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“Teacher Perspectives on HTTYR”
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AI education efforts must engage K-12 classrooms at public schools to make AI knowledge available to the common public.

Children are growing up surrounded by AI – toys and other devices, chatbots and voice personal assistants, web services and social media. AI will continue to play a large role in their future.

A lack of skills in emerging technologies could limit a person's ability to actively participate as a citizen and compete for the highest paying jobs.

AI skills gap exists and is widening.

Important that AI skills are democratized. Today we’re going to talk about how we scaled
an AI curriculum by training teachers to deploy a middle school curriculum. The big question we explore is: how do we make AI approachable and engaging to non-experts
Published studies on AI curricula in K-12 classrooms date back to at least 2010. The past 3 years have exploded.

Prior work:
1. How to define and recognize AI
2. Computers learn from data
3. AI algorithms embodied in autonomous robots
4. AI impacts society in both positive and negative ways
Curriculum Overview
httyr.media.mit.edu

Hands-on, technical and ethical activities

Low-cost, low-floor hardware and software platforms

Middle school teacher training and materials

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Five Days / 30 Hours of Project-Based Curriculum
Designed for students ages 11-15

In designing the curriculum, we prioritized hands-on activities, accommodating novice teachers and students, real-world relevance, and cost-effectiveness.

• We did not require or expect students or teachers to have any prior programming or computer science experience
• Balancing unplugged and plugged activities allowed students to exercise and develop their critical thinking as well as computational thinking skills
Key Activity Overview

Students dive into technical and ethical ideas then apply their knowledge to a problem of social import.

These are some of the key activities of the curriculum:

- The key technical ideas were identifying AI, robotics (sensors and actuators), neural networks (image classification), K Nearest Neighbors (text classification), and the creation of AI projects.
- Ethical concepts were embedded and they included stakeholder identification and analysis as well as biases present in neural networks and K Nearest Neighbors.
- The majority of the final days was dedicated to the projects, students had freedom to choose how to apply their knowledge.
**BACKGROUND**

“It is essential that teachers provide the right impetus in the classroom for the transformational role of impactful technologies such as AI…”

Vazhayil et al., 2019

AI education efforts must target K-12 classrooms at public schools, this means learning about how to work with in-service teachers.

Teachers

- Vazhayil ran a study where they trained 34 secondary school teachers in India
- Used ML4Kids and focused on project-based teaching
- Found that teachers were eager to begin using the tools
- Found that teachers were concerned about knowing enough to run a plugged, exploratory, project-based course
Teacher Training

**Educator Guide.** Lessons support different learning paths connect concepts to real-world

**Teacher Training.** Professional development prepares teachers for discussions and AI programming activities.

We provided teachers with curriculum materials (educator guide, slide deck, student worksheet materials, programming guides)
• Written by AI experts and a middle school teacher
• Employed the universal design for learning framework, variations of activities connect the subject matter to their students' strengths and interests
Provided teachers with synchronous training sessions
• PD sessions were ~8 hours long for a weeklong session
• And PBL support: modelling the classroom and having teachers complete a short iteration of the programming activities
• Focused on content knowledge: trickier material (What is AI?) and hardware troubleshooting
We ran this workshop twice. Once in 2019 with 7 teachers (3 participants) and 90 students in classrooms for a week.

Then we revised the materials and ran it again in 2020 with 7 teachers and 42 students, this was online for a week during the summer.
## Curriculum Iterations

<table>
<thead>
<tr>
<th></th>
<th>Aligning with Standards and Students</th>
<th>We redesigned activities to suit students with different strengths and interests. We adjusted activities to better align with national reading, writing, and CS standards.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Simplified Technology</td>
<td>Made technology simpler to setup and maintain. Removed software downloads, API accounts, and changed robots.</td>
</tr>
<tr>
<td>3</td>
<td>Accelerated ML Creation</td>
<td>Changed to machine learning platforms to make it quicker to create and iterate on models.</td>
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</tbody>
</table>

