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Over the past 10 years there has been growing recognition that digital media like movies, video games, and social networking technologies are changing the way we think about teaching and learning. Videogames and videogame development are an important component of this new media landscape as one of the largest grossing industries in North America (Entertainment Software Association 2015). Research related to education and videogames has examined the learning potential of playing digital games. Scholars have explored how game mechanics have a rhetorical influence on players (Bogost 2007) and how "serious" social and political content can be taught/learned through gameplay (Frasca 2001; Dahya 2009). Others have considered the important role of videogames for learning and literacy (Gee 2003; Squire and Jenkins 2003; Squire 2011), the rich social worlds of massively multiplayer online games (Steinkuehler 2004; Nardi 2009; Dickey 2011), and the complexities of identity and representation through interaction with videogames (Shaw 2014; Jenson et al. 2011). These studies (among many others) demonstrate the potential of digital videogames as a valuable component of formal and informal education and support the continued exploration of videogame design and play as an important part of 21st century education (for a range of examples, see Dickey 2007; Kahne, Middaugh, and Evans 2008; Gerber et al. 2014; Fisher and Jenson 2016).

There are compelling arguments for the need to include production and creation along with use, critique, and analysis of digital media in education to ensure multimedia literacy is comprehensive, relevant to, and applied in the lives of young people (Kafai, Ching, and Marshall 1997; Kress and Van Leeuwen 2001; Sanford and Madill 2008; Kafai, Peppler, and Chapman 2009; National Council of Teachers of English 2013; Ratto and Boler 2014). Creating videogames is one way to build multimedia literacy and improve computer-related skills and knowledge. Videogame development involves computational thinking, including the use of algorithms, setting game conditions, attributing specific variables for movement, speed, and action, continual problem solving, and it also includes significant arts-based practices (Kafai et al. 1998; Peppler and Kafai 2007; Carbonaro et al. 2010; Denner 2011; Denner, Werner, and Ortiz 2012; Kafai et al. 2012). Media making has also been a platform to interrupt limited expectations about what girls can and should do and for girls to participate in society in meaningful ways through popular cultural production (Kearney 2006). For girls, engaging in maker-culture has allowed them to demonstrate a capacity to create (rather than consume), to develop ideas using new technology, and to express interests and perspectives to peers and adults.

Despite these many studies promoting and exploring the role of videogames for teaching and learning, there is a persistent gap regarding who makes games and who engages in novice game making (computer programming) from a young age. As has been well-rehearsed for the past three decades, women constitute less than 25% enrollment in computer programming at both the secondary and postsecondary level (Ashcraft, McLain, and Eger 2016), with even fewer continuing into programming (Margolis and Fisher 2003; Hill, Corbett, and Rose 2010; Ashcraft, McLain, and Eger 2016) and into postsecondary programs and careers focused on videogame development (Haines 2004; Makuch 2014).[1] This disparity in participation has a multitude of intersecting causes, including access to tools and sociocultural contexts that make computer programs and videogaming spaces uninviting for girls and women (Schott and Horrell 2000; Jenson, de Castell, and Bryson 2003; Kafai, Peppler, and Chapman 2009; Carbonaro et al. 2010). The intersecting agendas of contemporary neoliberalism, capitalism and patriarchy, are manifest in professional, cultural, and educational spaces of the lucrative videogame industry; the systemic discrimination of girls and women, people of color, gender and sexual minority groups, and people in already under-resourced communities, persists.

At the same time, a number of studies have been designed explicitly to support girls making games, most typically in single-sex groups (Denner et al. 2005; Scott, Sheridan, and Clark 2014; Fisher and Jenson 2016). Few studies compare educational programming designed on principles of inclusive pedagogy and feminist practice for both girls and boys. Broadly defined, *inclusive pedagogy* refers to theory and practice in education that is adaptable and responsive to the intersections of difference (class, race, culture, gender, sexuality, ability) and aims to support learning for students with varying experiences and abilities; feminist practice in education centers the lives, experiences, and needs of girls, women, and gender nonconforming individuals toward equal participation and opportunities for success.

In this study, we designed an intervention to interrupt the disenfranchised position of girls within videogame culture and the tech industry writ large through videogame development and design. We also document the outcome of an explicitly feminist project to engage girls in the game making process. In doing so, we challenge the binary framework that positions girls and people of color as disengaged from or disinterested in videogame development and play. Instead, drawing on poststructural feminism, we consider the fluid social and political constructs of gender and race, and demonstrate through empirical evidence how changing the conditions of videogame development related to gender, race, and socioeconomic resources can engender radically different results. In this work, we do not purport or promote notions of "add and stir" girls and women of color toward more diverse representation in videogame play and development; the complexities of identity and representation in videogames are outlined in critical media work elsewhere (e.g., Gray 2014; Shaw 2014). Rather, we explore the purview of binary gender divides as related to videogame development in educational settings, considering how gender performances, self-reports on technological competency, and actual production of videogames ensue throughout a feminist intervention and mixed-method study.

Background: Videogames, literacy, and learning

Hill, Corbett, and Rose (2010), Margolis and Fisher (2003), and others have documented, social, cultural, and educational conditions in many science, technology, engineering, and math (STEM) fields can result in the continued disenfranchisement of girls and women from a range of computing and other technology related disciplines (see Ashcraft, McLain, and Eger 2016 for current stats reflecting this continuing problem). These conditions include ongoing and overt discrimination against girls and people of color, stereotypes and stereotype threat, implicit bias regarding beliefs about who can succeed in STEM fields, and the challenge of fixed versus growth mindset frameworks for understanding learning (in STEM fields as elsewhere, see Margolis et al. 2008; Hill, Corbett, and Rose 2010; Ashcraft, McLain, and Eger 2016).

