Connecting Spaces: Gender, Video Games and Computing in the Early Teens

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Abstract
Informed by evidence that computing attitudes may be uniquely constructed in informal contexts and that the early teens are a key period for academic decision-making, we investigate lines of practice that connect computing skills, attitudes, and videogames. We compare the relationship between computer skill, computer efficacy, and activities associated with gaming using a data set of 3,868 children in middle school. The time that children spend gaming has very modest association with skill and efficacy. Accounting for the frequency with which children modify games, engage in social gaming activities, and the salience of gamer identity explains the gender gap in computer skill and significantly narrows the gender gap in computer efficacy. We find support for the argument that computer skill and efficacy are dependent on children connecting often isolated social contexts, a socially embedded characteristic of the digital divide.

Keywords

gender, video games, STEM education, computer science, digital technology

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Computing has significant consequences for communities, industries and the state, but it has been challenging to bring different voices to the field. Often discussed in relationship to computer literacy (Gee 2003), video games have grown in popularity amongst girls and the general public (Lenhart et al. 2008, 2015; Rideout, Peebles, and Robb 2022; Rideout and Robb 2019) surpassing film box office returns in 2018 (Shieber 2019), but the association with early computing paths is unclear. A recent survey of children in grades 7 through 12 shows a rather large gender difference: 25% of girls are interested in learning computer science (CS) compared to 50% of boys (Google and Gallup 2020). This is of particular concern since middle school is when children begin decision-making about college preparation (DeWitt, Archer, and Osborne 2013; Legewie and DiPrete 2014) and computing is a subject largely decoupled from U.S. K-12 education (Puckett and Gravel 2020).

Videogames could be associated with children's skills and attitudes towards learning computing, but its role in early CS paths is rarely unpacked. In middle school, performances of gender are especially prized, perhaps more so than at any other time in the life course (Crouter et al. 2007; Williams 2006) and gaming may advantage boys (Fox and Tang 2017). Boys spend more time playing videogames than girls (Lenhart et al. 2015; Rideout et al. 2022), but usage patterns may be less influential than the values and practices associated with more socially embedded aspects of gaming such as programming, information seeking and playing with friends. For children, these activities are often not connected into "lines of practice" that sustain interest or coalesce around tech-savvy identities (Azevedo 2011; Carter, Gibbs, and Harrop 2012; Consalvo 2017; Garcia 2017; Ito et al. 2013). Accounting for engagement in advanced gaming activities and identity in this key period may elucidate gender differentiated efficacy in computing, especially in the current educational environment where children usually learn digital technology outside of school.

In the current paper we examine gaming activities, identity and their association with computer skill and efficacy. Using a data set of 3868 children in middle school we assess gender differences in frequency of play, time playing on various devices, knowledge-based and social gaming activities, as well as gaming identity. We consider the different gender gaps across the activities, examine which forms of gaming are significantly associated with skill and confidence, and then evaluate gender separate models. While our study is limited in that it is cross-sectional, our results demonstrate how children learn outside of school and amongst peers in ways that sustain interest in a subject, thus shedding light on the socially embedded aspects of the digital divide (DiMaggio et al. 2004).

LITERATURE REVIEW

Participation in early computing paths may be influenced by experience with electronic devices and perceived ability to learn computing. Academic efficacy, belief in the capacity to learn a specific curriculum or field (Bandura et al. 2001), is associated with effort regulation and persistence towards learning activities (Richardson, Abraham, and Bond 2012). Computer efficacy in particular is correlated with elementary and middle school children’s experience with digital devices at home (Blanchard, Gardner-McCune, and Anthony 2018) and programming class learning outcomes such as computational thinking (Ketenci et al. 2019). Skills and attitudes towards learning computing may be mutually reinforcing because efficacy is associated with risk-taking, experimentation and practices that are generative in computing paths (Gee 2003; Klimmt and Hartmann 2006). Middle school may be a pivotal time for computing interest because educational trajectories become more salient (Legewie and DiPrete 2014). But, like science efficacy which appears to decline before the transition to high school (Lofgran, Smith, and Whiting 2015), computer efficacy also declines across the middle school grades, even as computer skill appears to increase (Ashlock, Stojnic, and Tufekci 2022).

The earlier in life that children have experiences and develop practices with electronic devices, the more familiarity and confidence they may associate with them, but there is evidence of gender differences. As early as elementary school, girls may spend less time playing with computer games and technological toys (Cherney and London 2006), but more recent evidence from the UK suggests that the gender gap in digital play is closing (Livingstone and Pothong 2021). Alternatively, culturally shaped beliefs about innate ability, the history of the field, and gender schemas may dampen girls' interest in computer science more so than other STEM fields (Cheryan et al. 2017; Correll 2004; Huffman, Whetten, and Huffman 2013; Leslie et al. 2015; Master et al. 2017; Meyer, Cimpian, and Leslie 2015; Moote et al. 2020). Taking account of culturally shaped beliefs and social structural processes, a body of scholarship shows that like-minded peer groups, adult support and belongingness facilitate child development of science efficacy and "science-possible selves" (Gauthier et al. 2017; Hill et al. 2017; Robnett 2016; Robnett and Leaper 2013; Rogers et al. 2021). Much less is known about how children develop computer efficacy which is often navigated in the private sphere.

