Student Attitudes Survey for Science Discovery Robotics Class

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Introduction

The East campus of the University of Colorado at Boulder is home to the Science Discovery program. Throughout the year, this program hosts a number of different after-school sessions for students 5-13 years old. Currently, Science Discovery holds two sessions a semester devoted to LEGO Robotics. The class lasts for five weeks and is designed to let students explore building and programming the LEGO NXT robots. The Robotics course had eleven students ages 10-13.

My colleague, Phi Pham, and I were teaching assistants for this class, which had a rather free-form structure. Each week, the students were encouraged to build a robot using the building instructions we gave them and then program it so that it utilizes one of the sensors in an interesting way. After a while, I found that there were many different ways in which students approached the class. It was interesting to see the wide range of student reactions to problems they encountered while building their robots. Sometimes students would give up on a project when they found they didn’t have the exact pieces that the building instructions called for. When a robot didn’t perform the function they expected it to, their attempt to fix the program was often ineffective. As time went by, I started to fear that students were not equipped with the metacognitive skills needed to effectively build and program robots. Due to the relaxed form of the class, I also began to worry that students weren’t learning the science concepts about robotics that we wanted them to take away. For that matter, I didn’t think we had concrete learning goals for the
concepts we wanted them to learn. What was even more frustrating was that I had no way of measuring their understanding.

I came up with the Robotics Attitude Survey (RAS) to get students to think about how they approach building and programming robots. This attitude survey is meant to be given both at the beginning and the end of the 5-week course. At the beginning of the course, we want to see how a student might approach a malfunctioning robot or deal with a lack of building pieces. In addition, we want to know if and how students consider the science of what they’re doing in the classroom. I feel that by developing their metacognitive skills about what they’re doing, students will become better problem solvers. Our lessons will be based around developing these skills as well as recognizing the science involved with building robots.

**Literature Review**

Schoenfeld argues that a difference in success between a novice and an expert isn’t attributed to the difference in knowledge, but to the metacognitive approach experts take to understand what they’re doing and why they’re doing it. Instead of just reading the problem and exploring how to solve it, experts spend more time analyzing the problem, creating a plan for how they’re going to solve it, and verifying that it is the correct answer. In his research, Schoenfeld finds that experts spend a majority of their time “*thinking* rather than *doing*” (Shoendfeld, 194)

In analyzing the metacognition of our students, it’s important to find a way to collect data on their thinking. Specifically, we must find out how students:

- think about their own thought processes,
• keep track of what they do when they solve a problem and use this self-regulation to approach new and unfamiliar problems,
• and bring their beliefs and intuitions into what they’re doing.

One of the best ways to gather data on what students are thinking about their understanding is by using an attitudes survey. Reddish says that using research-based surveys are a great way to get feedback on student knowledge. Specifically, an attitude survey gives us insight into “whether our students are making any progress on our hidden curriculum of learning both process and scientific thinking.”

Survey Description

The first question is a simple, but important one. The assumption is that if these students have chosen to take the Lego Robotics course, it’s because they have some sort of interest in it. The reason it’s in the survey is to document any kind of change that happens in the students’ interest. We want to know if students care less for robots because of the way our course turns it into a science. Our hope is that an increase of understanding of the nature of robotics will be correlated with an increased enthusiasm. There is also a “why” section for this question to document any sort of change in the reason that students enjoy building robots.

The second question is used for tracking the general confidence of the student. It is a question to document how students measure themselves as good engineers. In addition, the following two questions measure their confidence in building and programming by asking them what they do to resolve a problem. It will be interesting to see if the confidence in question two has the expected correlation with the following two
questions or if the students think that being good at robotics involves something else than solving the kinds of problems that arise.

The final question asks them to discuss how building and programming robots is similar to doing science. At the beginning, we expect to see ambiguous and unclear connections to how a student relates the fun they envision having as an act of scientific exploration. But as a product of the lesson plans, we hope to see them make connections between the way they build and program and the evidence-based exploration that scientists use every day.

Data

The data analyzed in this paper are the results from a post-test given at the end of our second session in the fall semester. The survey was given at the beginning of class in conjunction with the overall attitude survey given to all Science Discovery students. Though we were missing a few students on the last day of class, nine students participated in the survey.