These persistent issues have been articulated in the research to date on gender and computing (Jenson, de Castell, and Bryson 2003; Cooper 2006; Anderson et al. 2008; Scott, Sheridan, and Clark 2014), including examples related to gender and gameplay (Cassell and Jenkins 1998; Kafai et al. 2008; Carbonaro et al. 2010; Fisher and Jenson 2016; Kafai, Richards, and Tynes 2016). An especially interesting study of video game design by students in classrooms was carried out by Carbonaro et al. (2010), who found that "although boys continue to play computer games significantly more than girls, there is no difference in their ability to construct computer games of comparable complexity" (1100). Carbonaro et al. (2010) argue that videogame design might well be a route via which women/girls might enter into STEM related fields.

Poststrutural feminism and computing education

Poststructural feminist theory presents a means for exploring nonessentialist perspectives about girls when social and political context do not dictate their role as outsiders by (sex/gender) design. We invite the reader to consider what it means to understand girls and videogames by interrupting their/our conventional expectations of gender within a male-dominated, hetero-normative social and cultural space. In addition, we highlight the commonalities between boys and girls that are evident when the social space (and consequently gendered politics of that space) is transformed. In this way, we adopt a perspective reflective of the complexity of identity and representational theories in critical media studies, wherein social context impacts how young people participate and perceive themselves in relation to videogames. Finally, we consider the intersections of racial difference in the participating community and research team, the importance of access to resources, and importantly thoughtful and feminist pedagogical practice to create equitable learning spaces where young people—especially those from nondominant groups—can thrive in their production of videogames.

We situate this study within the larger concept of 'technology as masculine culture' which addresses how technology has been constructed as a culturally exclusive male domain (Franklin 1990; Wajcman 1991, 2004) and which contributes to the positioning (or exclusion) of women in videogames. Poststructural feminism is focused on how these gender positions and gender relations are shaped, perpetuated, performed, and challenged with a focus on power dynamics and relations (Lather 1992, 1995; McRobbie 2009). In the context of technology and computing culture, including videogame play and development, poststructural feminism identifies the contextually situated social dynamics and relations that must be considered as part of how and why gender correlates to various facets of computing culture (Wajcman 1991). Writing on the politics of identity and how identity are formed and performed from a postmodern and feminist position, Harraway (1988) states,

> I am arguing for politics and epistemologies of location, positioning, and situating, where partiality and not universality is the condition of being heard to make rational knowledge claims. These are claims on people's lives. I am arguing for the view from a body, always a complex, contradictory, structuring, and structured body, versus the view from above, from nowhere, from simplicity. (589)

From this position, we consider the embodied role of gender in the videogame development process, including single-sex game development spaces and the inclusion of female, queer, racial minority, and gender non-confirming educators and mentors as defining factors within these spaces. These signifiers often intersect with class wherein women, people of color, gender, and sexual minorities are overrepresented in the ranks of the poor. The presence of these bodies is related to the assumptions and expectations about who can do what with regard to confidence and competence in the videogame development domain.

Recent incidents of harassment experienced by female game-makers and female game critics highlight the extreme inequity girls and women who are interested in playing and making videogames also face (online and off) (e.g., Sarkeesian 2012). The discrimination of women within the videogame industry has been at the forefront of popular media and public politics for at least the past 5 years, popularly discussed in relation to the sexist harassment campaign known as "Gamergate".[2] In these recent years, videogame industry and culture have engaged in critical discussions about sexism and gender inequality. However, the larger structural problems of gender, race, and class discrimination associated with capitalism and patriarchy remain strong. Women's entry into the videogame world can be seen as a way to challenge the essentialist ideals of male-female binaries that position men at the top of the power pyramid; women's exclusion from videogame development is a stronghold for sexism and patriarchy and poststructural feminism illuminates not only the nature of these power dynamics but also avenues to systemically challenge them. The issue often devolves in public and educational settings into a question of sex differences—of what boys and girls (inherently) can and can't do, and do or do not like, without adequate recognition of power differentials embedded in socially constructed gendered expectations. Hill, Corbett, and Rose (2010) offer one example of the power differentials at play, discussing how the mere presence of boys and pre-existing expectation of lesser success of girls can negatively impact girls' performance in STEM programs and tests (stereotype threat).

The violent and hostile debate about and directed toward women in games is deeply rooted in gender politics related to the construction of femininity—of what it means to be a woman (Butler 1990). Girls and women are ascribed certain characteristics (e.g., maternal/domestic, helpless) and refused other attributes (e.g., powerful, smart-developer) within/against social and political structures that uphold male-dominance in computing culture (see Abbate 2012; Jenson and Brushwood Rose 2003; Margolis and Fisher 2003), including in the videogame industry. It is by (active) social and political design that women and femininity are intentionally and persistently told that they/we are not and cannot be a part of one of the largest economic industries in North America.

The neoliberal agenda fueling the videogame industry persistently maintains the inequality that defines and is defined by both capitalism and patriarchy. A poststructuralist feminist perspective demonstrates how people, and particularly those who identify as women, come to view themselves as included, excluded, and/or marginalized in certain areas of work and study. Importantly, we consider how interrupting the status quo regarding videogame design and development practices in educational settings relates to larger efforts to breakdown narrow and stereotypical perspectives about the roles of young people beyond the binary sex categories of male/female. This work moves toward a more varied and representative form of digital engagement and participation for people whose gender, race, and class is always already excluded by a white, male hegemony in relation to technologies. In this way, the work of interrupting gender discrimination related to videogames and education serves more than to further a neoliberal agenda of creating more videogame industry workers; rather, such an intervention offers both greater avenues for all/any young persons to enter this lucrative field of work and additionally creates possibilities for a more varied community of people to participate in the making, playing, and critiquing of creative, social, self-expressive videogame worlds. This type of engagement may support more varied and representative videogame culture in future.

