Interaction and Societal Impact, with a focus on ethics
- Objective 3: Students are able to understand the impact of the LA Wildfires, and apply all their knowledge to combat a real-world problem

Instructions:

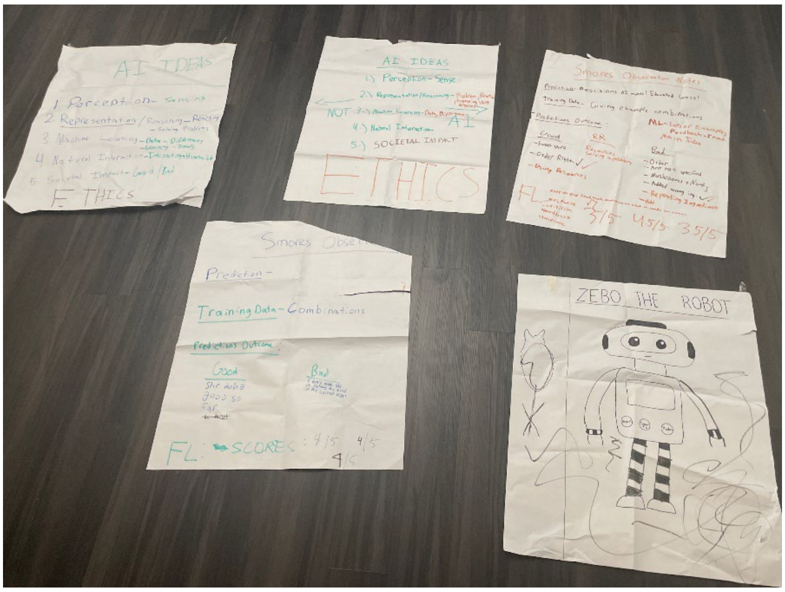
- (5 minutes) Students learn about the devastating effects of the recent Los Angeles wildfires for context.
- (5 minutes) Introduce student projects. Task students with creating solutions to wildfires using the power of AI, targeting two of the three wildfire combat principles:
  - Prevent: Precautionary methods to stop wildfires from happening.
  - Protect: Actions to safeguard structures, people, and nature.
  - Persist: Fighting the fires or aiding emergency personnel.
- (5 minutes) Students form into groups and proceed to individual workstations with laptops, design materials, and TVs.
- (10 minutes) Students first work independently to generate project ideas.
- (10 minutes) Introduction to the remaining big ideas of Natural Interaction and Societal Impact, with a focus on AI Ethics and its principles.
- (10 minutes) The class looks for three examples of how AI is currently used to combat wildfires in LA. Explore how these technologies use the five big ideas of AI.
- (10 minutes) Students brainstorm at the “ideation station” using sticky notes to create, categorize, match, and filter ideas.
- (15 minutes) Students work on virtual design board to:
  - Add more details to their ideas.
  - Sketch out designs on graph paper.
  - Incorporate the five big ideas of AI.
  - Discuss ethical implications, including positive and negative impacts and unintended consequences.
- (10 minutes) Compile all project information into a slideshow.
- (20 minutes) Students present their group project slideshows in a gallery-walk format, traveling to other groups’ stations to watch them present