Support in Early Computing Paths

Gender differentiated computer interest and efficacy may derive in part from the fragmented institutional and cultural support for computer science education in the U.S. K-12 education system. Technology education has been outside the purview of the U.S. Department of Education with separate state boards of education and "vocation-technical" schools. While parents, school administrators and teachers tend to agree that CS education is important (Google and Gallup 2020), the integration of technology throughout the curriculum is highly varied in part due to the emphasis that No Child Left Behind places on math and reading achievement over other subject matter (Gray et al. 2010; Puckett and Gravel 2020; Rothstein, Jacobsen, and Wilder 2008). There is evidence of change, but about 40% of middle schools do not offer any CS courses (Google and Gallup 2016, 2020) and when available, they are often not required which may disadvantage girls. Many children do not have a good understanding of what computing careers actually entail (Grover, Pea, and Cooper 2014), believing that computer scientists, for example, usually work in isolation (Hansen et al. 2017).

In social interaction, adult support for children's computing interest is also varied. Positive feedback from teachers and parent-led activities related to science and math are reliant on adult perception and discernment of child interest, which often advantages boys (Alexander, Johnson, and Kelley 2012; Archer et al. 2012; Lareau 2003; McKellar et al. 2019). Weak social support for teaching computing (Mazur and Woodland 2018) and cultural norms shape the framing of student digital skills in schools such that teachers have difficulty recognizing skills learned at home or do not see them as relevant (Paino and Renzulli 2013; Rafalow 2018).

Especially in the early teens, peers may play an important role in the development of computer skill and efficacy. As suggested by Gee (2003) and others, some forms of routinized play can become "affinity spaces" where similarly interested participants set goals and learn together by sharing passions and practices. Children may develop interest and confidence when equal access is provided in these low-stakes experiences, thus countering stereotypes (Gee and Hayes 2010). Shared hobbies are beneficial in science learning if they provide a forum for discussing interests and intersections of identity across multiple social contexts (Azevedo 2011), but since digital technology learning often takes place outside of school both in physical space and online, computing skills and efficacy may be dependent on peers and connected affinity spaces (Livingstone and Sefton-Green 2016).

Connecting Computer Skill, Efficacy and Gaming Activities into Lines of Practice

While much focus has been placed on gaming as a potential solution to the varied support for computer learning in the U.S., simply playing is likely insufficient because such contexts may be isolated in social networks and unassociated with affinity spaces. Even though physical and online spaces are often conceptualized by parents and others as mutually exclusive domains, this does not reflect reality. Rather, computer learning is an embedded social practice, a dimension of the digital divide which children may experience acutely (Livingstone and Sefton-Green 2016). The computer literacy and learning scholarship shows that children sustain their interest by actively connecting affinity spaces and advanced practices across multiple contexts such as school and at home, on gaming platforms and in the same physical space (Esteban-Guitart, Coll, and Penuel 2018; Ito et al. 2013, 2020). Analogous to Bourdieu's emphasis on the interplay of agency and structure (1977), connected learning experiences may depend on children knowing and interacting with peers who share their interests and practices such as modifying games with code, seeking information about the latest gaming technologies and developing the skills necessary to set up a gaming session which allows for multiple players. Called "paratexts" by some, children engage in activities beyond the game itself such that conversations, friends and practices overlap and emerge as "lines of practice" (Azevedo 2011; Carter et al. 2012; Consalvo 2017). Absent multiple connections to affinity spaces and social networks, gaming may function more as entertainment than as learning in early academic paths (Ferguson et al. 2014; Hartanto, Toh, and Yang 2018; Vedechkina and Borgonovi 2021). Lines of practice may contain several components which we describe below.

Knowledge-based gaming activities.

"Constructivist" practices like programming may build skill and confidence if connected to social contexts. Children enhance games through "mods", a form of programming that allows for various customizations, different progressions through games, and other options that are associated with computer efficacy (Bush, Gilmore, and Miller 2020; Consalvo 2009; Gee and Hayes 2010). Use of mods, cheats and other forms of programming rely on research into new games and strategies (Kahila et al. 2021; Lenhart et al. 2008; Williamson and Facer 2004). A recent study from Finland shows that 12 to 15 year old children engage in information seeking activities more often than discussing games, and both are more common than modifying games (Kahila et al. 2021).

Social gaming activities.