- Made the curriculum more clearly align with middle school reading, writing, and CS standards
- Gave teachers more options to approach activities for students with different interests and strengths.
- Faster to train unlimited ML models (ML4Kids -> TM)
- No software downloads and further simplified the setup procedure (esp. for robot), Replaced the hand-built Arduino robots with more reliable, commercial robots.
# Effectiveness and Engagingness of Activities

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<tr>
<td><strong>Overall Engagement</strong></td>
<td>Students deeply engaged with the ideas in AI and were excited by the activities</td>
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<tr>
<td><strong>Projects &amp; Programming</strong></td>
<td>Teachers observed that the programming activities were particularly engaging for students. Projects allowed them to connect their personal values to AI knowledge</td>
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<tr>
<td><strong>Embedding Ethics</strong></td>
<td>Teachers were excited about the way ethical content was embedded in the lessons; it was a great model for future lessons</td>
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- Students were engaged, even went above and beyond
- Programming was particularly engaging, students had the opportunity to engage in all parts of the AI development process “wheels to their ideas”
- Projects gave students a meaningful way to connect their knowledge to their values
- The “perfect mix” of ethical and technical content was a model teachers hoped to further use and explore in other subjects
Technology Use and Integration

1. Robots: The Good, The Bad
   Robots were both the object of students’ engagement and frustration.

2. Extending Block-Based Programming
   Teachers enjoyed using block-based programming to extend AI platforms and enjoyed being able to explore AI with Scratch, a familiar programming tool.

• The robots were a huge point of engagement, they also caused the most frustration and confusion for both students and teachers.
• The AI extensions to Scratch were seen as a huge benefit. Teachers who had used TM said this gave them the next step, a way to continue using the tools. For teachers who had used Scratch before, they were excited about the new kinds of technologies their students could explore with this very familiar, accessible programming platform.
• Using tools that some students were familiar with made it easy to pick up the new material. In the online class in particular, we had to leverage more tools. We used
slides (ethical matrices), spreadsheets (decision trees), and accessible math (2d graphs for word vectors)
### Supporting Students

<table>
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<tr>
<th>1</th>
<th>Supporting Learners Online</th>
<th>A wide-range of strategies, like dedicated breakout rooms and asynchronous forums, helped students get unstuck</th>
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<tbody>
<tr>
<td>2</td>
<td>Experts Adjusting to Teachers Adjusting to Students</td>
<td>AI experts and teachers constantly conversed about class content. Teachers supported students’ understanding in diverse ways</td>
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<tr>
<td>3</td>
<td>Conversations About Inclusion</td>
<td>Teachers supported students in developing skills and a STEM identity as they progressed through the course</td>
</tr>
</tbody>
</table>

- Finding ways to support students when they get stuck, especially in a virtual classroom
- There continues to be a tension with working with students with a wide range of needs
- Teachers adjusted the curriculum to what they knew about their students strengths and interests - ongoing partnership between AI experts and teachers
- Supporting students from underrepresented backgrounds by intentionally supporting the development of a STEM identity
**Key Takeaways**

Hands-on technical and ethical activities effectively explained and hooked students in AI.

Technology is an important tool for this work, but it does come with its limitations and difficulties.

AI experts partnering with classroom experts in the development and delivery of courses will facilitate broader adoption of curricula.

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• Implications not just for future K-12 AI curricula, but for non-expert retraining courses. Teachers were excited to take the course into their classrooms. Currently running that study!

• Thinking about the cost of robots, Further technology changes like creating an offline, mobile version.

• Biggest takeaway: think carefully about how we partner with others to design AI curricula that reaches “all”. Connecting ideas to art and future careers.
Thank You!
I2 Learning
Our student and teacher participants from
Georgia, Massachusetts, New Jersey, New York,
Ohio, and Texas
MIT Personal Robots Group Graduate Students
and Undergraduate Researchers
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Schools
MIT PRG and undergrads
Sponsors
All of you!
Teacher Perspectives on How to Train Your Robot

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