Gender and Game Making: Attitudes, Competencies and Computational Thinking

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INTRODUCTION
Studies on game construction pedagogy (GCP) indicate compelling links between game construction and increased confidence in computational literacy for middle and high school students. However, research continues to demonstrate sex-based differences related to computer programming confidence and STEM-related educational and career choices – girls and women are under-represented in computer science and engineering programs and the tech-industry in general (Ashcraft, McLain & Eger, 2016; Hill, Corbet & Rose, 2010; Anderson, Lankshear, Timms & Courtney, 2008; Denner, 2011). The goal of this study was to address this gap by administering a classroom-based GCP program in same sex girls and boys only groups.[1]

METHODS
Over six consecutive days, four groups of grade 6 students (N = 57, Mage = 11, f = 31, m = 26) learned to use the design software Game Maker to construct games within a team of researchers and facilitators. Participants engaged with Game Maker for 15 hours with

[1] We recognize that sex/gender are not binaries, however, in this study, all subjects at the time of the study identified as male or female, even as they were given the opportunity to identify as other than that binary. Further, literature on attitudes and competencies related to computer programming and entry in to computer science related fields has reported on the paucity of females in those areas for decades (see Abbate, 2012; Ashcraft, McLain & Eger, 2016; Hill, Corbet & Rose, 2010).

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students working in same-sex pairs. Near-peer support was scaffolded to encourage retention and application of new material and concepts. All participants completed two assessments before, and immediately after the study: a media literacy and attitudes questionnaire, and an evaluation of knowledge of computer programming concepts (i.e. variables, operations and functions and general programming knowledge). Two composite variables were created by summing items from the media literacy questionnaire: Programming Confidence and Attitudes Toward Programming. Programming Confidence included 14 items related to comfort levels in daily use of programming and computer skills (e.g. "I can learn to understand computer programming concepts"). Attitudes Toward Programming summed 5 items examining participant's attitudes based on perceive gender roles (e.g. "Computer programming is an appropriate subject for both boys and girls"). Both variables were rated on a 6-point Likert scale (*0 - strongly disagree to 5 - strongly agree*), with higher scores indicating more confidence and less biased views about technological skill (e.g. males are better at computer programming than females). Additionally, and following the program, each participant's video game was rated for polish, completeness and inclusion of basic or advanced programming concepts via two composite variables: Game Design Complexity (*score range: 4 – 58*) and Playability (*score range: 2 – 9*). For both variables, higher scores indicated higher overall ratings of complexity and playability.

RESULTS

Paired sample t-tests showed that participation in the program resulted in improvement in mean Programming Knowledge for both boys and girls ($p < 0.0001$, $d = 0.41$). Girls showed moderate improvements in Programming Confidence from pre to post-test ($p = 0.038$, $d = 0.38$), but no significant change in Attitudes ($p = 0.14$); boys displayed a reverse pattern, showing a very large effect for improvement in Attitudes ($p = 0.003$, $d = 0.83$), but no significant change related to Programming Confidence ($p = 0.129$). Bivariate correlations were performed next to further explore relationships between the variables. For both girls and boys, higher Programming Knowledge was related to less biased Attitudes at post-test (girls: $r = 0.38$, $p = 0.037$; boys: $r = 0.47$, $p = 0.015$). In addition, for girls only, higher Programming Knowledge was related to higher Game Design Complexity ($r = 0.378$, $p = 0.036$), while less biased Attitudes were related to increased Programming Confidence ($r = 0.435$, $p = 0.014$). Boys showed one additional near-significant relationship: Higher Playability scores were related to less biased Attitudes scores ($r = 0.35$, $p = 0.08$).

CONCLUSION

Our findings highlight three critical findings in relation to computational thinking. First, just one week of targeted instruction using game design software results in measureable changes in children's understanding of programming concepts, regardless of gender. However, gender differences may affect how children apply their learning of these concepts. And last, gender biases may play a significant role in children's confidence regarding their ability to excel in the application computational concepts. Although here we primarily saw improvement in understanding of those computational concepts, children may experience difficulties adapting to computational learning opportunities regardless of their intellectual ability when they are pre-disposed to stereotypes (i.e. individuals who work in technology are unpopular, girls can't be tech-savvy). Educational research has demonstrated for decades that if students cannot imagine themselves as experts or are not confident in their abilities, they will not pursue education in that area, and this is especially the case for girls and women and STEM fields (Hill,

Corbett & Rose, 2010). This study demonstrates the importance of explicitly targeted learning experiences especially for girls related to game design, computer programming and computational thinking.

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