Children who are particularly engaged with knowledge-based activities may select friends with whom they can discuss their enjoyment of gaming (De Grove 2014; Eklund and Roman 2017, 2019). Playing with friends in large online role-playing games may build skills and efficacy because they organize thousands of players for discussions of play, strategy, and programming (Deci and Ryan 2014; Steinkuehler and Williams 2006) and the information available in such spaces can facilitate dialog about the gaming industry (Paaßen, Morgenroth, and Stratemeyer 2017; Williamson and Facer 2004) which may be crucial for learning the different paths into computing (Grover et al. 2014). Though children who play videogames together in the same physical space may find a more supportive environment less vulnerable to hostile gaming cultures, online play usually requires more complex technologies and thus the characteristics of in-person play may constrain rather than expand experimentation and skill development (Klimmt and Hartmann 2006).

Gaming identity.

Now frequently referenced in popular culture, a salient gamer identity may stitch together goals, motivations and actions that are otherwise fragmented or isolated. Although definitions vary (Paaßen et al. 2017), gaming identity is associated with social activities as well as practices (Eklund and Roman 2017) thus connecting well-being, commitment and behavior in a feedback loop (Tajfel 2010). Identity is often embedded in one's social structure (Stets and Burke 2000; Stryker and Burke 2000) and thus depends on multiple social supports.

Gender Differences in Gaming Activities

A popular assumption about videogames in American culture is that boys will be advantaged in what is perceived to be an undifferentiated masculine domain. If the cultures around gaming closely parallel those of computing such that the traditional "geek" stereotype is associated with both, girls may be less interested (Cheryan et al. 2009; Cheryan, Drury, and Vichayapai 2013) and this tends to be reflected in gender differences in gaming frequency (Lenhart et al. 2015; Rideout et al. 2022). As shown by the delineation of the associated advanced activities above, however, gaming is multifaceted and some activities and identities may be less risky than others. Boys and girls may consider the social costs to various gaming activities and invest accordingly (Grooten and Kowert 2015).

For example, linguistic profiling of female players and hostile treatment appear common in popular first-person shooter games, particularly when cues of feminine identity are apparent (Gray 2014; Ivory et al. 2014; Kuznekoff and Rose 2013). Perhaps reflecting girls' preference for in-person experiences that are less hostile, gender differences for teens' play in person appear smaller than play with friends online (Lenhart et al. 2015). Stigma can also limit the acknowledgement of interest to others who may perceive the activity as incongruent to identity (Shaw 2012) and this appears to be supported in patterns of gamer identity. In a national sample of teens, Burch and Wiseman found that approximately 35% of girls answered "yes" when asked if they identify as gamers, compared to 69% of boys (2015). By comparison, gaming activities which do not require social interaction may have narrow gender differences. A survey of middle schoolers completed between 2009 and 2012 (*N*=5720) shows that 28% of boys and 18% of girls reported that they "create games on their computer" (Webb and Miller 2015). According to a more recent national study (*N*=754), modifying games is a relatively rare activity, with only 3% of 8 to 12 year-olds reporting that they do this often (Rideout and Robb 2019).

Exploring Gender Differences in the Benefits of Advanced Gaming and Identity

While bridging efficacy, practices and social contexts is challenging for many children, video games are popularly perceived as a masculine space where boys and men who play may have higher status (Klimmt and Hartmann 2006). Therefore, in comparison to boys, girls may get less of a return on gaming in terms of pay-off for efficacy or skills. Though “trash talk” during play is often normalized (Ortiz 2019), the harassment which occurs in these spaces may disadvantage girls (Fox and Tang 2017; Kuznekoff and Rose 2013; Richard and Gray 2018). Some girls continue to play despite these challenges, but assume a secondary status in gaming communities (Fox and Tang 2014) thus gaining less skill and confidence from these experiences (Kaye and Pennington 2016; Richard 2017; Shaw 2012; Vermeulen et al. 2016; Vermeulen, Van Bauwel, and Van Looy 2017). Given the likely presence of stereotypes, as well as actual hostile behaviors or microaggressions in these spaces, girls may not experience the same boost to efficacy or skills from gaming activities as boys.

While traditional computer science “geek” identity may be unattractive to girls especially looking to avoid its anti-social connotations (Cheryan et al. 2013), “gamers” are well known in popular culture. Experimental research with adult subjects in the UK shows that gamer identity may offer protection from stereotypes and other cultural beliefs that otherwise weaken performance and enjoyment (Kaye 2019; Kaye and Pennington 2016). In other words, evidence suggests that gaming identity might be even more important for women’s outcomes than men’s as it serves a buffering effect from stereotyping.

