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Board 385: Shark AI: Teaching Middle School Students AI Fundamentals Using Fossil Shark Teeth

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SHARK AI: Teaching Middle School Students AI Fundamentals Using Fossil Shark Teeth

Abstract

The effective introduction of the fundamentals of artificial intelligence (AI) to middle school students requires the novel integration of the existing science curriculum and AI concepts. This research focuses on leveraging 6th and 7th-grade science curricula related to state standards to introduce machine learning concepts by using fossil shark teeth. Researchers from engineering, education, and paleontology collaboratively developed learning modules to upskill Title I schoolteachers to meaningfully integrate AI fundamentals within their existing curriculum. With a special emphasis on machine learning (ML), five lesson plans were presented during a week-long teacher professional development. Teachers conceptualized and implemented ML models that distinguish fossil shark teeth by their taxonomy and primary functions to recognize ecological and evolutionary patterns. After introducing a lesson, each teacher curated the lesson plan content to directly relate to their specific context, in collaboration with each other and our research team.

We built the curriculum leveraging students' existing conceptions and misconceptions about AI from prior work while testing the feasibility of addressing AI learning objectives, as well the AI4K12's Five Big Ideas, in the broader context of middle school science, technology, engineering, mathematics, and computing (STEM+C) education. Our lessons were scaffolded using the iterative machine learning development process: 1) data collection and preparation; 2) selecting and training the model; 3) evaluating the models' accuracy; 4) tuning model parameters to improve performance. Each stage of the development process constituted a different lesson during a week-long summer professional development. Through these lessons, teachers were introduced to several open-source AI tools, including two platforms used to build/train ML models: Google's Teachable Machine and Roboflow. The fifth and final day of the professional development gave teachers time to conceptualize how these lessons could be integrated with their existing curricula.

Initial feedback from the summer PD indicated we overestimated the teachers' familiarity with technology and the capacity to access all of the information that we provided. More time was necessary to orient teachers to each AI tool. Teachers readily adopted the use of Seek by iNaturalist and myFossil. However, the teachers' use of AI tools in their classrooms highly favored Google's Teachable Machine to Roboflow, which may relate to the affordances and constraints of each tool. Preliminary mixed-method data analyses show teachers' self-efficacy around teaching AI improved after engaging in the summer PD. Longitudinal data collection is underway and will inform future work related to improving teacher and student self-efficacy related to teaching and learning AI, respectively.

I. Introduction

AI is a vehicle for disruptive innovations, transcending disciplinary bounds, and facilitating the creation of products and tools that transform industries. It is infiltrating every sector of our workforce, and students will need to be prepared to face the challenges and opportunities it presents. As school districts grapple with the need to overhaul their curriculum to provide high-quality computer science education, many are not prepared to provide pedagogy beyond introductory computational thinking skills. This NSF ITEST project is centered around integrating science, computer science, and engineering skills and content to facilitate the discovery of AI-related career pathways for students in middle school Title I classroom settings across the state of Florida. Since 2019, hundreds of Florida teachers have participated in PD opportunities and designed, implemented, and disseminated innovative science education and activities through an innovative program called, Scientist in Every Florida School (SEFS). Building off prior SEFS work [1, 2] that specifically engaged middle school students in learning about fossils and the science of paleontology, researchers from the University of Florida and St. Mary's College of Maryland designed a year-long teacher PD experience. The Shark AI project leverages middle school students' interest in fossil shark teeth to explore ML concepts. Sharks captivate public interest, as evidenced by the popular *Shark Week* programming on the Discovery Channel [3]. Fossil shark teeth also have a simplistic morphology that varies by species and dietary preference, providing the ideal basis for developing and testing ML models that categorize objects using 2-dimensional images.

The state of Florida is known for the ability to easily find fossil shark teeth along river bottoms and local beaches. Similarly, the fossil collections at the Florida Museum of Natural History contain approximately 200,000 fossil shark specimens that have been accessed for this project; many more are also available in existing large online biodiversity databases (e.g., GBIF https://www.gbif.org/) [4]. Further, thousands of images have been acquired by participants from biodiversity databases, including the community science-driven myFOSSIL eMuseum [4]. Each of these resources is accessible to scientists and researchers and all participants in our study for curriculum development and in-class activities.

