Girls, Robotics Learning, and Internalized Stereotypes: Is There a Relationship?

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Abstract: We investigated the incidence of negative attributions of ability as girls participated in a robotics workshop. Video and audiotaped data were collected. Participants were 17 girls, ages 8-13 (M = 11.725). We analyzed utterances made during collaborative problem solving utilizing a modified form of sentiment analysis. Our analysis indicates that the all-girl groups do use negative internal attributions to describe their own robotics learning activity. However, the overall incidence of these attributions are miniscule as a percentage of overall talk. These results indicate a negligible role for internalized stereotypes in girls' learning with robotics.

Given the dearth of women pursuing computer science (CS) degrees and careers (National Science Foundation, 2015) and the fact that early experiences with technology are important to future pursuit of CS (Margolis & Fisher, 2002), as well as the findings related to the role of stereotype threat (Steele & Aronson, 1995) and stereotype consciousness (McKown & Weinstein, 2003) in affecting performance for women, we investigated the role of negative internal attributions of ability as girls' participated in robotics learning. Our goal was to understand if negative stereotypes about women's technology ability surface for girls during robotics participation.

To investigate this question we performed sentiment analysis of five hours of student talk as girls solved robotics problems. Sentiment analysis is a computational technique that seeks to identify positive or negative expressions in a text (Liu, 2010). Furthermore, we used Rotter's (1966) construct of internal and external locus of control (LOC), defined as a generalized expectancy regarding the source of control for certain events. At one extreme are those individuals who perceive the source as being a result of external forces (fate, luck, chance, powerful others, etc.). At the other are those who identify the source as being internal and therefore have control over events. We reasoned that negative internal locus of control comments would provide insight into the role of internalized stereotypes in girls' perceived ability with robotics.

Methods

Research Design and Participants, Data Collection and Analysis

In this observational case study, we collected video and audio data as participants took part in a day long, all-girl introduction to robotics event. The participants in this study included 17 girls, ages 8-13 (M = 11.725). Fourteen of the participants identified as ethnically white, and three as Latina. Materials for the research event included the Lego Mindstorms® robotics kit (see Sullivan, 2008 for description) and the First Lego League's 2011 Food Factor game board and challenges (see http://www.firstlegoleague.org/past-challenges), as well as colored team t-shirts. These t-shirts allowed us to easily identify girls who were in the same group.

A total of eight video cameras and 17 wireless microphones were used. All of the interactions of each group were video and audio recorded over the day long activity, resulting in five hours of talk from each group. Audio data were fully transcribed. We used a modified form of sentiment analysis to determine positive and negative attributions identified in the text. Sentiment analysis requires a researcher to develop a list of terms with positive or negative valence for a given context (Wilson, Wiebe, & Hoffman, 2005). Because we were interested in the role of internalized stereotypes, we chose to focus on the incidence of negative attributions across the six groups. The list of terms used in this analysis was developed through an iterative process of discussion and refinement among the three authors, they are: *angry, awful, bad, bad mood, blows, boring/bored, difficult, don't care, dreadful, dumb, dummy, fail, failing, flat, frustrated, frustrating, goof, hard, hate, horrible, idiot, impossible, mess up, negativity, not interesting, not smart, numb, over with, stinks, stupid, sucks, terrible, tired, tiresome, ugly, upset.* Once we had identified utterances containing terms with a negative valence, we counted the frequency of such attributions per group. Next, we lexically identified the locus of control for each negative attribution (e.g.,

internalized attributions will feature the pronoun "I" or the possessive pronoun "my," whereas external attributions feature the pronoun "it"). We then counted the total number of negative attributions and we counted the number of internal vs. external references.

Results and Discussion

Table 1 presents the results of our sentiment analysis of negative attributions and the locus of control for these attributions by group.

Table 1: – Negative Attributions and Locus of Control by Group

Group	Total Utterances	Negative Attributions	Internalized LOC	Externalized LOC
Green	2693	15	6	9
Dark Blue	3212	23	6	17
Yellow	3588	63	38	25
Dark Gray	3776	22	9	13
Light Blue	4063	41	11	30
Light Gray	4379	54	19	35

As can be seen in Table 1, negative attributions were either a fraction of a percent or a very small percentage of overall comments in every group. Moreover, with the exception of the Yellow group, the girl participants were more likely to make attributions with an externalized locus of control. This seems to indicate that the girls did not view their own ability as the sole source of difficulty, frustration or failure with the task, but rather attributed such, more often, to external aspects of the activity. To further understand the nature of these data, we provide examples of both internalized and externalized locus of control comments, drawn from each of the groups in Table 2.

Table 2: – Examples of Negative Attribution/LOC by Group

	Internalized LOC	Externalized LOC
Green	*I hate it when I do that.*	*Otherwise, it might be ugly.*
Dark Blue	*I'm too bad at this.*	*See this is what boredom does to one.*
Yellow	*I just don't really like…whatever I'm doing, I'm just like I'm out of here.*	*Stupid thing.*
Dark Gray	*Because I'm good at it? I'm horrible at it.*	*I know it's getting me frustrated.*
Light Blue	*I'm bad at reading the labels. Like I get them and then I forget the other half.*	*We just swapped that one because it was really difficult.*
Light Gray	*I'm kind of worried about the programming? Whatever we do it doesn't seem to work. Fail, fail, we failed again.*	*Go, there go, do it, do it. You stupid plough.*

It is important to note that all of the girl participants opted in to this study and wanted to study robotics. Therefore, this is not a particularly representative group of middle school aged girls. Also, it is not clear how the gender exclusive nature of the activity affected the girls' experience. For example, if the workshop had enrolled equal number of boys and girls, would the salience of negative stereotypes about girls and technology been greater, and would that have had a negative effect on the girls? Prior research suggests this would be the case (Steele & Aronson, 1995). That said we view these findings as very encouraging. It appears, in our study, that the girl participants do not seem to have internalized negative stereotypes about women/girls and technology ability.

Future research should examine if and how negative stereotypes may, yet, impinge on girls' efficacy in robotics learning environments. For example, does the mere presence of boys in a robotics setting affect how the girls feel about themselves? What would the impact of an all female teaching team have on a gender inclusive robotics workshop for middle school aged students? Research on these questions will aid us in continuing to support girls who are interested in pursuing technology studies.

References

Dasgupta, N., (2011). Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry, 22*, 231-246.

Liu, B. (2010). Sentiment analysis and subjectivity. *In N. Indurkhya & F.J. Damerau (Eds.) Handbook of natural language processing, 2nd ed.,* (627-666). Boca Raton, FL: Taylor & Francis Group.

Margolis, J., & Fisher, A. (2002). *Unlocking the computer clubhouse: Women in computing.* Cambridge, MA: MIT Press.

McKown, C. & Weinstein, R.S. (2003), The development and consequences of stereotype consciousness in middle childhood. *Child Development, 74*(2), 498-515.

National Science Foundation, (2015). *Women, minorities and persons with disabilities in science and engineering 2015.* National Center for Science and Engineering Statistics. Retrieved from http://www.nsf.gov/statistics/wmpd/

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. P*sychological Monographs: General and Applied,* 1-28.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797–811.

Sullivan, F.R. (2008). Robotics and science literacy: Thinking skills, science process skills, and systems understanding. *Journal of Research in Science Teaching, 45*(3), 373-394.

Wilson, T., Wiebe, J., & Hoffman, P. (2005). Recognizing contextual polarity in phrase-level sentiment analysis. *Proceedings of the Human Language Technology Conference and Conference on Empirical Methods in Natural Language Processing, Vancouver, Canada, October,* 347-354.

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