The Current Project

Despite interest in gaming as a generative path to CS, its role is largely unknown in the crucial middle school period, a time in which young people are likely to avoid activities that do not easily mesh with their evolving gender identity. Informed by the research above, this project evaluates how children develop lines of practice by bridging contexts for learning computing as they pertain to gaming. Specifically, we examine a sample of middle school students and evaluate the relationship between skill, computer efficacy and the frequency with which children engage in the aforementioned gaming activities. In multivariate regressions, we control for household SES as previous scholarship has shown a relationship with social class and interest in computing (Charles and Bradley 2006; Yardi and Bruckman 2012), and for grade level as efficacy may decline in the early teens (Lofgran et al. 2015)

First, in middle school there are likely to be gender differences in skill and computer efficacy, as found in other research. Bivariate analyses will assess this hypothesis.

> Hypothesis 1: On average, boys will report more skill and computer efficacy than girls.

For children in their early teens, gaming may be a rare opportunity to develop computer skills, confidence and tech-savvy identities, but as described in the research above, boys and girls may differentially engage in gaming activities due their varied social risks.

> Hypothesis 2: Boys will report more hours of play on all devices with higher frequency than girls. Boys will also report higher frequency of knowledge-based activities, social activities and more salient gaming identity than girls.

In light of the research outlined above, the multivariate regressions may show that accounting for lines of practice may reduce the gender difference in skill and computer efficacy, net of controls.

> Hypothesis 3(a): Net of controls, accounting for modes of play, frequency of play, knowledge-based activities, social activities and gaming identity will reduce the gender differences in skill.

Hypothesis 3(b): Net of controls, accounting for modes of play, frequency of play, knowledge-based activities, social activities and gaming identity will reduce the gender differences in computer efficacy.

Some aspects of videogames have a masculine culture and this may lead to girls and boys having different experiences in affinity spaces. Evidence suggests that gaming identity, when salient, protects from stereotyping and hostile environments.

Hypothesis 4(a): Net of controls, gaming activity and identity will predict skill differently for girls than boys.

Hypothesis 4(b): Net of controls, gaming activity and identity will predict efficacy differently for girls than boys.

METHODS

Sample and Data Collection

This study reports analyses of a sample of middle school students in the Southeastern United States. Our methodology has been published previously (Ashlock et al. 2022) so we provide an abridged summary here. After focus groups and survey piloting in early 2015, the survey was administered in classrooms in Fall 2015 through Spring of 2016, in a paper-and-pencil format, resulting in an initial sample of 5235 students.

Respondents came from a stratified sample of high school students in three school districts in the Southeastern United States. We used a non-random sampling technique described in Cohen (1992), statistical power analysis, which places the focus on obtaining a sample that is diverse and large enough to allow for sufficient statistical power in the analyses. The choice of schools was based on the proportion of children eligible for reduced lunch, as well as the proportion of black, Latin American and Asian students according to publicly available information. In total, permission was obtained from fifteen schools, including 13 public schools (magnet and nonmagnet). The proportion of students surveyed in each school depended on the degree of access and resources of surveyors. The student response rate was high, in part due to IRB approval for an "opt out" form. We aimed for a near census of the schools, and according to publicly available information, we took an average sample of 83% of the school population. When we were unable to survey all students due to staffing constraints and other issues, a convenience sample was achieved, although a representative sample was made whenever possible. Thus, the proportion of white, black, Hispanic, and Asian students surveyed in each school is very similar to the public information of each school.[1]

As mentioned above, the three counties surveyed are located in the Southeastern United States. The U.S. South has higher poverty rates than the national average, and there is some evidence that gender differences in math and English language arts scores in the Southern region reflect more traditional stereotypes about gender-appropriate careers (Pope and Sydnor 2010). Reardon et al. (2019) find that the gender difference in math and English language arts state accountability tests tend to reflect the Pope and Sydnor findings but there is considerable variation by school district. For the three counties surveyed the gender difference in state accountability tests for math is -.05 to .05 standard deviation units (with upper bounds for boys) and -.35 to -.25 standard deviation units for English language arts (with upper bounds for girls) which indicates that they are representative of most counties in the United States (Pope and Sydnor 2010). The proportion of respondents with parents working in a STEM field is higher than the national average and thus may be more knowledgeable of STEM fields than other children in the United States.

A consistent analytic sample was specified with information for all models. Listwise deletion reduced our sample by 26% (from 5235 to 3868) but did not

[1] Additional information is available upon request.

significantly change the mean SES, the gender differences across the models, nor the substantive results. Demographic characteristics of the sample are described in Table 1. Overall 36% of the sample is estimated to receive reduced cost lunch. Typically underrepresented in surveys of this kind, Black students comprise 16.4% of the data set (634 respondents), Hispanics 11.7% (454 respondents), Asian Americans 10.8% (419 respondents) and multi-racial children 16% (621).

(Table 1 about here)

Measures

Dependent variables.

