To Cite:

> Sullivan, F.R., Keith, P.K., & Poza, R. (2016). Internalized stereotypes: do they play a role in girls' robotics learning? *Paper presentation to the annual meeting of the American Educational Research Association, Washington, DC, April 8-12, 2016.*

Internalized Stereotypes: Do They Play a Role in Girls' Robotics Learning?

Abstract: We investigate the incidence of internalized stereotypes as girls participate in a robotics activity. We operationalize this hidden phenomenon by examining the prevalence of negative internal attributions uttered during activity in the robotics environment for an all-girl group, in contrast to an all-boy group and a mixed gender group. We utilize a modified form of sentiment analysis to examine student talk as they solve problems. Preliminary results indicate that the all-girl group made more negative internal attributions than both the all-boy and the mixed gender group. Further analysis indicates that the all-girl group used derogatory terms to describe their activity, in comparison to the all-boy and mixed gender groups. These results have implications for the professional development of teachers.

Purpose

Girls begin disengaging from computer science and technology oriented study in middle school, and by high school their interests are all but extinguished (Doerschuk, Liu, & Mann, 2007; Margolis & Fisher, 2002). For example, only 11% of all of the high school students taking the computer science advanced placement exam in 2004 were girls (Doerschuk, Liu, & Mann). In this study, we seek to contribute to our understanding of factors that may impinge on girls' interest in studying computer science. We conjecture that internalized stereotypes related to technology and gender may play a role in girls' interest in the field. This may be so because specific domains, such as science and technology are perceived by many to be male domains (American Association of University Women, 2010; Margolis, 2008; Nosek, et al., 2009); which may affect girls' participation in computer-based activities (Underwood & Underwood, 1990).

In this study, we seek to investigate the role of internalized stereotypes through examination of the prevalence of negative internal attributions vis-à-vis activity in a robotics-learning environment. We accomplish this through sentiment analysis of hours of student talk as they solve robotics problems. We analyze data from three middle school age student groups: an all-girl group, an all-boy group and a mixed gender group. In this way we compare the prevalence of negative internal attributions across gender.

Perspective

We base this work, in part on Steele and Aronson's (1995) articulation of stereotype threat. Stereotype threat refers to negative outcomes that accrue when an individual is in a situation in which negative stereotypes about the group that individual is a member of, are made salient. For example, in the case of women, stereotype threat may be a concern in a high level mathematics class with a high number of male students in it, due to the prevalence of the stereotype that women are not as good at math as men. While much of the stereotype threat research has been undertaken with adults, McKown and Weinstein (2003) have demonstrated that between the ages of six and ten years old, children develop "stereotype consciousness" (p. 498). Stereotype consciousness is awareness of prevalent societal stereotypes that may apply to others or oneself. In the case of our study, the operant societal stereotype is that girls are not as good at computers as boys. This stereotype persists even among young women who have gained entry into the most prestigious and elite computer science undergraduate program in the country (Margolis and Fisher, 2002).

To help us investigate whether or not internalized stereotypes may have a role to play in girls' engagement with technology we turn to the construct of internal and external locus of control (LOC). LOC was defined by Rotter (1966) 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 extreme are those who identify the source as being internal and therefore have control over events. It has been shown that individuals that have an external LOC orientation attribute their failures to external sources, where those with internal LOC orientation attribute failure to their own actions (McNeill & Jacobs, 1980).

Studies regarding differences by gender have been mixed over the years. Early studies in gender and LOC reported that females tended to attribute their success to external and uncontrollable factors, such as luck. Also, females attributed failures to internal factors, such as ability (Dweck & Reppucci, 1973; Nicholls, 1975; Chandler, Shama, & Wolf, 1983). More recent studies have shown that there is no significant difference between genders for LOC (Pandya & Jogsan, 2013; Sarrasin, Mayor, & Faniko, 2014). However, all of these studies were correlational and were not subject matter or task specific. Therefore, we believe that the LOC construct may, yet, be useful in helping us understand if and how internalized stereotypes are at work, particularly in situations where stereotype threat is relevant, such as technology activities for girls.

Methods

Research Design and Participants

The data used in this study comes from two separate research projects. The first project took place in two sixth grade science classrooms at two public schools in Holyoke, Massachusetts. Seventy-eight percent of the students in the Holyoke Public School District are Latino, and 79% are eligible for free lunch (Massachusetts Department of Education, 2012). The public schools in Holyoke have been consistently rated as the weakest on the statewide standardized assessment, and in 2015, the Massachusetts Commissioner of Education placed the entire district into receivership.

The participants in this first study included two classes with a total of 45 students (22 girls and 23 boys). Among the 45 student participants, two focal groups were selected for video and audiotaping, one from each school. The first focal group represents a mixed gender group of three Latina/o students, two girls and a boy. The second focal group is an all male group of two white boys.

Data from a second project was also used. This data was collected at a day long, all-girl introduction to robotics event called Girls Connect, which is periodically offered to girls in the Massachusetts region by the Commonwealth Alliance for Information Technology Education (CAITE). The participants in this second study included 17 girls, ages 8-13, who attended an all-girls robotics workshop held in Holyoke. These 17 students came from five different schools in New England. Purposeful sampling was used to select students from various backgrounds and geographic areas from the pool of students who volunteered for the event. For purposes of this study, we selected one group of two white girls for inclusion. Pseudonyms are used throughout. Hence the participants in this study include three collaborative groups engaged in solving robotics problems, one all-girl group, one all-boy group, and one mixed gender group. In both research projects, students used the Lego® Mindstorms® robotics kit (see Author, 2008 for a description of this kit).