Regarding the first question all nine students demonstrated a very high interest in robotics. Their responses explaining why they had such a high interest ranged from “Because it’s fun,” to “Because it’s cool,” (one student confirmed that robotics was both “cool” and “awesome”). These are answers that we expect to be typical for the age group performing the test. These responses demonstrate students are excited about playing with the robots, but cannot fully articulate what it is that interests them. One student, however, claimed: “It is fun to be able to program the robots to do interesting things.” This shows that the interest lies in the ability to use robots to perform specific tasks.
The next three questions did not have any short answer pieces, but here were the outcomes of the student responses:

<table>
<thead>
<tr>
<th>Responses</th>
<th>General Confidence</th>
<th>Building Confidence</th>
<th>Programming Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>1 (11%)</td>
<td>3 (33%)</td>
<td>4 (50%)</td>
</tr>
<tr>
<td>High</td>
<td>7 (78%)</td>
<td>4 (45%)</td>
<td>3 (37%)</td>
</tr>
<tr>
<td>Neutral</td>
<td>0</td>
<td>2 (22%)</td>
<td>1 (13%)</td>
</tr>
<tr>
<td>Low</td>
<td>1 (11%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very Low</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Seeing a majority of students in the High-Very High range surprised me based on the actions of students I saw in the class.

Finally, only two people actually responded to the final question, regarding the connection between science and robotics. One response was that “it includes programming” and the other made the comparison that “in NASA they program robots. That’s why it’s science.” These responses hint at the notion that programming is science, but they say nothing about building and programming with purpose to achieve a certain task or the method with which they approach fixing problems.

Limitations/Revisions

There are many limitations of doing a survey on students’ attitudes toward science. One issue is that students don’t always take it seriously. I found that the free-response parts of the survey were not filled out very thoroughly. This might have something to do with the time I administered the survey, because I believe that students just wanted to get it done so they could go play with the robots. Another problem is that students are sometimes not the best evaluators of their skill level. One student who
answered high on building confidence once gave up on a project because his kit did not have the piece he needed. I can understand the frustration this creates, since the building instructions sometimes have very intentional pieces for the design to work. But the student was not able to improvise or modify the model so that it could still work, contrary to the high building confidence on his survey showed.

**Suggestions for Reform**

Because this is only a post-test for one session, there is no way to make claims about how the course changes the students’ attitudes throughout the five weeks. With this data, we can make claims about what attitudes were at the end, but not at the beginning. After analyzing this data and relating it to how I see the students behave in class, I have determined that students do not have a deep understanding of how they view themselves as confident engineers. In addition, they cannot clearly articulate how robotics is a science. Because of this, I have some suggestions for reforming the class to help develop their self-awareness and metacognition.

When Schoenfeld looks at how an expert mathematician begins to solve a problem, she finds that it is not what he knows that is important, but what he decides to use as tools to find a solution. This is the attitude we want to encourage for the students in the LEGO Robotics course. If we can create problems or challenges for the students every week, they can explore the functions of the pieces they have by completing the challenge instead of arbitrarily playing with the individual sensors. This gives them a more clear purpose for using the sensor.

In addition, I believe it would be helpful to have students do more planning for the tasks they must complete. Students should draw a rough outline of what the robot
needs in order to function in the desired way. Students should discuss questions like “What parts does it need?” and “What would be the best way to build this?” They should also do this with the programming. I try to ask students to “walk me through” what their robot is going to do by describing each component of the code. This eliminates solving programming problems with trial and error.

In addition to reforming the course, I would like to also edit my survey. Because there is a small volume of students, I think it would be beneficial and reasonable to have questions that are free-response and more open ended. I think we will learn more about what students are actually thinking by letting them express themselves without constraints.

**Conclusion**

I believe that with some fundamental changes in the way we approach building and programming robots, we can help students better understand what it is they’re doing. I believe this will encourage students to be more excited about robots and be more involved in the course. I do not see this as a conclusion to my research, but more as the motivation behind the reformation of next semester.
Bibliography:

