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Development of a game-design workshop to promote young girls' interest towards computing through identity exploration

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A R T I C L E   I N F O

A B S T R A C T

Despite recent improvements, women remain underrepresented in Computer Science (CS) in both industry and higher education. Self-perception and identity play an important role in young women's opinions of careers in CS. We believe that by presenting software programming in a way that facilitates identity exploration early on, young girls will be more likely to consider careers in CS later in life. In partnership with an organization that focuses on technology education for middle school girls we developed a game design workshop in an effort to change young girls' perception of CS by increasing their knowledge of programming and empowering them to develop their own identities as computer scientists. This paper presents the results of a case study with 21 participants that was carried out to evaluate the workshop's short-term influence on young girls' attitudes towards CS. The study employed a mixed methods design, including a pre and post application of a validated survey instrument, focus-group interviews, and content analysis of games developed by the students. The pre and post surveys focused on how students' attitudes towards computing may have been influenced by their participation in the workshop; the focus-group interviews aimed to gain further insight into their workshop experience; and the content analysis of games focused on the learning outcomes of our workshop. The findings suggest that the workshop resulted in improvements in both young girls' attitudes towards CS as well as in their self-reported confidence and competence with computers. These results highlight the importance of providing positive identity exploration opportunities in shaping female students' attitudes towards CS.

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1. Introduction

While gender parity can be found in some areas of technology, game design is faced with great gender disparity; though roughly half of the gamers in the US market are women, only 11% of game designers are women, and of that percentage, only 3% are developers (Burrows, 2013). Women utilize Internet and computer technologies nearly as much as men do; however, they usually act as technology consumers, rather than designers, creators, or producers of computer technologies (Margolis &

Fisher, 2003). Although the overall percentage of women employed by video-game companies has increased over the past ten years, nearly all of that growth has occurred in non-technical fields like public relations (Burrows, 2013).

The gender disparity in computing practice has been identified as a key issue in computer science (CS) education and the computing community. Existing efforts to address this gap includes the promotion of women's participation in CS research and practice through scholarships and grants, such as the Anita Borg scholarship and the Women Techmakers program initiated by Google (Welle & Smith, 2014). In particular, the Techmakers initiative has expanded on the scholarship program by promoting a community of women IT developers through retreats, meetups, as well as an online platfom that provides an infrastructure for social support among women in the IT industry. Although these are valuable initiatives, some of the root causes of gender disparity in CS can be traced back to negative and highly gendered early educational experiences (Adya & Kaiser, 2005; Teague, 2002). Systematic efforts are needed to stimulate young girls' interest towards computing early in their educational careers in order to maintain interest in computing and technology-related careers.

Related studies in CS education literature have identified several motivational and social factors possibly underlying the gender disparity in the computing profession. In particular, Teague (2002) argues that a combination of personal, social, and structural factors including career stereotyping and related misperceptions contribute to these trends. Personal barriers are primarily related to self-perception and identity. In particular, personal barriers like lack of fluency in technology, lack of early positive experiences with technology, and lack of information about possible career options may drive women away from CS. Secondly, social barriers such as gender role expectations, or a lack of female role models may convince women that there is no place for them in the field (Werner, Campe, Bean, & Denner, 2005). Social norms, available training, professional development opportunities, as well as the amount of support granted to working parents affect women's decisions to pursue careers in computing (Abbate, 2003). Finally, structural barriers like girls' aversion towards narrowly or technically focused programming classes or instructional methods that prevent girls from becoming technical problem-solvers might contribute to their lack of preparation for employment in this field (Knobelsdorf & Schulte, 2005). Young girls who show interest in CS early in their educational careers may lose their interest over time due to lack of confidence, negative comparisons to peers, lack of effective pedagogical approaches, and/or biased environments (Margolis & Fisher, 2003; Schulte & Knobelsdorf, 2007).

We believe that some of these barriers can and should be addressed at the K-12 level. Students tend not to be interested in or identify with domains in which they lack specific knowledge (Markus & Nurius, 1986; Renninger, 2009). When students consider possible occupations, they fail to consider some options because they are either unaware of them or because they find them unappealing (Brophy, 2009). Among the options they consider to be appealing, some are eliminated because they do not feel confident about the requirements of those occupations (Brophy, 2009; Eccles, 2009). Therefore, carefully designed activities are needed as early as primary school to avoid the development of self-limiting attitudes towards CS among female students. Activities designed along the *identity exploration* framework (Kaplan, Sinai, & Flum, 2014, pp. 243—291) may be particularly effective at addressing this need because they emphasize scaffolded and engaging activities that encourage self-identification with the target profession. Related work in CS education suggests that game-design is a suitable genre to stimulate girls' interest towards computing as they enjoy playing video games (Stewart-Gardiner, Carmichael, Latham, Lozano, & Greene, 2013). Therefore, structuring a game-design activity along identity exploration principles can be a promising strategy for stimulating young girls' interest towards computing.

In this paper, we propose a game-design workshop structured along the identity exploration framework (Kaplan et al., 2014, pp. 243—291) and explore its effectiveness for changing young girls' attitudes towards CS as a profession through a case study. We aimed to evaluate the impact of identity exploration activities on young female participants' attitudes towards CS in a full-day workshop that features the scaffolded use of professional-grade game development tools. To that end, we used a validated survey instrument developed by Robertson (2013) before and after the workshop to identify how young girls' attitudes towards computing may have changed as a result of workshop participation. We also conducted focus group interviews after the workshop to obtain further insights into the participants' views on their game-design experience and their identities as prospective game developers. Finally, we conducted a content analysis of the games developed by the participants during the workshop to identify specific actions indicative of identity exploration.

The rest of this paper is organized as follows. The following sections paper reviews the gender disparity issue in CS as well as related research that aims to address this disparity by designing activities targeting girls. Next, we describe the *identity exploration* framework (Kaplan et al., 2014, pp. 243—291) and how we incorporated these principles into our workshop curriculum design. This is followed by a description of the instruments used for data collection and analysis. Next, we present the results obtained through pre and post surveys, focus group interviews, and game content analysis. The paper concludes with a discussion of the main findings and pointers for future work.

2. Gender disparity in CS practice & education

In general, the image of a computer scientist tends to be highly stereotyped (as cis-male and light skinned), which can cause female students to disclude CS from their existing gender identity (Black, Curzon, Myketiak, & McOwan, 2011; Cheryan, Plaut, Davies, & Steele, 2009). However, by portraying the diversity of CS identities early in K-12 education, female students can be granted more opportunities to consider CS as a viable career option. For example Stewart-Gardiner et al.'s (2013) findings suggest that girls' experience with specifically designed games showing that they can have societal impact by practicing CS can influence them to view themselves as being capable of designing computer programs in the future. If students can see themselves reflected in the range of possible CS identities, they will be more likely to attach themselves to