

# **Robot-Assisted Learning and Teaching for Whole Child: An Exploration of Early Learning in Urban Communities Fall 2022 - Spring 2025**

**PI: Lujie Karen Chen**

## **Final Report**

### **Phase 1 - Fall 2022 - Spring 2023**

#### **Main Task Completed**

- In Year 1 of the project, seven ABii robots were used in two BPCSS schools: Arundel Elementary and Lakeland Elementary and Middle School.
- In Arundel Elementary School, one Kindergarten classroom (Ms. Williams) and one 1st grader class (Ms. Eustace) participated. In Lakeland Elementary and Middle School, one dual language classroom (Ms. DeSander) and one Special Education classroom (Ms. Chester) participated.
- In the Fall of 2022, the project adopted a “soft launch” approach with Arundel Elementary School. The research team administered the robot lessons during the personalized learning blocks in a separate classroom. About 25 students from Kindergarten and 1st graders participated in this phase of studies. We collected observational data, students’ system logs, and interview data during this phase. We identified students’ engagement patterns and, where applicable, challenges of independent learning with robots. We trained the teachers to use robots in their classrooms in early Spring 2023.
- In Spring 2023, two classrooms in Arundel deployed 4 robots (2 robots each) in their classrooms. Each teacher decided on the robots' lesson schedules and subjects. The research team and the Van Robotics team continued to support teachers throughout this period. Lakeland teachers Ms. DeSanders and Ms. Megan also joined the pilots. They could use the robots with minimal guidance from the research team.

#### **Main Findings**

- Overall, we noted the robots were well-received by teachers and students. The preliminary data from the intensive data collection in Fall 2022 showed that students could sustain engagement with robots over an extended period. Qualitative data from students indicate that they welcomed the personalized features of the robot and its ability to encourage students, even when they made mistakes on the problem.
- Teachers motivated to use a robot appreciate that ABii brings alternative educational technology to the classroom that can potentially engage students and, in some cases, supplement teaching by previewing or reviewing lessons.

- We also identified a few challenges in using robots, for example, in the Kindergarten classrooms at Arundel. The location of the robots in the classroom has a poor Wi-Fi connection, which causes the robots to break down a few times, requiring the support of the research team and the Van Robotics team. We also noticed that some students found robot lesson challenges, particularly those below grade level and those with attention issues (more in Kindergarten classrooms). Some ESL students in the first-grade classroom have challenges with “ABii’s accent,” i.e. obstacles in understanding ABii’s English.

## Phase 2 - Fall 2023 - Spring 2025

### Main Tasks Completed

- The 2nd phase of the study involved recruiting teachers to create custom lessons using the Lesson Creation Tools from Van Robotics, and pilot the lessons with respective classrooms. We recruited two teachers Ms. Williams from Arundel Elementary (a returning teacher) and Ms. Chester from Lakeland Elementary/Middle student (in special education classroom).
- In Summer 2024, we engaged two teachers and collaborated with three undergraduate students: **Joy Ware**, an African American INDS student specializing in education technology; **Camila Chombo Sam**, a COEIT/CSEE student from a Latino background; and **Ellen Jagne**, an African American IS student. The team met with teachers regularly to understand classroom contexts and requirements for custom lesson designs. The team identified a few focuses for pilot lesson creations.
- Once the school year began in Fall 2024, Joy and the PI visited the school to gather specific student information, such as ethnic background and hobbies, which informed the development of customized lessons. Using large language models (LLMs), we explored the generation of culturally adaptive lessons tailored to students’ identities and interests.
- These lessons were piloted with UMBC students in Spring 2025 as part of Joy’s undergraduate thesis research. In parallel, we also conducted initial tests of the lessons with children at the school and collected their feedback to refine the approach.

### Main findings

This study investigated UMBC students’ reactions to LLM-generated second-grade lesson plans that were adapted to include cultural content. Two guiding research questions framed the work: What are UMBC students’ reactions to the cultural relevance of the lessons, and how engaged are students when exposed to culture-based LLM content? A total of 114 students responded to the survey, providing insights into both cultural alignment and perceived engagement of those lessons.

- When examining students’ perceptions of cultural representation of the lessons, important differences emerged across ethnic groups. Among those who felt the lessons represented their culture well, the majority were students of color, accounting for 72% of this group. Specifically, 44% were Black, 22% were Asian, and 6% were Hispanic/Latino. By contrast, among students who felt the lessons **did not represent** their culture well, almost half (47%) identified as White. This distribution was not unexpected, given that the lessons were adapted primarily to reflect

minority cultures. Within this group, 22% were Asian, a small proportion were Hispanic/Latino, and notably, no Black students reported that their culture was not represented. These results suggest especially strong positive responses among Black students, who consistently found the lessons to be culturally aligned, while Asian students showed more mixed reactions. Indeed, 78% of Asian students felt the lessons reflected their culture, while 22% did not.

- Looking at overall cultural relevance ratings, the findings were generally positive. A majority of students (62%) rated the lessons a 4 or 5 for cultural relevance, while only a very small minority (2.6%) gave a rating of 1, indicating poor cultural alignment. This distribution points to broad acceptance of culturally adapted content generated by LLMs.
- The study also explored the relationship between students' perceptions of cultural relevance and their level of engagement. The Pearson correlation coefficient between these two measures was .74, indicating a relatively strong positive association. Among students who rated cultural relevance highly (4 or 5), 93% also rated the lessons as highly engaging. By contrast, students who did not perceive cultural relevance (ratings of 1 or 2) were less consistent: 27% considered the lessons not engaging, six students rated them moderately engaging, and three still rated them as highly engaging. These patterns suggest that while cultural alignment is a strong predictor of engagement, it is not the sole factor. Some students may be drawn in by other elements, such as the novelty of LLM-generated materials or the instructional design of the lessons themselves.

Taken together, these results provide encouraging evidence that integrating culturally diverse representation into educational technology can enhance student engagement and leave positive impressions. At the same time, the findings highlight the complexity of engagement and point to the need for further research to clarify the unique contributions of cultural relevance relative to other drivers of student involvement.

## Summary of Project Outcomes

- The findings from Fall 2022 were presented at the Robot 4 Learning workshop at the Human-Robot Interaction Conference in March 2023 and the Sherman Research Conference in June 2023.
- The final mixed-method analysis of data collected in Phase 1 (Fall 2022 and Spring 2023) was documented in a journal paper submitted to the Education and Information Technologies Journal, currently under review.
- The Phase 2 results were documented in Joy Ware's INDS thesis project report.
- In June 2025, we submitted a proposal building upon those pilots.

## Attachment

1. Chen L.K., Shah P,\* Prabhu K\*, Daughrity L, Shetty S\*, Lopez Delgado M\*, Hamidi F, Godwin K, Lipsmeyer L. ABii at School: Some Initial Findings from a Long-term In-school Field Study with a Commercial Robot-assisted Learning System. March 2023, The ACM/IEEE International Conference on Human-Robot Interaction (HRI) 2023, Robot for Learning Workshop.

2. Chen L.K., Daughrity L, Sakowicz M\*, Hamidi F, Godwin K, Lipsmeyer L, ABii at School: Findings from a Long-Term In-School Field Study with a Commercial Robot-Assisted Learning System, *Education and Information Technologies* (under review).
3. Ware J, The Impact of Representation in Educational Technology: Insights from Exhibitionist Research Study, UMBC INDS Undergraduate Thesis Report.