In April 2021, nine science, technology, engineering, mathematics, and computing (STEM+C) teachers participated in a pilot PD series on fossils and AI. Teachers from the Flagler County public school district in Florida learned about the fundamentals of AI, fossil sharks, and how to leverage Google's Teachable Machine to distinguish shark teeth adaptations and their use (either for cutting, grasping, or crushing). Teachers were then tasked with implementing these concepts in their classrooms and reporting the outcomes. The results of the wrap-up session indicated they (and their students) were interested in both fossils and AI. The teachers found the content relevant to their curriculum. However, we determined many science and AI misconceptions, and there was a low self-efficacy related to teaching this blended curriculum.

Informed by the successes and lessons learned from these projects, our team designed a week-long PD for teachers that (1) increases awareness and interest in STEM+C careers and (2) promotes STEM content learning and skills acquisition in underserved (Title I) Florida schools. While there are several overarching objectives of this NSF-funded project, this work focuses on the co-development of a curriculum designed for use by the teachers selected for the week-long PD. The aim of our curricular model was to provide a generalizable and transferrable method of AI-enhanced paleontology exploration, complete with an online library of customizable open-source lessons and activities.

II. Project Details

The Shark AI project includes a year-long teacher PD engagement for 6th and 7th-grade science teachers from Title I schools. Beginning with a week-long summer PD in July, teachers are introduced to computer science, engineering, and science concepts and other pedagogical tools they can use in their classrooms, including five Shark AI lesson plans. They are then expected to adapt these lessons to be integrated into their existing courses to complete their engagement, complete with a pre- and post-assessment for themselves and their students. They are provided check-in opportunities with project personnel and expected to invite experts into their classrooms for visits (in person or virtual) using the SEFS infrastructure in the subsequent fall and spring terms. Finally, the teachers showcase their student's work in a gathering organized by the Shark AI project team in May. The primary deliverable of this project will be the five lesson plans that are developed, tested, and improved by teachers, with expert input and support. We began by leveraging the 5E Model of Instruction, an existing framework often used in the K-12 environment [5].

A. Conceptualizing a Curriculum Design

The framework for the curriculum was adapted from the 5E Model of Instruction; an evidence-based, up-to-date Next Generation Science Standards (NGSS) created to improve science education for K-12 students

[6, 7]. 5E includes sequential learner-centered phases: Engage, Explore, Explain, Elaborate, and Evaluate. Due to its national reach, the 5E model was selected to broaden our potential impact beyond the state of Florida once the modules are made publicly available. Initial conceptions of the curriculum design involved participants' engagement with the ideas and the project team to develop five modules that included several lessons and activities.

Figure 1. Alignment of Lesson Plans with Standards

Title, Content, and Learning Goals	**Activities**	**Assessments & Artifacts**	**CPALMS** (abridged Florida state public K-12 middles school standards)	**NGSS Equivalent** (abridged NGSS equivalencies)
Fossil Species - How paleontologists identify "morphospecies" by fossil shape; landmark analysis	Sort a collection of multiple shark tooth species from the same fossil locality	Sets of fossil teeth into morphological groups; upload to myFOSSIL eMuseum database	SC.6.L.15.1: Organisms classified with shared characteristics (i.e., Linnaean system) SC. 8.N.1.5: Methods used to develop scientific explanation	MS-LS4-1: Analyze and interpret data for patterns in the fossil record
Intro to AI and Megaladon Teeth - Human vs. Google's Teachable Macihne feature analysis	Human description of fossils compared to Google's Teachable Machine	Illustrate and label fossil teeth; Google's Teachable Machine model outputs	SC.6.N.1.3: Experiment and other types of scientific investigation, benefits and limitations of each SC.7.L.15.1: Fossil evidence & theory of evolution	MS-ETS1-2: Evaluate competing designs using systematic process to determine how well they meet criteria and problem constraints
Megaladon Evolutionary Adaptations - Identifying fossil types; functional groups	Use of Google's Teachable Machine to discriminate fossil types (species vs. functional groups)	Output data and Google's Teachable Machine models	SC.7.L.15.2: Theory of evolution by natural selection SC.68.CS-CP.1.2: Use of data-collection technology, view, organize, analyze, and report results	MS-LS4-2: Construct explanation for anatomical similarities and differences between modern and fossil organisms to infer evolution
Darwin's Lament - In-complete fossils; limits to machine learning with fragmented fossils	Use of Google's Teachable Machine to sort fossil tooth fragments; discussing limits to its accursacy	Output data and Google's Teachable Machine models	SC.7.N.3.2: Identify the benefits and limitations of the use of scientific models	MS-ETS1-3: Analyze and interpret data to determine similarities and differences in findings
Misconceptions - Megaladon Extinction; Career role models	Big datat 101 submit queries to determine extention geography	Downloaded .csv files, world map of species distributioanl outputs	SC.7.N.1.7: Scientific knowledge is the result of a great deal of debate and confirmation within the science community	MS-LS4-1: Analyze and interpret data for patterns that document diversity, extinctino, and change of life forms on Earth; natural laws operate today as in the past