Data Collection Methods

The data in both studies were collected using wireless microphones and video cameras. In the first study, two cameras were used, one camera was stationary and the second camera was used to occasionally follow students around the classroom. The students worked on a ten day physics-based, robotics unit. Classes met for 90 minutes per day. Approximately 80 minutes of the class was actually devoted to the activity and 10 minutes for other class activities.

In the second study, eight video cameras were used. Each group of girls had their own worktable, EV3, and laptop computer to build and program their robot. Two challenge arenas were set up in the room so that the girls could test their solutions. A video camera mounted on a tripod was used at each group table to capture the building and programming of the robots. Two additional cameras were used, one at each of the arenas, to capture the test-runs of the robots. See figure 1 for an illustration of the room set-up. We chose to leave the cameras stationary so as to attenuate the impact of the cameras on the participants' activity.

[Figure 1 about here]

Each of the participants in both studies wore a wireless microphone. From these data, we created a video and audio recording of each group's activity and discussion for the respective time periods. A professional transcriptionist transcribed all group talk from both studies. For purposes of comparability, we selected to include the video and audio data from the class meetings on days 3-6 for the Holyoke students. These data represent about 5.25 hours of student work on solving robotics problems. This is similar to the amount of time the group from the second study spent working on robotics problems.

Data Analysis

We used a modified for of sentiment analysis to determine positive and negative attributions identified in the text. Sentiment analysis is a computational technique that seeks to identify positive or negative expressions in a written text (Liu, 2010). 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 are interested in the role of internalized stereotypes, we chose to focus on the incidence of negative attributions across the three groups. The list of terms used in this analysis is presented in Table 1.

[Table 1 about here]

The presence of one or more of the words in Table 1 does not, necessarily, mean that the utterance, as a whole, had a negative valence. For example, the word "hate" is embedded in the word "whatever." As a result, utterances identified in the initial lexical analysis were further examined and false positives were removed. Utterances by chaperones, teachers and/or other non-participants were also removed. Utterances made over the five hours of data collected from each group ranged from approximately 3500-4800 per group. We grouped utterances into segments of 20 in order to more efficiently analyze the data.

Once we had identified utterances containing terms with a negative valence, and we had removed the false positives, 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

Table 2 presents the results of our sentiment analysis of negative attributions and the locus of control for these attributions by group.

[Table 2 about here]

As can be seen here, the all-girl group, while making about 700 fewer utterances overall, made almost twice as many negative attributions and internalized LOC comments as the all-boy group, and 2.5 times as many as the mixed group. To further understand the nature of these data, we provide examples, drawn from the data, of negative attributions internalized and externalized locus of control comments made by group by group (Table 3).

[Tables three about here]

As can be seen from these data examples, each group experienced the difficulty of the task. It is interesting to note that one of the students in the all-girl group used a more derogatory term (stupid) to refer to herself, whereas one of the boys made the same point, but directed the negativity away from himself "I'm not mister smarty pants." In his utterance the term "smarty pants" has a negative connotation. This connotation does not apply to him, yet, the term as used also indicates a lack of knowledge.

Our analysis here is preliminary. Our goal is to analyze the remaining all-girl groups in our data set to further explore this question.

Significance

Women continue to be underrepresented in the field of computer science (The American Association of University Women (AAUW), 2010; AAUW, 2000; Margolis, 2008; Margolis & Fisher, 2002). This is true for computer science majors at colleges and universities (National Science Foundation, 2011), and in the field of computing at large (Tapia & Kvasny, 2004), even as the demand for employees in this sector increases (National Science and Technology Council, 2009). Nationally, women earn fewer than 20% of the CS bachelors degrees awarded each year (National Science Foundation). It is vitally important that we address the issue of the underrepresentation of women in computer science, not only as a matter of meeting the demands of the economy, but, more importantly, as regards issues of equity. As Margolis (2008) has eloquently argued from her research in the Los Angeles Unified School District, the lack of computer science learning opportunities for women in secondary school is part and parcel of a broader, historical system of exclusion and privilege. Our research sheds light on the role of internalized stereotypes on girls' work in computer science environments via the utterance of internalized negative attributions. This analysis will have implications for the professional development of teachers and the creation of curriculum that counters these, sometimes hidden, inhibitors.

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Table 1 – Sentiment Analysis: Negative Valence Terms

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
interesting
mess up
negativity
numb
over with
smart
stinks
stupid
sucks

terrible
tired
tiresome
ugly
upset
we are not smart.

Table 2 – Negative Attributions and Locus of Control by Group

	Total # of Utterances	Negative Attributions	Internalized LOC	Externalized LOC
Girls	3588	63	38	25
Boys	4292	33	20	13
Mixed	4876	24	9	15

Table 3 – Examples of Negative Attribution/LOC by Group

	Internal	External
Girls	*I just don't really like…I do a certain period of time I lose my attention spans, I just want to leave whatever I'm doing, I'm just like I'm out of here.*	*Stupid thing.*
	Stupid Allison.	*Shut up. It's really hard to get it…*
	I'm gonna unplug it so I can get it in. Actually stupid I was like pulling in stuff and I'm just like oh yeah, you don't pull it.	*Oh my god forty, are you kidding, no this sucks. Negative fifty right.*
Boys	*how are we going to know I'm not mister smarty pants*	*that would be bad if the n x t broke it wouldn't it be that bad if like one other little piece broke*
	I did horrible I did horrible	*stupid thing*
	okay my bad	*cool actually it'll probably be bad*
Mixed	*I don't know I'm I'm tired I can't do it*	*it seems kind of hard yes it is turn it around turn it around turn it around put the arrows to the side now*
	woah I've already found one is so hard	*stupid light*
	this is the baddest thing we've ever done	*yeah because it hates you*