Hill, Corbett, and Rose (2010) suggest that girls at a young age "develop disbeliefs that they cannot pursue particular occupations because they perceive them as inappropriate for their gender" (23). What happens when we create an environment where girls are given ownership of the space, tools, and their learning process in making videogames? What happens when female, queer, and racially diverse mentors demonstrate that it is possible to hold multiple identities related to race, gender, and as videogame makers at the same time? We argue that co-constructive mentorship can serve to interrupt otherwise repressive gender constructions particular for girls/women in relation to videogame development. Intervening in school, when young women are cultivating their interests and later thinking about career pathways is essential to increasing their interest in and access to STEM professions. Research has shown the important role of mentors in hands-on computer education, and especially of mentors as co-constructors of content with participants (Kafai, Peppler, and Chapman 2009; Robnett and Leaper 2013; Scott, Sheridan, and Clark 2014). With co-constructive mentorship, power differentials and hierarchies are minimized in place of collaborative and constructivist learning, participant self-esteem around technology use can grow, and positive relationships between mentors–mentees can establish community-oriented educational models grounded in collective problem-solving and support (Kafai, Peppler, and Chapman 2009).

Feminist methodological approach

As part of an ongoing, decades long effort to counteract these injustices related to girls and games, and to reopen pathways into STEM fields for them, we created and implemented a feminist research study. This study purposefully focused on the perspectives and experiences of girls and women and considers the role of gender, sexuality, race, class, and culture in defining and understanding their/our experiences (Harding, 1987; Lather, 1991). Uniquely, we apply a feminist methodological approach to also consider the relationship between gender and gender-based interventions on the experiences of boys. We combine quantitative findings from self-assessment surveys and researcher coding of videogames made during this study with broader discussions about qualitative observations from embedded researchers documented in field notes.

The goal of this study was to intervene in the existing sociopolitical system and to support girls making games while documenting this process and outcome for both boys and girls. Race was addressed through active recruitment of facilitators of color who were also representative of the participants in this study. This project sought to expand the reach of videogame development to participants beyond the expected limitations of girls working within and fighting through the power-dominance of "boy culture." In addition, we posit that working with primary ethno-racial minority communities—and ensuring a diverse make-up of those who were in leadership positions in this study as well—similarly challenged the picture of Whiteness that predominates technology sectors, unbalancing the status quo related to race, gender, and power in these spaces. Such an intervention adopts a complex relationship with representation and meaning making, adopting Hall's (1997) approach to culture suggesting, "Things 'in themselves' rarely if ever have any one, single, fixed and unchanging meaning" (3). Rather, the cultural norms and practices associated with videogame development can be changed through various forms of representation, dialogue, and critical intervention. We sought out to build meaningful, diverse, and sometimes divergent relationships between young people and mentor-facilitators.

This project addresses key issues: (a) the lack of access to technology and the digital arts for girls and boys in under-resourced schools (class); (b) the lack of access to and participation in creative and digital culture by these communities and girls in particular as a result of persistent gender divides and socio-economic divides; and, most significant to this article was, (c) to contribute to a fast growing body of research intervening in the lack of representation of girls and racial minorities in videogame development by putting technology and technology training in their hands, and by exploring their engagement through a poststructuralist feminist lens.

This work has aimed to co-construct meaning in these practices among researchers, educators, and participants as well as to shift cultural norms and practices related to videogame making in these educational settings. By doing so, we sought to challenge the predominance of White men in the technological sector and research how girls engaged in the game making process compared to their male peers. We applied feminist pedagogy and practice to the videogame development program with a focus on girls' interest, girl-supportive spaces, and nonhierarchal pedagogy where instructors, mentors, and participants worked together in co-constructive ways. Importantly, both boys' and girls' groups had mostly female, non-white, and gender queer mentors who were often near-peers in the early years of their university programs. Through mixed-method data collection and analyses we sought to understand patterns related to confidence, participation, and engagement in the videogame development process for boys and girls under these changed conditions.

Methods

Data collection consisted of mixed qualitative and quantitative methods, including pre- and postgame development surveys, coding of student games for game mechanics and style, facilitator/embedded researcher surveys, exit interviews with students and facilitators, and field notes. We focus here on survey findings and embedded researcher observations which are complementary data to student self-reports. We chose a mixed-method approach as it allowed us to capture valuable demographic information as well as self-reports from participants toward and experience with game design prior to the study. These methods allowed us to explore participant reports about game design after the study, and also to enrich those self-reports with an analysis of their observed behavior throughout the research process. In addition, coding of student games offered a view to what they learned through what they made in concrete ways. The study is mixed-method and a small sample which limits the generalizability of the findings. As such, we do not make claims that exceed the evidence we can provide, but rather draw on these findings to illuminate the ways in which the construct of gender—something that is always already fluid, but in relation to technological competence and self-reports of confidence is often presented as fixed—is malleable given explicit attention to pedagogical context (Carr 2005). Here too we posit that a poststructural feminist approach may illuminate the potential fluidity of competence and confidence for participants working under the changed educational settings created for this study.