ML models are capable of quantitatively classifying scientific data, but their predictive power is constrained by human inputs. Through their engagement with our curriculum, 6th and 7th-grade students will understand what AI is and what it is not, how ML models are developed to enact AI and the inherent limitations of applying ML to authentic paleontological datasets.

B. Integration of AI Concepts in Each Lesson

Within the five proposed lessons outlined in Fig. 1, students will conceptualize and implement an ML model that distinguishes fossil shark teeth by their primary function to recognize ecological and evolutionary patterns. During lesson 1, students are completing the first two stages of ML development: *data collection and preparation* [8]. Given a sample of fossil shark teeth, students will sort them into different categories. After discussing sorting strategies, we will determine that sorting teeth by functional groups is most meaningful for interpreting ecological roles and how this process relates to authentic paleontological research.

During lesson 2, students will *choose and train the appropriate model* based on the options provided by Teachable Machine (TensorFlow neural net model using 2D images). With their dataset sorted into categories, they will train an ML model to assign fossil shark teeth to different functional groups (e.g., grasping, cutting, or crushing). Students will evaluate the model by recognizing input limitations that may bias our results, such as sample size, number of defined categories, or extraneous information in the sample (e.g., type of background in the photograph), and deduce the implications for training more effective ML models. Students will also hypothesize what influences classification accuracy in AI and experiment with training a model based on different numbers of epochs (training iterations). Students will examine and interpret data on accuracy per epoch and compute and discuss accuracy per class (e.g., grasping vs. cutting) discussing why the accuracy classification results may be different.

During lesson 3, students will *evaluate this model* using a second sample of fossil teeth that represent species within the charismatic megatooth shark lineage. This evolutionary progression depicts a gradual transition from grasping-type teeth to cutting-type teeth. Using this new sample, participants will test how well their model predicts tooth function in the megatooth lineage. An accurate model should place early ancestors (i.e., *Otodus obliquus*) in the grasping-type category, intermediate species should fall somewhere between grasping and cutting, and the final species (*Otodus megalodon*) should be assigned to the cutting-type category. Thus, the model is quantitatively illustrating the evolutionary progression from grasping-type teeth to cutting-type teeth. We will then discuss why this transition occurred, which relates to the evolution of a new prey source for these sharks (i.e., marine mammals).

During lesson 4, we will *test the model* with a sample of poorly preserved fossils. This activity will serve as a teachable moment regarding limitations in our ML model that paleontologists are faced with frequently, i.e., broken, or incomplete fossils. Students will learn how fossil preservation can also impact the reliability of our sample. This will set up a more in-depth discussion on the output limitations of ML (e.g., the model cannot always perceive what is missing, the model cannot define new categories, and the model cannot interpret the meaning of the results). Students will understand that ML models are a tool created and used by humans, but they cannot replace humans, nor can they reason like humans.

The final lesson will give participants an opportunity to *conceive their own ML model*. Students will define a problem, determine the necessary input data and the most appropriate type of ML model (i.e., 2D images, audio files, or video files), and identify potential limitations. This activity will also serve as an authentic, project-based summative assessment to evaluate students' conceptions of ML and AI.

C. Participants

The project was designed to support 6th and 7th-grade science teachers from Title I schools with a high percentage of students from historically underrepresented groups in STEM+C. Recruitment was announced in the SEFS newsletter, through internal correspondence in participating school districts, at the annual Florida Association of Science Teachers conference, and disseminated via our social media and existing SEFS teacher learning network (~1,000 participants). Participants were selected based on a rubric intended to broaden the representation of geography (throughout Florida), teacher demographics, kind of school (urban, rural), length of years in service, the content domain of STEM+C taught, and their written statement about why they want to participate and how it will impact their students' learning.

