The Robot Algebra Project

Robotics as a motivator and integrator for engaging 4th-8th grade students in using and understanding mathematics in technological design

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Competition Studies

What opportunities are there to use math in introductory robot design activities & does the math help?

In competitions, there are a range of strategies, but most teams don’t use math (measurement or proportional reasoning) even though most teams use dead reckoning.

Lots of variability in success of the teams that do use math in their strategies (the two highest-scoring & two lower-scoring teams).

Curriculum Design

What kinds of instruction would help students engage with & learn about integrating math & robots?

Focus on proportional reasoning to understand relations between physical features, program parameters, & movement.

Model-eliciting activity (MEA) of Robot Synchronized Dancing (RSD) – a series of express-test-revise cycles in a design task

Implemented in many different types of classrooms (formal/informal, mixed/all girls, mixed/all minority, elementary/middle).

Learning Experiments

What are more productive ways for students to engage with & learn about integrating math & robots?

Mechanistic (physical quantities/actions) vs. Calculational (numerical values/operations)

What is the difference?

Mechanistic teams more likely to design higher-quality solutions – clearer, valid, fully-specified, and generalized.

Mechanistic teams more likely to transfer strategies from instruction to competition task rather than see them as unrelated.

Calculational Group

S: Not really. No. Cause there isn’t any, like, it isn’t like we are comparing two different robots to do the same thing. All robots are the same in this. We’re not using two different robots to do the same thing. So there really is no need for any strategies like that.

S: Like how far it was from here to here. And then we like said, I think the robot had to do it. And then we said, I’m not sure. How far did the robot go? We don’t know if the robot wanted it to be 26 cm or what.

I: What do you mean by measured the area?

S: We used the strategies that we learned all throughout the week. Uh, we use the circumference of the wheel was 26 cm, so we said one rotation would be 26 cm, two rotations would be 52 cm, three rotations would be 78 cm, and so on. Then we used the line sensor to find the area.

Conclusions

What are more productive ways for students to engage with & learn about integrating math & robots?

Math can be integrated with robots in ways that maintain interest but encourage development of more formal ideas.

We are developing a series of units on understanding the math underlying simple robot movements:

- Measurement
- Proportional Patterns
- Mechanistic Proportional Relationships

We are targeting transfer of understanding proportional reasoning (relative change, covariance, invariance, and adaptive strategy selection) to non-robot contexts.