Our analysis focuses on the survey data that pertains to the wider (and harder to quantify) social and cultural norms and beliefs related to boys' and girls' positions within videogame development. We refer to observational field notes to contextualize and situate study findings and to enrich our analysis of those findings through a poststructural feminist lens. These observational findings are presented and integrated throughout the discussion section, following presentation of survey data and videogame coding outcomes. In our presentation of findings, we include those with no statistically significant differences to demonstrate where boys and girls perform similarly under the changed conditions of the educational setting, in comparison to the more common binary and essentialist view purporting girls and boys as inherently different.

The study was explicitly designed as a feminist intervention, one that meant that we set out to change the conditions under which girls (and boys) would experience game making. Our guiding research questions are:

1. In what ways is it possible to change the balance of power that masculine culture has on video game design and play through the construction of conditions that challenge the *status quo*?

2. How do girls and boys in sex-segregated instructional settings self-report on their own abilities to succeed in video game development?
3. What are the differences in self-reports and observed performances of boys and girls, in Grades 6 and 9, creating video games in sex segregated spaces?

Mentor training addressed ways to support girls and boys learning collaboratively and in self-directed ways, prepping mentors to not prescribe learning but rather to facilitate student experimentation and exploration with the videogame development process. This aspect of the intervention was also crucial for the boys of color in our study who may not have had opportunities to see themselves represented in the videogame development domain.

The study was conducted with 87 Grade 6 and Grade 9 boys and girls over 1 year in three locations. Table 1 offers an overview of data collected relevant to this article. Table 2 presents the gender and grade breakdown of participants in the study. We worked with two schools in the Toronto area: one junior-middle school and one secondary school. In addition, we ran a summer camp in an underserved community in one of Toronto's larger suburbs. Participants in the two Toronto schools were predominantly from ethno-racial minority communities, documented as in the lowest school-achievement groups in the Toronto area. This socioeconomic reality points to issues of lesser access to computers and computer game development tools and training that also structurally impact who goes on to succeed in the videogame development world (Margolis et al. 2008). We focus on the quantitative analysis of participant pre- and postgame development surveys, as well as the coding of students' games. Together, these data sets address students' attitudes about making games before and after the intervention, across all-girl and all-boy settings, as well as across grades. They also reflect in concrete terms the form of engagement across groups depicted in the games they made, coded for game mechanics and style.

The summer camp community was comprised of predominantly White and Indigenous participants situated in a socioeconomic region that is also among the lowest in Ontario. All three schools shared in their "low academic achievement" status, and even with the White students from the summer camp, the majority of participants were from nondominant racial groups and lower income communities.

Table 1. Relevant data collected in 2013–2014.

Type	Student survey data	Totals (out of 81 participants)	Totals by sex
Qualitative coding and quantitative analysis	Coding student games	76 games	42 female 34 male
Quantitative analysis	Pregame development program entrance survey	74 respondents	42 female 32 male
Quantitative analysis	Postgame development exit survey	85 respondents	44 female 38 male 3 missing

Table 2. Breakdown of classrooms by gender.

Grade	Male	Female	Total
6 (Pre)	15	23	38
9 (Pre)*	17	19	36
6 (Post)	18	23	41
9 (Post)*	20	20	40
6 (Matched)	15	21	36
9 (Matched)*	14	15	29

*2 students did not report their gender and were excluded from gender analysis.

In each school, we ran sex-segregated clubs with boys and girls working separately in groups of 10–12 participants. This was an active measure and intervention to the common, long-standing, and well-documented benefits of all-girl education (Ransome and Moulton 2001) and reality of male-dominant culture of technology in school spaces (as elsewhere) (Jenson, de Castell, and Bryson 2003). We followed the same curriculum in each cohort, a curriculum that was developed and refined by Dr. Jenson and her research team over 4 years of videogame development projects with young people in and out of schools in the Toronto area. This curriculum consisted of short modules to teach explicit game mechanics through "modding" (making modifications to existing games), followed by longer exploratory design periods where students would follow their own interests and directions with regard to learning new development skills in Game Maker (GM). In some cases, instructors and mentors would trouble-shoot problems with students, and oftentimes we would encourage participants to support each other and use Internet search engines to resolve their problems.

Instructors and mentors participated in a 2-day training that included game development homework assignments using GM. There was a ratio of approximately 4:1 mentors to participants throughout the year to support participants' game design, as we found that in order to support STEM learning students require hands on technology training as well as quite a lot of support to carry out their work. Survey data was considered from the pregame development scores, postgame development scores, and the change between these two surveys (calculated by subtracting pregame development scores from postgame development scores).

The survey in use was developed over a decade of research focused on educational technology and specifically girls and boys playing and making videogames. It was designed to gauge how participants report on their own technological skills and how they assess those of others (see Jenson, Fisher, and de Castell 2011; Jenson and Droumeva 2016; Jenson and Fisher 2017). Data collected from the survey has always been paired with findings from coding the games made by participants and discussed in relation to observations noted in researcher field notes. This combination of methods allows for cross referencing of findings. We make no claim to external reliability and instead use this data to point to alternate ways of understanding social and cultural conditions of game making in educational settings. Conclusions based on null-hypothesis testing (e.g., statistical significance/*p* values) should be interpreted with caution with a relatively small sample size. Rather, these analyses can be considered exploratory in nature. They have value as informing directions for future research and replications, as well as for theory building in this domain. By examining the trends and patterns in this data, future studies can be designed to focus on promising findings to conduct additional in depth investigation and replication.