To date, two cohorts have been identified, with the first cohort completing their year-long engagement with our program in June 2023. This paper discusses the engagement with Cohort 1, which initially consisted of 13 participants representing 9 counties in the state of Florida.

D. Design-Based Approach

The design-based research (DBR) approach was chosen to investigate the use and effects of our curriculum in middle school classrooms [10]. DBR is an evidence-based methodology for the design and development of educational projects as it can help improve practice through iteration. This includes the analysis, design, development, and implementation as researchers and practitioners are invited to collaborate in real-world settings to develop context-specific solutions [11]. For the first year, there were two key research questions we sought to address, presented in Table 1 with the methods and expected outcomes of the work.

TABLE I

Project Year 1 - Key Research Questions, Methods, and Outcomes

Research Question	Methods	Outcomes
a) How can we leverage students' and teachers' conceptions of AI in science to design an effective AI in paleontology curriculum?	a) Interviews, focus groups, (Mis)conceptions of AI survey	a) Data on participants' conceptions on AI in science and insights to inform curriculum design
b) What components constitute an effective integrated STEM activity aligned with NGSS	b) NGSS EQuIP rubric, focus groups, peer reviews by teachers	b) Curriculum design guide

The following section discusses how the researchers leveraged their domain-specific expertise to contribute to the development of each lesson plan.

III. Instructional Design

The project was awarded in April of 2022, and the first cohort was recruited to participate in our first summer PD in July of the same year. With this tight turnaround, we spent two months collaboratively working toward the development of our PD curriculum. The authors, graduate students, and SEFS key personnel contributed to the content. Shark AI project personnel were selected as leaders for each lesson plan activity based on their experience and interest. These leaders held weekly or bi-weekly meetings to update content. Monthly meetings provided a space for each leader to provide an update on the content creation and discuss ideas for cross-collaboration. Relevant information, including references, images, website links, other resources, etc. were compiled within a shared Google Drive folder for the project to allow for asynchronous contribution.

A. Lesson Content Preparation

A template was developed by adapting the 5E Model, which is presented in Fig.2. This empty template includes descriptors of each of the 5Es to allow teachers to make adaptations to the content using the same method we used for development. Through this standardized structure, contributors were able to maintain consistency in the presentation of the materials and for dissemination purposes. This also gave the teachers a consistent reference point for content. Teachers were provided with digital and physical copies to write notes and make changes in real time during the summer PD.

As mentioned, the Shark AI project staff includes SEFS personnel who are also former K-12 teachers. Their major contribution to the curriculum design included identifying state and national standards that aligned with each of the lesson plans. These standards were organized by grade, discipline (e.g., computer science, or general science), as well as by type of standard (e.g., Florida State standards [CPALMS] or NGSS equivalencies). Their input was also critical to understanding the needs and constraints of teaching at the middle school level in an under-resourced environment. Though many considerations were involved in the proposal submission stage, the real-world integration of this work was still a novel concept.

Our intention was to create content that could be easily adapted by teachers after they were introduced to the curriculum for their use. This meant that the lesson plans would need to fit within a standard period, a block period (for intensive courses), or two successive normal class periods for a middle school class. Designing with a standard bell schedule in mind meant that on average we would have 40-60 minutes of instructional time per standard period. However, some of our proposed activities would span longer than a typical class, stretching a single lesson to more than one day.

The content began with foundational information necessary to understand fossils and fundamental ML concepts and built skills to allow students the ability to conceive of their own ML model. Initial test datasets of shark tooth images that were pre-aggregated from the Florida Museum, Calvert Marine Museum, and myFOSSIL. The following “Big ideas” were developed for each lesson plan:

1. Based on their shape, paleontologists classify fossils into different taxonomic groups and interpret their functional ecology.

2. Collecting and preparing input data is an essential step before creating a machine learning (ML) model.

3. Input training data can be manipulated to answer different research questions and/or improve a model’s accuracy. There are many different ML tools that are available, two are reviewed and compared here, i.e., Google’s Teachable Machine and Roboflow.

4. Machine learning models and algorithms are biased and limited by the input data used to train the model.

At the end of the development of the lesson plan content, the SEFS personnel on the project felt that much of the content was too technical and comprehensive for the teachers as it was written. In support of this information, we also developed a glossary of the terminology used in the lessons prior to its release. This was also helpful to ensure that we were all on the same page with defining concepts that were present in each lesson.