Our *task-based skill* measure (or "task-skill" for brevity) is a scale generated from a list of twelve tasks that students reported to have ever done on a computer (0 to 12). Respondents netted an additional point on the scale for each task completed. Self-reported task familiarity constructs have good predictive power of actual skills completed in a lab environment (Hargittai 2005, 2008; Hargittai and Hsieh 2011; Hargittai and Kim 2010). Our task-skill index consists of a battery of self-reported literacy items in using software, hardware, and the internet and is similar to a more recent survey, the National Assessment of Educational Progress Computer Access and Familiarity Study (National Assessment of Educational Progress (NAEP) 2019:23). The Cronbach's alpha for the tasks is .76. Since self-reported tasks do not necessarily indicate actual skill, readers should take caution when interpreting the results.

Computer efficacy is a measure which evaluates perceived competence in a specific field of academic study and was developed by Bandura et al. (2001). Students in the survey were asked: "Please rate how well you feel you are able to do each of the things described below" with the numbers 1 through 10 listed for them to circle. "Learn computers" was included in the list of five items (see Figure 1). Our measure is future-oriented and specific to academic learning of computers.

(Figure 1 about here)

Variables of interest.

There are two groups of gaming variables used in this paper: general and advanced. The *general gaming measures*, *mode* and *frequency,* are broad indicators of gaming activity. The mode variables are hours per week that the respondent plays on various devices. They derive from a battery of questions which ask the respondent to report the number of hours (on schooldays and weekend days) for different uses of technology (chatting, doing homework, surfing the web, watching videos, watching TV), including separate items for playing games on specific devices (cell phone/tablet (a combined question), console, computer, or something else). We use the cell phone/tablet, console and computer gaming measures only as these uses were overwhelmingly the most common in our sample and chatting, homework and surfing were not associated with computer skill or efficacy. (Additional information is available upon request.)

The second general gaming measure is gaming frequency which is reported on a scale of 1 to 5 ("almost every day" to "I don't play video games at all"). This measure was then reverse coded and converted to 0 to 4 to facilitate more intuitive interpretations of the regression coefficients.

The *advanced gaming measures* include two *knowledge-based activities*, three *social activities*, and *gamer identity*. The two knowledge-based activities are (1) the frequency with which the respondent looks up game reviews, gaming strategies or "cheats" (a form of coding that gains access to additional content or customization), and (2) uses mods or scripts when playing video games. *The social activities* include talking to friends about video games; playing video games with friends in person, in the same room; or playing video games online with friends who are not in the same room. The scale for all of the above items ranges from "often", "sometimes", "rarely", and "never" and are reverse coded such that higher values indicate greater frequency (1 to 4). *Gaming identity* is a single-item measure derived from a section of the survey in which respondents were presented with a battery of six different statements, “I consider myself a _______” (gamer, fashionista, jock, geek, music buff, nerd). Respondents were asked to report how much they felt each statement was true on a scale of “Not at all true of me” and “Very true to of me” (1 to 4). Only the gamer measure is included in our analyses.

Control variables.

Gender is a dichotomous variable, in which self-identified girls were coded as 1 and self-identified boys were coded as 0.

Socio-economic status (SES) is a composite adapted from the measure of SES in PISA (Programme for International Student Assessment 2014:16), a well-known cross-national comparison of 15-year-old student achievement. PISA combines parents’ highest education, highest occupation socio-economic index, and an index of 23 household items intended to measure wealth, cultural possessions, and educational resources. The weights assigned to each component are empirical; they come from the principal component analysis. We emulate the PISA measure of SES, the only exception being that we use a different index in the place of home possessions. More detailed information about the SES measure can be found in Ashlock et al. (2022).

Variables describing *race and ethnic origins* derive from an item on the survey, “What is your race or origin? Check all that apply” with the following categories: “White”, “Black or African American”, “Hispanic/Latino/Spanish”, “Asian (including India/Pakistan)”, “Native American” and “Other. Specify:”. Our measure is similar to the combined race and ethnicity question described in Krogstad and Cohn (2014). Only those respondents who placed themselves in the single race category were coded as such. The “Other” category was checked for answers consistent with multi-racial identity. Children who indicated “White” and also reported European American lineage in the “Other” section were coded as White. The “other” category consists of Native American and multiracial children. Readers thus need to be careful when interpreting this category or making comparisons to it. The “race” categories in all regression analyses are dummy variables. The omitted category is “White”.

The *computer ownership* measure is constructed from a question on the survey which asked respondents if they own a computer and if they have their own device, if they shared it with people in their family, or if they didn’t have the device. Answers were coded as “owning”, “sharing”, or “not having” and ambiguous answers coded as missing.

Dummy variables for *cell phone, tablet and game console ownership* are also included in the models to distinguish students who “never” play games with students who own the devices but do not use them. The coefficients are not reported in the models as they are not statistically significant and a note is included in the table for readers.