B. Artifacts

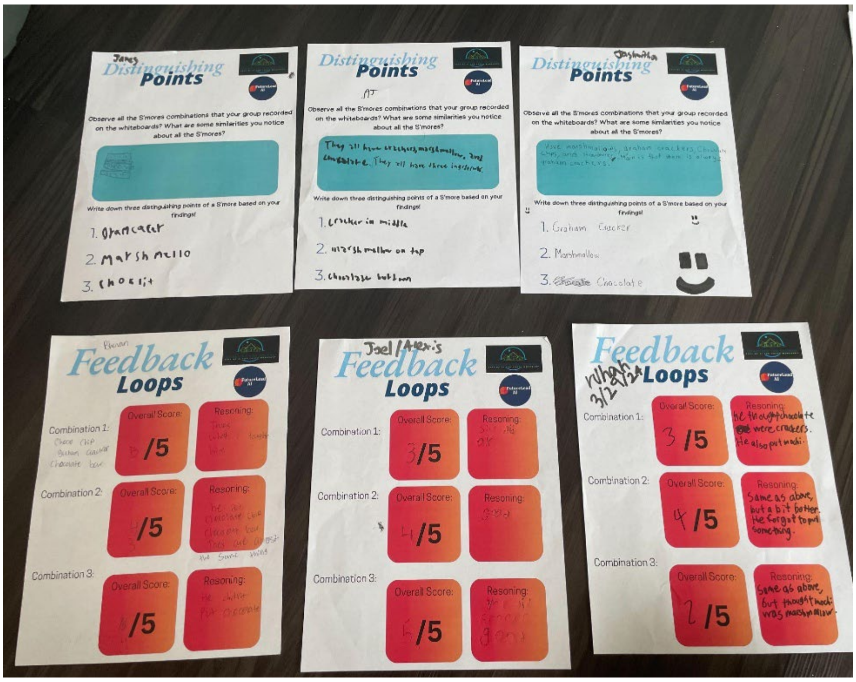
B. 1. Student Worksheets



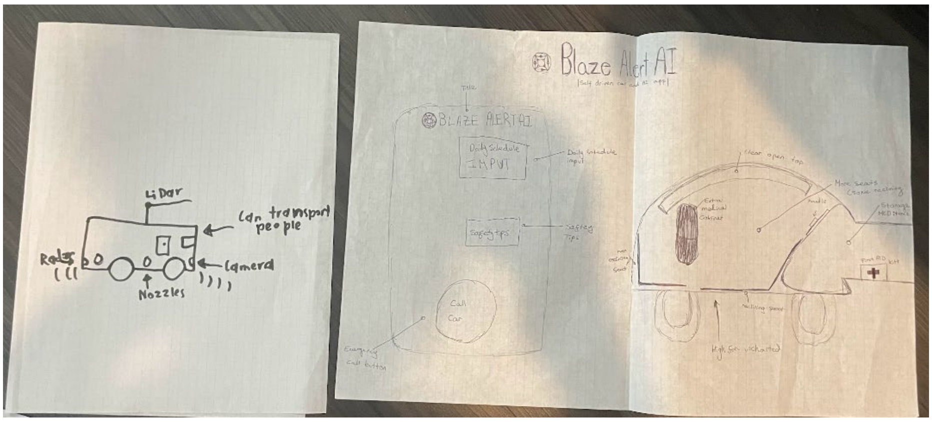
Pre-Design Journals and Flowcharts



Students' Notes, S'mores Worksheet, and AI Robot Design



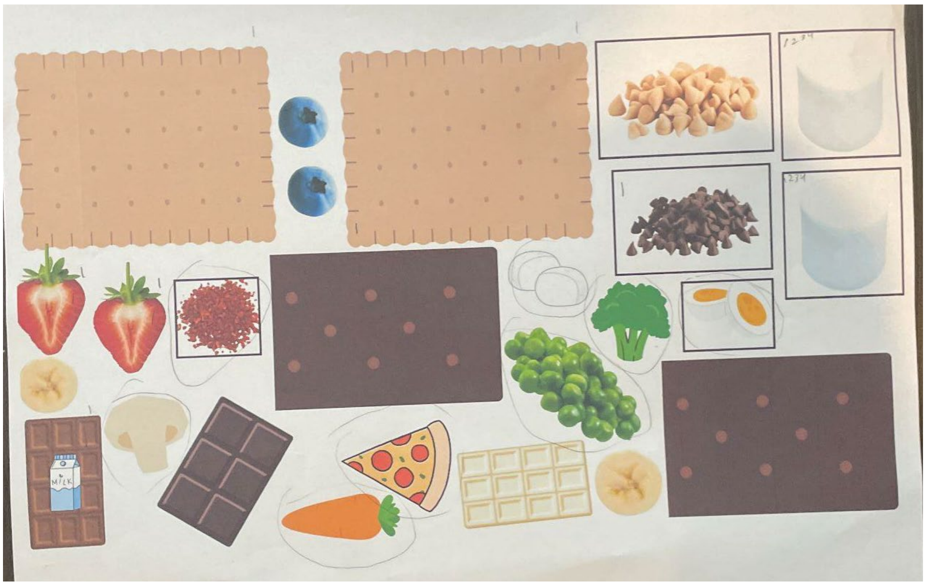
Campfire S’mores Chef and Feedback Loop Worksheets



Wildfire AI Design Worksheet “Blaze Alert AI”

B. 2. Gamified Activities Materials

Campsite Cruiser Gameboard Map



Campfire S’mores Chef “Ingredients” Paper Cutouts

C. Pre- and Post-Surveys

Linear Scale (1-5):
Interest in AI

- I am curious about AI technologies (Post: I found AI technologies fascinating.)
- I think learning AI will be interesting (Post: I found learning AI interesting.)

Attitudes

- I think learning about AI is relevant to me
- I think AI can be helpful
- I am aware of AI’s impact on everyday life

Tendency to learn

- I am confident about learning AI (Post: I believe I can continue to learn AI)
- I want to use AI to solve problems for my community

Job Inclination

- I know there are jobs that use AI
- I am interested in jobs that use AI
- I am interested in making and using AI in the future

AI Knowledge Assessment:

1. Which of the following is not an example of AI?
    a. A self-driving car
    b. A computer that can play chess with human
    c. A software that can automatically write a story based on your idea
    d. A robot that can walk and run
2. Which of the following is "data"? (Select all options that apply)
    a. Numbers
    b. Pictures
    c. Videos
    d. Texts
3. A camera is a perception sensor.
    True
    False
4. AI can get better and better through...
    a. increasing storage
    b. feedback loops
    c. smart chips
    d. reading an instruction
5. What is "algorithm"?
    a. A big computer
    b. A digital software
    c. A series of instructions

d. A set of large numbers

6. Cars powered by AI has several advantages because ___
   a. AI will never get into car accidents of any kind.
   b. AI can react to unpredictable road conditions faster than human drivers.
   c. AI knows when to honk better than human drivers.
   d. AI cars have higher speeds.

7. ChatGPT, an AI chatbot, can communicate with you like a real person. This is an example of ____
   a. Perception
   b. Societal impact
   c. Natural interaction
   d. Representation and Reasoning

D. Interview Questions

Before

- How are you feeling today? What is your favorite subject? What are your hobbies?
- What brings you to this workshop today?
- What do you look forward to learning the most? / What do you want to learn today?
- What kinds of activities would you like to join?

During

- What do you think about AI technology now, and why?
- Now that you have learned about the Five Big Ideas, what would you like to know more? Why are you interested in this topic?
- How do you feel about this activity? How would you describe the lessons so far?

After

- What have you learned? Which activities did you work on?
- Which activities have you enjoyed the most? What were the challenges? How would this workshop better help you learn?
- What more would you like to learn about AI after this workshop? How would you learn about it? What learning resources would you like to use? If there are similar workshops like this one in the future, would you be interested?
- What do you think about AI after this program? What do you think about the experience of learning AI? What surprised you?