First and Third Graders' Conceptions of Programmers

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Abstract: To identify early elementary students' conceptions of programmers, we interviewed 32 first graders and 37 third graders using a draw a programmer test. Students' responses were roughly split between drawing a person at a computer, drawing a computer only, drawing a person only, or skipping it. Unlike in related studies, students did not have strong gender divisions in their drawings. Future work should focus on how students' conceptions change over time with programming interventions.

Background and research question

Currently, in the US, there is increased attention to programming, fueled by the International Society for Technology in Education's (2019) computational thinking competencies, computer science standards, and more schools participating in the Hour of Code (Partovi & Sahami, 2013). Research on students' perceptions of themselves in computer science careers or characterizing others in them illuminated gender-stereotyped features (Mercier et al., 2006; Pantic, Clarke-Midura, Poole, Roller, & Allan, 2018). Studies in which students completed the *draw-a-computer-type person* task found that students largely perceived these occupations as a male activity; of drawings involving females, most were drawn by females (Brosnan, 1999; Mercier et al., 2006). Most research on students' perceptions of computer scientists or computer users and attitudes towards computing careers have focused mainly on middle school levels and older (Hansen, Dwyer, Iveland, Talesfore, Wright, Harlow, & Franklin, 2017). Overall, as students get older and are more exposed to computers, females' attitudes towards computers become more negative (Brosnan, 1999; Mercier et al., 2006). Yet, there is relatively little data on students' conceptions of programmers specifically and in particular for elementary students. Despite the negative perceptions towards STEM-related occupations by gender stereotypes, parents' roles as early models are important in career construction because "[it] is considered the result not only of intrapersonal but also of contextually built processes" (Soresi, Nota, Ferrari, & Ginevra, 2014, p. 150). Our research with younger students can help identify initial factors that influence their perceptions before exposure to computer science education. In this study, we explored: How do early elementary students conceptualize programmers?

Method

We recruited 32 first graders (14 female, 18 male) and 37 third graders (15 female, 22 male) from a public school in the midwestern United States. The school had approximately 11.3% English Language Learners and 46% qualifying for free or reduced-price lunches. Similar to the draw a computer-type person test (e.g., Mercier et al., 2006), we asked each student to "draw what a programmer looks like" and explain their drawing. We coded students' pictures and responses for elements related to stereotypes, family, and characteristics of programmers.

Results

Overall, when asked to draw what a programmer looks like, most students (42%) either skipped the task or only drew an object (no person) (see Table 1). Of the 17 students who only drew an object, 10 drew computers (2 females; 8 males - one drew a math game on the computer; see Figure 1 - right). Other objects included a camera, a pick axe (such as from Minecraft), auditorium seats, and a 3D printer. Females were most likely to draw females (see Figure 1 - center). Although a few female students drew male programmers, no male students drew female programmers. Males were also about twice as likely to draw non-gendered people than females (see Figure 1 – left). Four students who drew males, four students who drew females, three students who drew a non-gendered person, and two students who drew objects also indicated verbally that programmers could be either gender. One female third grader explained why a programmer could be either gender, "I think a programmer looks like a regular person. They would look like a regular person, but they might do some things that you don't do." Further, of the 40 students who drew people, 16 of them drew a person alone, 18 of them drew a person with a computer, 3 of them drew a person with an iPad, phone, or computer chip, and 3 of them drew a person with some other type of object. There was some evidence that females drew upon their family as role models for being a programmer, as two females drew their dads, two females drew their moms, and one female drew her grandfather; only one female drew herself. In terms of common stereotypes, two females indicated that the person had glasses, and two

females said the person would have headphones. A few students' responses indicated that their conceptions of programming were limited to a different meaning of the word, namely, that they were thinking about a program as a presentation. For example, one female third grader drew a dancer, and another male first grader drew auditorium seats for "sitting on the seats and watching it [the program]."

Table 1: Gender in Students' Drawings

Students	Gender				Object	Skip
	Both	Female	Male	Neutral		
Overall (N=69)	1%	13%	17%	28%	25%	17%
Females (n=29)	3%	31%	10%	17%	24%	17%
Males (n=40)	0%	0%	23%	35%	25%	18%

Figure 1. Examples of Students' Drawings of Programmers.

Discussion
In terms of the first and third graders' conceptualization of programmers, we found that as with prior research, females often drew female programmers (e.g., Mercier et al., 2006). However, students did not draw many stereotypical features and generally drew *non-gendered* people. Therefore, the stereotype of programmers being male may be lessening or early elementary students are not aware of these stereotypes because their experiences with programming are primarily as part of school where all students are involved in the same activities. This result suggests potential implications for future work reducing stereotypes around programming. On the one hand, the results suggest that introducing students to programming in a school context early could reinforce their conceptions that *anyone* can be a programmer. On the other hand, given the prevalence of stereotypes in upper grades, and females' lower self-efficacy for programming in later grades, researchers and teachers implementing programming interventions with younger students need to take extra care to appeal to all students. The majority of biases against programming seem to arise when programming becomes a larger part of the curriculum (or after students become aware of it), so it is important that their early exposure does not lead to these stereotypes.

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