Math grades and science grades are self-reported. Higher values indicate As, lower values indicate Ds, etc. Self-reported grades are adequate measures of academic performance as students tend accurately respond to such questions in surveys. It should be noted that respondents may inflate their performance when such an item is sensitive, as in the case that they are lower performing (Rosen, Porter, and Rogers 2017). Readers are advised to take these issues into account.

Since other research finds declines in science efficacy across the middle school grades (Lofgran et al. 2015), dummy variables for *grade level* are also included, with 6th grade as the omitted category.

Missing Values

Stata applies listwise deletion to observations with at least one missing value in any variable. We identified a consistent analytic sample with information for all models. The following descriptive statistics, correlations and regression models include only those respondents who have non-missing data across all models. While this reduces our sample size overall by about 26% (from 5235 to 3868), the substantive conclusions reached did not change.

Analytical Strategy

Our analysis takes place in two main parts. First bivariate analyses evaluate the extent of the gender differences across the dependent variables (hypothesis 1) and variables of interest (hypothesis 2) and then a correlation matrix is presented. Second, multivariate analyses using ordinary least square regressions evaluate gender differences in computer task-skill as well as computer efficacy, net of the general gaming measures (mode and frequency) and advanced gaming measures. Skill is evaluated first to test support for hypotheses 3(a) and 4(a) and then efficacy is tested to evaluate support for hypotheses 3(b) and 4(b). Gaming identity is included as a separate step in the models to evaluate if it is associated with the other measures or whether it has an independent effect. The task-skill measure is also added to the efficacy models to evaluate its effect independently from the other gaming activities, thus connecting "lines of practice". In order to make comparisons across the two dependent variables in the multivariate analyses, we standardized them. The coefficients in tables 4 and 5 should be interpreted as changes in standard deviation units as they are associated with the dependent variable, abbreviated as *SD* units. To account for possible correlated residuals amongst students in each of the 15 schools, the cluster() option was used in Stata. Post-hoc tests for evaluating the significance of the coefficients in the gender-separate models include the ANOVA with Barlett test for equal variances and Lavene's test.

RESULTS

Bivariate Analyses

The bivariate results provide support for some of the predicted gender differences (table 2). While there are gender differences in both dependent variables and this supports hypothesis 1, the gender difference in computer skill is smaller (0.21 in comparison to 0.55 *SD* units).

Overall, children engage in a wide variety of video game play. As predicted in hypothesis 2, boys play more frequently and for more hours on all devices. The gender difference for time spent per week playing on computers is 0.34 *SD* units, about half the size of the difference for time playing gaming consoles (0.64 *SD* units).

Turning to the gender differences in the advanced gaming activities, frequency of engagement is higher for boys overall, further supporting hypothesis 2. Gender differences in the knowledge-based activities are smaller than for the social activities, similar to previous research (Lenhart et al. 2015; Webb and Miller 2015). When asked if they consider themselves a gamer, the average for girls is closer to “2”, “mostly not true of me”, and for boys it is closer to “3”, “a little true of me”. This gender difference in identity amounts to one *SD* unit. The gender difference grows as commitment to the identity rises. About 40% percent of boys in the sample indicated that this was “very true of me” in comparison to 10% of girls, a significant difference which is larger than previously found (Burch and Wiseman 2015).

(Table 2 about here)

Correlation Matrix

The bivariate correlations offer an overview of the interconnected gaming activities (table 3). Task-based skill is correlated with gaming frequency at .1 and is significantly correlated with hours gaming on a computer, but not gaming on cell phones/tablets and consoles. While the knowledge-based activities of looking up reviews and modding games are similarly associated with skill and efficacy, most of the social activities and identity are more strongly correlated with computer efficacy. Gender is most strongly correlated with the social activities and gamer identity.

Gaming identity salience is strongly associated with all of the advanced gaming activities. The strongest correlates with gaming identity are talking to friends about games (.71) and playing online with friends (.61). The other advanced gaming activities are also strongly associated: looking up game reviews (.58), modding games (.53), and playing in person with friends (.49) and frequency of play (.47).

Grade in school (6, 7 and 8) is associated with more computer skills, suggesting accumulating skill, but grade level is associated with significantly *less* computer efficacy. Self-reported science grades are negatively correlated with all of the gaming measures though they are not significant for frequency of play, talking about games, and playing in person.

Multivariate Analyses

Computer task-skill. Overall our measures explain 22 percent of the variance in computer task-skill, as shown in table 4. The gender difference in computer skill is -0.21 *SD* units in the constrained model (see model 1). The addition of the general gaming measures (model 2) reduces the gender difference in computer skill by .09 *SD* units or 43% such that the gender coefficient is no longer statistically significant. The hours per week played using a computer has a large role in reducing the gender gap. The addition of the knowledge-based activities and social activities in model 3 reduces the gender coefficient another .12 SD or 98%. This step in the analysis reveals that playing on a computer is associated with skill-enhancement through the knowledge-based activities. Playing games online with friends appears to be associated with computer gaming in particular. Gaming identity has a modest association with skill and does not explain additional variance in the dependent variable. When identity is added to the model, the coefficient for talking about games becomes significant and negative. Overall these results suggest that the gender gap in task-based skill is explained by the knowledge component of gaming. These findings generally support hypothesis 3(a).