Quantitative analysis was performed on survey items that were presented with continuous response options (e.g., Likert scale) using participant gender and grade as predictors. Because gender and grade were dichotomous predictors, they were "dummy-coded" for ease of analysis and interpretation by using 0 for female and 1 for male, 0 for Grade 6 and 1 for Grade 9.[3] To compare differences between the means for gender and grade, survey scores were primarily analyzed using independent *t*-tests.[4] Independent *t*-tests allow for the comparison of score distributions from two unrelated groups (e.g., females and males) to determine if the distribution of these groups is statistically different from one another. Table 3 presents mean, standard deviation, and *t*-test results from the survey findings. Findings that were statistically significant were denoted by *($p < .05$) or **($p < .001$), whereas findings that approached statistical significance were denoted by †($p < .10$).

Coding of game mechanics and design was deemed important by the research team to complement survey data with more concrete information about what participants produced (compared to what they reported experiencing throughout production) and a coding schema was developed by analyzing the games participants created. The games were analyzed by game feature (rules, mechanics, use of "nonplayable characters" [NPCs], and scoring system), whether or not they contained original art and sound, and whether they were playable or not. Coding was completed using a two-step process first involving the creation of codes by the research team and application of those codes to the games produced by participants. Two members of the research team independently coded the same 10 games, then met and revised codes for consistency and reliability so that they were coding more similarly and resolving conflicts between codes. Finally, all 53 games were coded and any large discrepancies were discussed and resolved by the entire team. This coding was then also analyzed using the following quantitative methods: for all dichotomous coding (i.e., the presence or absence of a game feature) chi-square tests were performed and for continuous coding (i.e., the quality of a game feature) *t*-tests were performed.[5] In the next section, we discuss the quantitative findings from the study. In the discussion section, wherever possible, we augment those with qualitative observational data from field notes and identify how/where a poststructural feminist standpoint illuminates these findings.

Table 3. Mean and *t*-test results.

Finding	Group	*N**	Mean	SD	*t*
1	*I expect using GM will be difficult*				
	Female	42	3.19	0.89	1.91†
	Male	32	3.59		
1	*I fear GM*				
	Female	41	1.71	0.68	−2.03*
	Male	32	2.13	1.07	
2	*I have a lot of self-confidence when it comes to GM*				
	Grade 6	38	3.92	0.78	2.19*
	Grade 9	37	3.49	0.93	
2	*I am no good at GM*				
	Grade 6	37	2.51	0.90	−3.59*
	Grade 9	38	3.21	0.78	
2	*I am not the type to do well at GM*				
	Grade 6	38	2.21	0.96	−2.61*
	Grade 9	38	2.79	0.88	
5	*I enjoy using GM to create video games*				
	Grade 6	41	4.56	0.50	4.12*
	Grade 9	40	4.03	0.66	
6	*How confident are you that you can problem solve if you get stuck on a problem in GM*				
	Pretest	65	6.69	1.78	2.65*
	Posttest	65	5.95	1.91	
6	*How confident are you that you can figure out what to do when you get stuck on a problem in GM*				
	Pretest	65	6.65	1.84	2.91*
	Posttest	65	5.88	1.85	
7	*GM is enjoyable and stimulating*				
	Female	35	0.37	0.77	2.37*
	Male	29	−0.07	0.70	
7	*Once I start working on a game in GM, I find it hard to stop*				
	Female	36	0.67	0.96	2.53*
	Male	29	0.03	1.05	
8	*Rated sprite quality in created games*				
	Female	33	1.84	1.01	−0.62†
	Male	28	1.41	0.78	
9	*Rated music quality in created games*				
	Grade 6	34	1.65	1.18	6.45**
	Grade 9	27	0.11	0.42	
9	*Number of levels in created games*				
	Grade 6	34	4.15	3.45	1.73†
	Grade 9	27	2.74	2.71	

**Note*: Minor fluctuations in N occur because some students opted not to answer every question, resulting in missing cases for some questions.

Findings

There are a number of findings from this study worthy of report. Here we present each finding first in summary in Table 4, and then follow with a short description about the relevance of each finding to the issue of girls' making videogames in an educational context. The findings we report on are those most significant or approaching significance in our quantitative data analysis from both the pre- and postsurveys, as well as from the analysis of codes assigned to participants' videogames. In some cases, we highlight a lack of significant differences to demonstrate the similarities in boys' and girls' participation in these clubs, a partial artifact we later argue as relevant to

Table 4. Summary of findings (descriptive).

Finding 1	Girls in Grades 6 and 9 expected using GM to be less difficult than their male peers (this relationship approached, but did not reach statistical significance), as well as expressed less fear regarding the use of GM before engaging in the game development work.
Finding 2	Grade 6 participants reported statistically significant results showing more self-confidence in using GM as well as fewer negative self-attitudes (e.g., believing that they were not good at GM, or not the type to do well at GM). This was true across male-female participants, not only girls.
Finding 3	In the postsurvey, there were no statistically significant differences between gender regarding attitudes toward GM.
Finding 4	In the postsurvey, there were no statistically significant differences between gender in self-reported confidence regarding GM.
Finding 5	Grade 6 boys and girls showed statistically significant results related to their enjoyment using GM more so than Grade 9 girls and boys.
Finding 6	Participants reports were statistically significant and showed feeling less confident both that they could problem solve and that they could figure out what to do if they got stuck in GM after the intervention.
Finding 7	Girls reported more agreement than boys that they found GM to be enjoyable and stimulating, that they would have a hard time stopping once they started working.
Finding 8	There were no significant differences between boys and girls or across grades, except that coders showed a trend toward better quality sprites by girls than boys.
Finding 9	Grade students had better quality music in their games and created games with more levels than Grade 9s, although this second finding approached but did not reach statistical significance.
Finding 10	There were no statistically significant differences between the frequency each genre was created by male and female students with the exception of sports games. Sports games played a greater role in boys' game designs.*

*$\chi^2(1, N = 65) = 12.97, p < .001$. GM = Game Maker.

the design of videogame production in these carefully constructed single sex groups. To improve readability, we have included descriptive information to supplement research findings in addition to the summary statistics Table 3 (above) and findings Table 4 (below).

