Roversa Robotics

Case Study: Integrating Computer Science through Robotics in K-5 Education

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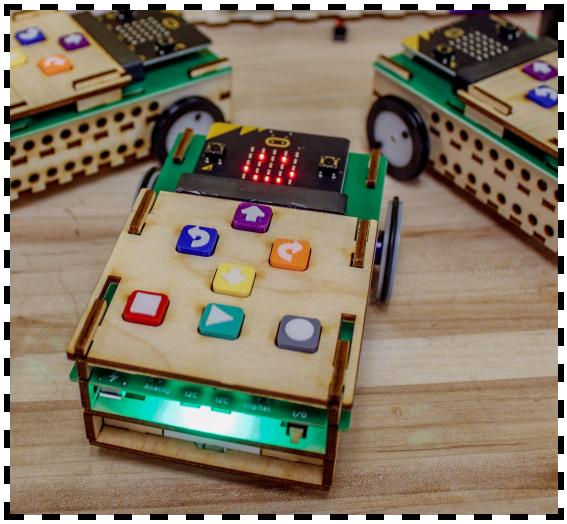
Introduction

Educational robots offer a powerful way to develop computer science (CS) skills through hands-on, interactive learning experiences. However, many of the robotic platforms currently available for elementary classrooms are expensive (e.g., over $100 per device) and often lack the flexibility needed to adapt to a wide range of educational needs. The Roversa Robotics platform was developed to address these issues by creating a low-barrier, adaptable, and multilingual robotics platform.



This case study examines a pilot program in a Southwest Virginia school district, where two elementary schools integrated Roversa robotics into their math and English curricula. Thirteen teachers, most of whom had never taught a CS-infused lesson before, collaborated with the Roversa Robotics team to create high-quality, open-source lessons. This pilot was made possible by an Advancing Computer Science Education grant from the Virginia Department of Education.

Project Timeline

July

- The Roversa team partnered with the district's Instructional Technology Resource Teacher (ITRT) to recruit teachers for the project.

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August

- The Roversa team developed pre- and post-surveys to measure teacher self-efficacy in CS and robotics.
- The ITRT distributed the pre-survey and collected curriculum standards that teachers wanted to integrate with robotics.

September

- The first professional development (PD) session introduced teachers to Roversa and provided debugging and troubleshooting strategies. Teachers participated in robotics activities from a student perspective and received a robot to take home for practice.
- Collaboration between the Roversa team and ITRT helped identify integration opportunities based on curriculum standards.
- A second PD session was held, where teachers tested the initial lesson plans and provided valuable feedback to refine activities for their students.

October

- Robots were delivered, integration lessons were finalized, and custom accessories were developed.
- The ITRT created a cart for the robots with craft supplies, mats, and other curricular materials.
- The ITRT worked with 5th-grade after-school CS clubs, preparing the older students to support teachers as near-peer mentors during their robotics lessons.
- Teachers began implementing their integrated robotics lessons in the classroom.

November

- Teachers completed lesson implementations and the post-survey.
- An online debriefing session provided insights into teacher experiences and program effectiveness.

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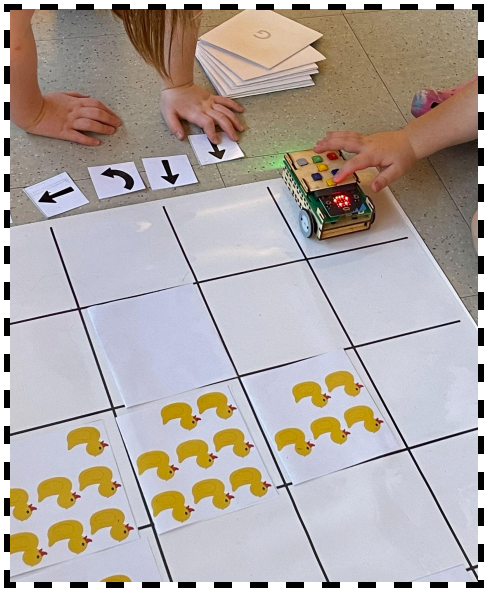
Outcomes

Teacher Growth

- Pre-survey results showed that seven teachers had no prior experience with robotics, while five had limited exposure.
- Post-survey results indicated increased confidence in teaching CS and integrating robotics into their lessons.
- Teacher feedback reinforced the program's success:
    - *"The possibilities are endless."*
    - *"This is very easy to grab and adapt to whatever lesson."*



Student Engagement

Teachers reported high levels of student engagement:

- *"They were fully engaged for the full 45 minutes. It was amazing because usually their attention span is so fleeting."*
- *"The kids thoroughly enjoyed it and liked the challenge."*
- *"It was hopping and moving, they were excited, and it was loud, but they were all engaged."*
- *"I was really surprised how fast the kids caught on."*

Obstacles and Lessons Learned

Technical Challenges

Testing the robot prototypes with students revealed a couple of issues we wanted to address. One was that the right and left buttons were confusing, especially for younger students. We had originally color-coded them, but the ITRT requested adding arrows. We added arrows as raised symbols for tactile accessibility.

Another issue was with servo motor performance affecting movement precision. Hobby servo motors, while cost-effective, exhibited inconsistent RPM values. To address this, the

team developed a process to test and pair motors for improved accuracy. Future improvements will explore hardware and software solutions, such as integrating feedback from a 9-axis IMU, to enhance movement precision. Additional efforts will focus on optimizing low-cost components, including chassis materials, sensors, and programming software.

Curriculum Development

The pilot underscored the importance of co-designing lessons with teachers. Their insights ensured lessons were engaging, practical, and included self-checking mechanisms that allowed students to assess their own work. This approach increased student autonomy and reduced teacher workload during robotics activities.

Conclusion

The pilot program demonstrated the feasibility of integrating robotics into elementary education while supporting teachers in teaching CS and core subject standards. Teachers gained confidence incorporating CS concepts, and students responded with high engagement and enthusiasm. The lessons learned from this pilot will inform future iterations of Roversa, ensuring continued improvements in accessibility, functionality, and instructional design.

Moving forward, the Roversa team aims to refine both the robotics platform and supporting materials based on teacher and student feedback. Additional research will focus on enhancing hardware reliability and expanding lesson offerings to include more subject areas. By prioritizing affordability, adaptability, and inclusivity, Roversa has the potential to transform K-5 CS education on a broader scale.

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Appendix: CS Integration Lessons

Grade	# of teachers	Title	VA Standards of Learning
K	2	Robot Counting Challenges	Math: K.NS.1, K.CE.1 CS: K.AP.2
1st	2		Math: 1.NS.1, 1.CE.1 CS: 1.AP.2
2nd	4	Guess and Compare Game	Math: 2.NS.2 CS: 2.CSY.1
3rd	1	Robotic Book Report	ELA: 3.RL.1 CS: 3.AP.1, 3.AP.1.d
4th	1	Robotic Function Machine	Math: 4.PFA.1 CS: 4.AP.2
5th	1	Robotic Book Report	ELA: 5.RL.1 CS: 5.AP.1, 5.AP.1.d
	2	Robot Sorting Challenges	Math - 5.NS.1.d. CS - 5.AP.2