Hypothesis 4(a) predicted that gaming activities would be experienced differently by boys and girls. Time played on a computer and modding are associated with more skill enhancement for boys than girls and supports hypothesis 4(a), congruent with stereotyping. Curiously, playing online has similar association with skill for boys and girls, however (comparing models 5 and 6). As the descriptive results show, boys more frequently engage in modding (table 2), and they may get more out of this activity as well, perhaps by engaging in more intensive programming. Gamer identity has a modest association with skill and similarly experienced by boys and girls. Hypothesis 4(a) is partially supported.

(Table 4 about here)

Computer efficacy. Overall the models explain 29 percent of the variance in computer efficacy. The gender difference in efficacy, -0.55 *SD* units, is over twice as large as the difference in the constrained task-based skill model (comparing model 1 in table 4 to model 1 in table 5). While including the general gaming measures reduces the gender difference in efficacy by 0.08 *SD* units or 15%, the addition of the knowledge-based and social activities reduces the difference by another 32% to -0.31 *SD* units (comparing models 2 and 3 in table 5). Knowledge-based activities and talking to friends about games have significant associations.

When gaming identity is added to model 4 it does not substantially change the gender co-efficient, but the coefficients for time played on a computer and talking to friends about games are no longer statistically significant. Gaming console time also shifts to a significant negative association. Overall, this suggests that children who identify with gaming play more hours on a computer, modify games and discuss games in ways that enhance their efficacy more than children who do not identify. Hours played on a console, when not associated with gaming identity, tend to be negatively associated with computer efficacy. The coefficient for identity (.16 in model 4) explains more variance than the knowledge-based activities, an effect which appears independently associated with computer efficacy. Gaming identity remains a robust and independent component of efficacy when skill is added to the model. Overall these findings provide support for hypothesis 3(b).

Comparing models 6 and 7 to evaluate hypothesis 4(b), there are no significant gender differences for the general gaming measures nor the gaming activities in the computer efficacy models. This suggests that gamer identity has a similar effect for girls and boys and thus does not support hypothesis 4(b).

A separate analysis (not shown) does not find any significant gender differences prior to the addition of the skill measure in model 5, including for computer efficacy by grade level. The significant gender difference by grade level found in models 6 and 7 suggests that while boys appear to experience a similar downward trend in efficacy, the gap across the grades appears more severe for girls, net of skill.

A few overarching themes emerge in the results. Overall, the gender gap in computer efficacy is larger than the gap for skill. Skill appears largely associated with the knowledge-based activities as well as playing with friends online. Efficacy, on the other hand, has a direct socio-psychological component (gamer identity) which is independent of task-based skill. Efficacy also has an indirect knowledge-based component through an association with task-based skill. While popular, in-person play does not have a significant relationship with computer skill or efficacy in the models, though it is correlated with gaming frequency and talking about games with friends.

Playing games on a computer appears to be associated with more frequent participation in gaming activities overall, perhaps because children who use computers to play games find that they facilitate more forms of play, experimentation and social interaction than other devices, thereby enhancing lines of practice. Even though many of the gaming activities were negatively associated with math and science grades in the correlation matrix, math and science grades are positively associated with computer skill and efficacy net of the controls. This suggests that strong academic performance is positively associated with early computing paths.

(Table 5 about here)

DISCUSSION

Informed by scholarship on the fragmented support for computing in the U.S. and the importance of children developing lines of practice that connect efficacy, practices and social activities, we evaluated the relationship between different forms of gaming on skill and computer efficacy. *As described above, we find support for hypotheses 1, 2, 3. Hypothesis 4(a) is partially supported and 4(b) is not supported.* The gender difference in computer efficacy is much larger than the gender difference in computer skill which supports other work which points to more socio-psychological explanations of the gender gap in early computing paths, as opposed to skill or intrinsic qualities such as ability. We find gendered patterns in most of the gaming variables, and the contrasts are especially evident in social activities and gamer identity which may have greater social risks. We also find that the advanced gaming activities such as programming games, social activities and gamer identity explain the gender difference in computer skill and reduce the gender differences in computer efficacy by half. The gender stratified models on the whole show advanced gaming has similar association with skill and computer efficacy for boys and girls, including gaming identity. The results in total do not support the common claim that girls are initially less interested in gaming or that it has different meanings for them. Rather, the differences at this stage appear to be about engaging in practices and cultivating identities because generally when girls do this at rates similar to boys, they will develop the same skills and efficacy.