Figure 2. Shark AI Lesson Plan Template

The SHARK AI Project
Workshop Cohort 1 July 2022
Lesson #X. Lesson Title

Created by: ITEST Cohort 1 Teacher participants; **Lead facilitator**:

Date:

Subject area / course / grade level: General Science, grades 6 and 7

Context:

Notes:

Lesson plan title:

"Big Idea" (one sentence):

Overall learning goals and objectives:

Intended prerequisite:

Activity synopsis (What will the learner do?):

Materials and resources:

Florida State Standards (CPALMS):

NGSS equivalencies:

Amount of time anticipated for this lesson:

Other/Interdisciplinary Learning objectives (if applicable):

Differentiation strategies to meet diverse learner needs:

1. Engagement (xx minutes)

Describe how the teacher will capture students' interest. What kind of questions should the student ask themselves after the engagement?

2. Exploration (xx minutes)

Describe what hands-on activities students will be doing.
List "big idea" conceptual questions the teacher will use to encourage and/or focus students' exploration.

3. Explanation (xx minutes)

Student explanations should precede introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students connect their exploration to the concept under examination?

List higher order thinking questions which learners will use to solicit student explanations and help them to justify their explanations:

4. Elaboration (xx minutes)

Describe how students will develop a more sophisticated understanding of the concept. What vocabulary will be introduced and how will it connect to students' observations? How is this knowledge applied in our daily lives?

5. Evaluation (xx minutes)

How will students demonstrate that they have achieved the lesson objective?

This should be embedded throughout the lesson (formative) as well as at the end of the lesson (summative).

Formative Assessment

Summative Questions

Lesson Plan Extensions, or other related activities or connections (optional)

Resources

Reflection

What worked and what didn't? For what didn't work, is there anything you would do differently?

B. Instructional Tools and Activities

Fossil Shark Teeth

A set of 16 fossil shark teeth were provided to the teachers, along with a guide sheet as a point of reference. The guide sheet is double-sided and includes shark tooth functions and shark tooth taxonomy. On the functions guide, participants are provided visuals of each tooth, a written description of its structure, and the diet of the shark it came from. While, on the taxonomy guide, common name, order, family, genus, and species descriptors are beneath images of each tooth.

Seek by iNaturalist

Seek is a nature-focused application that allows the user to identify plants and animals around them. It began as a project out of UC Berkeley's School of Information in 2008 and grew through the support of the California Academy of Sciences and the National Geographic Society [12]. Users contribute crowdsourced species identification and organism occurrence information, by leveraging a robust computer vision model.

myFOSSIL

MyFOSSIL is an online social network consisting of almost 18 thousand members, that is free, easy to use, and teacher-friendly. It is accessible through a website and mobile application and includes open and private one-on-one discussion spaces, a project forum, and includes a repository for resources and implementation stories. It also has a project calendar and event notifications. MyFOSSIL is widely used by K-12 educators across the United States (US). We invited teacher participants to join the project prior to their arrival at the summer PD for it to serve as a space to be used for an online community of practice [13]. We also envision that the myFOSSIL eMuseum could be used as a platform to upload fossil images that then could be used to train machine learning models.

Roboflow and Google's Teachable Machine

To encourage the development of models in the classroom, two different software systems were employed. Both systems can be seen as "software-as-a-service" products that allow users to build their own machine learning model. They can be easily accessed via the web and have free versions for public use. Neither requires coding skills for use.

C. Summer PD Structure

The summer intensive PD is integral to the success of our program. As we develop, implement, and iteratively improve our curriculum, we receive critical feedback to improve the experience for teachers and students alike. The PD consists of the following activities:

- Pretest of teacher's perceptions of integrated STEM+C and AI in K-12 education,
- Paleontology: introductions to paleontology as a multidisciplinary science for teaching STEM+C in middle school,
- Technology and engineering: introductions to hands-on activities with AI technology for building, testing, and using ML models for science,
- Pedagogy: The benefits of socio-scientific reasoning and project-based learning in integrated STEM+C education,
- Deconstruction of each lesson plan and discussion of the integration of STEM+C and alignment with NGSS and Florida state standards,
- Brainstorming lessons and activity ideas,
- Presentation and discussion of activity ideas (instructional design, standards alignment, feasibility, etc.),

- Tours of UF facilities, including labs in engineering and the natural area teaching lab, museum exhibits, and more,
- Speakers including industry professionals, faculty, students, and staff,
- Post-test of integrated STEM+C and AI in science education conceptions,
- Discussion of the project expectations for teacher participants and sustained PD over the course of the school year,
- Optional (but encouraged) cohort-building social activities,
- Focus group assessments and PD evaluation.