Presurvey

Findings 1–2 are based on participant responses to questions pertaining to their comfort (e.g., "I expect using GM to be difficult"), confidence (e.g., "How confident are you that you can participate in class discussions about GM?"), and fear (e.g., "I fear GM") with regard to making computer games. Questions in the presurvey can be characterized in terms of their focus on (a) self-reporting on attitudes toward GM/game development on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), and (b) self-reporting on confidence in abilities to problem solve while using GM on a 10-point Likert scale ranging from 1 to 10. Independent sample *t*-tests were conducted on both sets of questions using gender and grade as predictors.

Postsurvey and difference analysis

Findings 3–5 are drawn from the postsurvey and are also based on participant responses to questions pertaining to their comfort, confidence, and fear with regard to making computer games after having completed the game development program. Because the content of the post-survey closely mirrored the questions of the presurvey (with some minor differences), the analysis follows an identical strategy for that of the pre-survey responses. Findings 6 and 7 are drawn from a difference analysis between the pre- and postsurveys. Difference analysis was applied for those items in the pre- and postsurvey that were identical (e.g., “GM is boring”) or well matched (e.g., “I expect using GM to be difficult” and “I found using GM to be difficult”). Difference analysis was conducted using two strategies. First, paired *t*-tests were used to compare each individual’s response on the postsurvey to their initial presurvey response. Second, difference scores were calculated by subtracting pre-survey values from postsurvey values for each question. These difference scores allowed for the comparison of the rate of change between the pre- and post-survey as predicted by gender and grade.

Coding of game mechanics and design

Findings 8 to 10 are drawn from quantitative analysis of qualitative coding of game mechanics and design. These ratings resulted in binary codings of presence/absence that were subsequently analyzed using chi-square tests. For example, coders indicated whether or not more than one game mechanic was present in the game such as run and jump and/or whether or not the designers had included their own original art or not. Chi-square tests are used to determine whether the distribution of binary outcomes differs between two groups (e.g., gender). Other game mechanics were coded based on the quality of their implementation, such as the quality of music or art for character sprites. Because these ratings were continuous, subsequent analysis was performed using independent *t*-tests with gender and grade as predictors.

Discussion

In the survey (Finding 1), girls report themselves as confident in their ability to create games. The fact that the girls reported feeling confident about their abilities was interesting as it was somewhat contradicted by the day to day observations of them making games, where embedded researchers observed that they performed technological *incompetence* more often than did the boys. In other words, mentors observed girls saying they did not know how to do something, or that they did not understand particular videogame development processes, though they did typically manage to successfully program the desired game mechanic and self-report as feeling confident about game making going into the program. This is an important contrast between their outward performance of gender related to being girls and creating videogames, compared to the actual work they were doing and additionally how they felt about their own abilities. Our study design allowed this important artifact of social and cultural conditions to be seen, highlighting the relational and situational meaning of how girls described themselves (competent) and performed (incompetence), while ultimately succeeding in their technical videogame development work. This marks a poststructural and feminist artifact related to language, relationality, and performativity in an educational setting (St. Pierre 2000) pertaining to the culture of videogame development and technology for girls (and boys)—one where they presented specific behaviors and speech acts outwardly that did not always align with their self-reported confidence to succeed.

Boys' high level of enthusiasm for making games might similarly be explained with reference to the general culture around gameplay and videogame development which is hyper-masculinized and male-dominated. In this regard, the boys more closely represent the status quo with regard to gender and gaming performing masculinity through their enthusiasm for the process at the outset. Videogame making became an opportunity for boys to display or perform their masculinity through a show of interest and enthusiasm in making games, which was also noted in their daily interactions with the research team. Because, however, the boys were separated from the girls, their enthusiasm and claiming of space was not experienced by the girls, something that was noted in the extensive field notes we took and that we posit directly impacted girls' ability to engage more fully and more freely in the game making process over time. This finding suggests that girls purported "inherent" disinterest in videogame making is at least in part influenced by the social conditions of the game making space.

When comparing survey responses from girls and boys between Grade 6 and Grade 9 (Finding 2), Grade 6 boys and girls reported more self-confidence in using GM and fewer negative attitudes about their ability to successfully use this (new to them) program. Gender-based identity as well as overall confidence (or lack thereof) is noted elsewhere as heightened in high school and adolescent years for girls and boys (Hill, Corbett, and Rose 2010). What is interesting and offers a new perspective on videogame development with children and youth from this finding pertains to the emphasis on age and grade as the distinguishing factor rather than sex. This matters immensely in trying to understand who participates in videogame development, and why, in a landscape where sex binaries and sometimes race-based assumptions about interest are the (erroneous) prevailing explanations of difference in boys and girls of color going into (or not going into) STEM fields (see Margolis et al. 2008).

There were no statistically significant differences found in the post-survey regarding girls' and boys' attitudes toward GM after completing their videogame development program and after having each made their own games (Findings 3–5). These findings challenge, again, the widespread notion that "girls don't like playing games," that "girls don't want to make games," or that "girls are no good at making games." A Google (2015) report about students, parents, and educators' perceptions about the image of computer science indicate that the prevailing viewpoint that "boys are more interested in learning computer science than girls, and that boys are more likely to be successful in their learning" (Finding 3) remains strong. Our results take an empirically grounded step toward challenging this prevailing point of view.

Participants in this study, boys and girls, Grades 6 and 9, indicated that they were less confident in their perceived ability to successfully create videogames specifically using the program GM after the intervention (Finding 6). This suggests that their general confidence in creating games before engaging in the process and working with a particular tool changed after participating in the game development program, as they were less confident in their abilities after the study. This indicates that the participants possibly learned that they did not know as much as they thought they did about game making. Such a reality may point to a need for greater and more in-depth digital and computational literacy for girls and boys in these schools, across Grades 6 through 9. This finding may also suggest that the positive affordances of videogames, discussed predominantly in relation to gameplay (see Gee 2003; McGonigal 2011), may be inadequately represented in school based cultures. Gee (2003) has indeed argued that the learning and literacy inherent in the game play process is overlooked in formal education. The interest of our participants in game making reflects the cultural role of games and game making in contemporary youth culture, whereas their changed confidence after engagement with this process shows that early enthusiasm lacks situated understanding of the process.

Considering Findings 6 and 7, there is an important outcome regarding the role of videogame development for girls' education. Girls and boys felt less confident that they could problem solve programming issues in GM after the intervention. And yet, after the intervention girls also reported significantly more agreement that they found GM to be enjoyable, stimulating, and "hard to stop" once they started working. These findings suggest that even though they became less confident with GM after using it, that a model of videogame development that builds on their interest to continue troubleshooting through these challenges might prove worthy for computing education. McGonigal (2011) has noted, "gamers spend on average 80% of their time failing the game worlds, but instead of giving up, they stick with the difficult challenge and use the feedback of the game to get better." Again, we parallel our findings to the positive affordances of game play suggesting that game making also provides players with satisfying and challenging problem solving activities, situated among meaningful social connections (Gee 2003; McGonigal 2011; Young et al. 2012). Our results indicate that these girls in particular actively engage in the problem-solving processes of computer game development and also benefit from hands-on, student-driven, creative, feminist, racially inclusive, and development-focused learning of computational skills.

The findings from the coding of game mechanics and design offer an interesting perspective into the videogame development work these young people completed during the program (Findings 8–10). The lack of difference across girls and boys with regard to most coded mechanics and genre suggest that given comparable conditions—conditions that actively challenge the typical role of girls as subaltern within mix-sex videogame play and computer programming domains—girls and boys create videogames in comparable ways. In other words, when the stereotypical performances of masculinities and femininities are confined to same sex groups, and when the expectation of hetero-normative interaction is controlled for by those same sex groups, those normative expectations are shifted. We argue that by altering the conditions under which girls in this study made games, including our attention to modeling expertise by female, nongender conforming, and racially diverse mentors, rendered temporarily a different ecology for game making. This ecology included greater access to tools and to training as a socioeconomic condition and fundamentally changed and challenged the otherwise male domain of technology in these schools.

In addition, we observed that the quality and complexity of game design (mechanics) and the type, style, or genre of the games made in this study varied little between groups. The few differences that were identified include girls taking more time and care to design their sprites (a two-dimensional display of an object in a game), boys creating more sports games, and Grade 6s having better quality music and more levels than the Grade 9 participants. In this regard, the differences that are observed fall more on the lines of grade than sex, and those that are divided by sex are not reflective of engagement, interest, or quality of games-made (nor were games defined by stereotypical codes of feminine/masculine pink/blue markers).

On the topic of masculinity, the typical culture of homophobia and hypermasculine performativity were also challenged. Given our mixed-sex and gender-varied mentor community, there was only one qualitatively documented incident of queer-phobia between male participants in Grade 9 involving a homophobic slur toward one gender nonconforming mentor (still using the pronoun "he" at that time). This incident was quickly reprimanded as unacceptable behavior and never again displayed openly during videogame development sessions. This same gender nonconforming mentor was in fact noted as one of the "favorites" among Grade 9 boys by the end of their participation, noting his skill and helpfulness as defining and valued qualities. This suggested that the nonconformity of the mentor's gender performance—wearing nail polish, lip stick, and pink and pastel clothing, as examples—was noticed as "not masculine"; at the same time, his presence was normalized to the extent that his contributions were celebrated among many of the otherwise "typically masculine" Grade 9 boys, rather than hypermasculine discrimination prevailing as the norm. In this regard, poststructural feminism illuminates how the performances of masculinity boys often reproduce have variability and relationality to space, relationships, and bodies in the room. In a setting where mentors, in their positions of power, were diverse in their representation of who creates videogames and gender representations, overt expressions of cis-gender hypermasculinity were tempered (at least temporarily and within these spaces). Importantly, boys succeeded in meeting the learning objectives of the program and did so acknowledging the positive contribution of male and female, racially diverse, gender queer, and non-conforming mentors.

The finding that girls report strong self-confidence compared to boys in relation to the game development program stands in stark contrast to prevalent and normative discourse about girls being unable or uninterested to do this kind of videogame development and maker work. Of interest also is the finding that girls were especially drawn to the challenge of solving problems with GM in terms of programming game mechanics and understanding the algorithmic processes of implementing their ideas. This type of directed interest and motivation to learn is an important outcome of this study and one that can be applied in concrete ways to engage girls in computer programming curriculum (through videogame development); it directly challenges the idea that girls are not capable or interested to be videogame developers.