Evaluation

In addition to internal surveys developed by the project team, our project has engaged the services of Brad Davey, Principal of Technology for Learning Consortium, Inc. Dr. Davey attends the summer PDs, monthly Shark AI team meetings and will conduct formative and summative evaluations using mixed-methods surveys and focus group interviews. All of our evaluation tools, procedures, and protocols are approved by the University of Florida Institutional Review Board.

IV. Discussion

This project began as the world began navigating a return to in-person modalities. For the first cohort of the PD, we received fewer applicants than expected, but enough to invite more prospective participants than the 15 we originally designed the program to support. Though we invited 20 participants, only 13 ended up attending the summer PD. We are awaiting the completion of year 1 to report final data related to their full experience.

During the summer PD, the execution of the lesson plans did not proceed as originally envisioned. Teachers had challenges with using technology we assumed they would have no issues with. For example, one teacher had difficulty logging into their Google account to access our shared folder on Google Drive. Others had issues with data entry using Microsoft Excel. Student facilitators worked one-on-one with the teachers to help them get up to speed. Once ideas related to the ML models were introduced, more technology-related challenges emerged. Additional time was allocated to review data preparation and the use of Roboflow and Google's Teachable Machine. A longer 5th lesson plan design focused on how to "conceive your own ML" lesson plan was reduced to accommodate this need.

Recognizing the teachers were unable to engage with the fully developed curriculum during the PD was of great concern to our team. Despite reiterating that the lessons were customizable, teachers consistently communicated that felt our expectation was for them to implement everything., even during the implementation stages. There were also challenges with receiving timely feedback from teachers once they returned home from their PD. Recorded group Zoom sessions provided an avenue to provide teachers with the content we presented as a team and maintain a cohort atmosphere. During these sessions, as well as email communications, we learned how the in-classroom integrations occurred. This also provided insight into real-world scenarios the teachers faced during class. Some teachers had interruptions in their class period. For example, one teacher had lunch scheduled at the end of one of her class sessions. When students returned, they only had 10 minutes to wrap up the session. Others were presented with new teaching assignments at the beginning of the term that required them to navigate unprecedented changes.

At the end of the PD, the teachers described a sense of community while participating in the project, which was brought to light during focus group interviews. However, they did not engage with the myFOSSIL community of practice. The teachers developed their own communication channels, opting to use a text message group to stay up to date with each other, without our oversight. This meant we were not able to provide feedback like we anticipated doing via myFOSSIL. But it was a welcome change to the project, as it showed our efforts to develop meaningful relationships among our participants worked.

However, it was still imperative for us to remain in contact with our teacher participants over the course of the academic year to ensure they followed the structure of the project, including adapting the curriculum for use in their classroom and conducting pre- and post-assessments for themselves and their students. While the assessments were not described in this work, some teachers expressed that the number of assessments was difficult to implement. This is of concern because we did not intend to over-assess the students or the teachers. Future work will explore the response rates of these assessments to determine the feasibility of obtaining rigorous data from the project.

V. Future Work

Complete data from the first cohort is being analyzed and will be used to update the existing curricula ahead of the second teacher cohort's summer PD. Beyond the curriculum design, several other research questions will be pursued related to the goals of the project. These questions are presented in Table II.

TABLE II

Project Years 2 & 3 - Key Research Questions, Methods, and Outcomes

Research Question	Methods	Outcomes
Y2. How is the Shark AI approach perceived and used by teachers, students, and staff and what scaffolds are needed?	a) Comparative case study analyses; observations, interviews, and focus groups with teachers, students, curriculum, and support staff	a) Feasibility data with implications for improving implementation, Shark AI Implementation Guide
Y3. How does the Shark AI curriculum impact the development of interest and identity in STEM+C and the practice of scientific processes?	a) Interviews; mixed linear modeling using student interest in technology and science scale and science process skills inventory	a) Data and insights on the evolution of student STEM+C identify development, career interests, and practice of scientific processes

These questions are being explored using a multi-methods approach, including validated instruments already used in education and engineering education research to assess socio-emotional and cognitive outcomes. Additional work includes the investigation of epistemic insights gained by participants regarding implanting AI in the K-12 environment.

VI. Acknowledgment and Disclaimer

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