The finding that girls took more care, according to our coders, with their sprites, may warrant further investigation. Also significant were differences between the grade six and grade nine students. That Grade 6s showed better quality music and more levels can be interpreted as a show of the also noted finding (Finding 5) that the Grade 6 s enjoyed using GM more overall than the grade nines. Interestingly, the finding that boys made more sports games can be understood as a clear reflection of the role of sports in boys' lives and the considerable association boys have with sports (as a show of masculinity). Again, we posit that these findings simply demonstrate differences that are not at all divisive, that do not indicate quality-control divided by sex, but that may point to more nuanced ways in which the social construction of gender influence boys' and girls' engagement with the process of videogame development.

Something that was of great significance in this study is the absence of significant difference between boys and girls when we controlled the conditions of engagement with technology. In this study, we worked hard to shift the conditions under which girls make games by separating them from their male counterparts—predominantly also racialized and all situated in low socioeconomic communities—and by providing strong female role models who were confident and competent at game making. It should be noted that boys also had female role models, as well as queer identified role models, and they participated fully and produced quality work of equal measure to their female peers.

Conclusion

To consider how videogame development can be used to support education in under-resourced schools, we identify the importance of framing how we look at what young people do (or can do or want to do). This is especially important for girls of color in schools where there is a trifecta of challenges. These include inadequately trained teachers who are often not from the communities where they teach, the persistent male-dominant culture of technology and videogames, and a lack of access to technological resources and training that leaves girls of color in under-resourced schools at a significant disadvantage. In these settings, girls and other underrepresented minorities are not only at a disadvantage with regards to their access into STEM professions but are also on the outside of cultural production and participation further limiting the prevailing cultural standards writ large.

It appears in this intervention that learning twenty-first century skills such as problem solving, computational thinking, and the resilience to continue working through technical problems could be situated in supportive, videogame development, and digital media making environments. It is also apparent from this study that focusing on differences between the sexes is not a productive or empirically grounded way to approach the question of girls' interest and abilities in the videogame development world.

Rather than approach this problematic disparity related to who makes games as an essentialist debate about gender differences (of boys versus girls), we are arguing that the power structures that guide (or dictate) the meaning of "feminine" and "masculine" (ascribed to male and female bodies, respectively) requires interrogation and critique (Butler 1990). Shaw (2014) articulates that the relationship between identities, bodies, and gameplay is complex and layered, related to, and situated within fluid and varied social and cultural contexts (including but not directly related to representative playable and non-playable characters in games). In this article, we consider what it means to think about social, cultural, economic, and political space before binary sex/gender distinctions; we altered the normative conditions of educational technology spaces in under-resourced schools and comparatively documented under these changed conditions how girls and boys reports on their engagement and on how they performed.

In this intervention, we bracketed off girls from boys and this same-sex grouping allowed girls to engage with mentors across race, gender, and sex (and sexuality) in a supportive, growth-oriented environment. Girls did not have to self-identify as different from the boys—that difference being a defining quality of a patriarchal culture where girls and women are distinctly (and definitively) not men/male and where girls and women are presumed and required to be "lesser than" men, particularly in powerful economic and political sectors like technology. Typically, in technology settings boys self-segregate, excluding girls; we created a more equitable environment by separating the sexes and offering equal access to tools and training, facilitated by a racially, sexually, and gender diverse community of near-peer mentors. Through this changed setting we have demonstrated the way social conditions shape the outcome of girl-boy participation in making videogames and demonstrated those changes in statistically significant (or insignificant) terms.

In addition, and very much at the intersection of racial and gender difference among young people working with technology, we also consider the implications of socioeconomic structures guiding the lives of these young people in many ways. In particular, these were not youth who could necessarily go home and work on their games, as they shared computer and screen time with older siblings or adults, nor did they have any particular background in computer science concepts given its absence especially in public school curricula. As such, the social conditions and constructs related to participation in videogame development are related to race and gender representations (and related assumptions about who can and does this type of work) as well as being related to class access. Such an opportunity creates an entry point toward social and economic capital associated with the technology sector and video games in particular; doing so also presents avenues for more representative participation, where culture is represented (or codified; see Hall 1997) through the signs and symbols of both videogames as digital artifacts (where language is multimodal) and through the process of videogame making.

In conclusion, we want to emphasize how gender-difference research can sometimes reinscribe stereotypes and highlight here the conditions under which we might instead write about gender similarities (Connell 2009). Focusing on the common engagements of these boys and girls in the videogame development process challenges the notion that girls' exclusion from technological domain has inherent or essentialist foundations related to sex. Rather, we emphasize the important role of good, regular, consistent access to technology, representative mentors who offer meaningful engagements with young people around technology, and adequate support in terms of qualified teachers and instructors to create opportunities for young people to learn these important twenty-first century skills. Socioeconomic considerations related to tools, training, and human resources remain essential components to truly leveling the playing field.

Notes

1. This is true despite 48% of game players being female.
2. "Gamergate" refers to a harassment campaign against female game makers and feminist videogame critics triggered in August 2014.
3. "Dummy-coding" is a method of categorizing a variable that has only two levels (i.e., gender: students in this sample identified as either male or female) to allow these variables to be included in statistical analysis; each coded value represents a category in the dummy-coded variable.

4. A *t*-test is a statistical procedure that compares the averages of two groups to determine whether there is evidence that averages of those groups are significantly different. Independent *t*-tests are used when the groups being compared are "independent"—members of one group do not also belong to the second group (e.g., students are either in Grade 6 or in Grade 9, they cannot be in both).
5. A chi-square test is a statistical test that is used to determine whether the frequency of a categorical outcome (e.g., presence of a game feature) differs based on a categorical predictor (e.g., gender).

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