An ongoing concern about the digital divide is that literacy includes knowledge-based and social practices that take place in the private and public sphere. As Livingstone and others have noted, children may experience these disconnects in especially acute ways when computing is not integrated in early education. Thus, the generative elements of digital gaming are not necessarily encapsulated by the net hours in which children play or frequency of play, but developing practices and identities that consistently build upon one another. For example, we find that knowledge-based activities such as modifying games are associated with skill development as found in other research (DiSalvo, Crowley, and Norwood 2008; Gee 2007), but that boys engage in this activity more frequently and in more skill-enhancing ways than girls, perhaps because they play on a computer more frequently. Boys also play online with friends more frequently where together they may find information about modifying games, but this activity may be socially risky for girls.

The most potentially stigmatized dimension of gaming is perhaps the salience of gamer identity. Gaming identity appears to bundle frequent play, computer play, programming, skill, and online play together in such a way that they are efficacious and associated with skill. When combined, attitudes towards computing, identity and knowledge-based activities may build tacit knowledge, a kind of understanding that becomes “second nature” and requires less cognitive effort (Azevedo 2011; Consalvo 2017; Eklund and Roman 2017; Garcia 2017; Lizardo 2017). But since girls may not have as much access to friends who validate this identity, they may find more difficulty engaging in social gaming and knowledge-based practices that sustain learning. Though playing video games is likely not the only generative activity in computing paths (Master et al. 2017; Nugent et al. 2019), the gender differences in advanced gaming practices and identity reflect the difficulty - especially for girls – to game in ways that sustain interest in computer science (Wong 2016) and may lead some to depart computing paths.

Though limited, our results support the idea that interests are associated with both self-conceptualizations and practices. Our results suggest that gamer identity depends on connecting and engaging in frequently isolated contexts – modifying games, playing on a computer, online gaming, and talking with friends. Girls and boys receive the same boost in computer efficacy when they have the same level of identity. A body of research shows that STEM identities in particular may have long term benefits for the pipeline, over and above that of field-specific confidence (Cech et al. 2011; Ceci and Williams 2010; Simpkins, Davis-Kean, and Eccles 2006; Stets et al. 2017). Prior research has shown that STEM self-expressions act as a kind of emotional "buy-in" in early paths (Charles 2017:11) and in the case of gaming this may often require negotiating gender expressions in the private sphere. Characterizations of gamers in popular culture personify gamers as masculine which may contribute to perceived entitlement in these spaces for children who identify. Regardless of gender, however, our results suggest that a critical aspect is engaging in the specific activities associated with this identity, as well as not avoiding this identity when one participates in such activities.

There are alternative explanations for our findings. For example, since we do not account for participation in computer classes, after school activities, or out-of-school learning activities that incorporate game programming or social activities, we are not able to account for the extent to which social contexts are isolated for our respondents (Alexander et al. 2012). Girls may do more work to bridge contexts than boys due to emphasis on same-sex friendships at this age, for example. We do not account for play with parents and siblings and the bonding which takes place in families may be a generative factor (Eklund 2015; Harvey 2015). It is also difficult to determine how online and in-person gaming differs in early computing paths since children often play both online and in person. All else held equal, in-person gaming does not appear have a significant association with skill or efficacy in our results.

When it comes to digital divides, advantages come in the form of access, various forms of device usage, as well as the information available in social networks (DiMaggio et al. 2004). The present research highlights the ways that identity may enhance or hinder lines of practice. Beyond the contribution of material resources and cognitive skill, a child's confidence in their ability to learn digital devices is a form of cultural capital that may have long term consequences for career paths.

Limitations

Our results should be evaluated with the knowledge that our methodology allows for a comparison of gender differences in gaming, but it does not offer the ability to evaluate the processes by which these relationships come to be. Our study is cross-sectional and thus our results do not evaluate causality, only correlation. We also excluded survey items such as intended college major as they may have primed respondents in the survey and biased answers. Thus, our findings may only be relevant to this age group. Finally, due to our research site location, parent labor force participation in STEM fields is very likely above the U.S. average. While controls for parent occupation did not change the regression results, our respondents' knowledge of computing may be higher than other children in the U.S.

Future Work

Our results inform future research on children's computer learning. Research into additional gaming activities, social contexts, gaming identity and connections with learning would be well-served. For example, literacy practices in libraries and afterschool are increasingly popular as are gaming walkthroughs (such as those on Twitch.tv). These may add additional dimensions to connected learning practices (Ito et al. 2020). Stereotyping and boundary work in gaming spaces may discourage underrepresented groups from participation and additional aspects of identity could be incorporated.

As others have noted, informal learning spaces such as advanced gaming fill a gap in the current K-12 curriculum but our results further support the movement to bring more computer learning into early education. Many educators, researchers and gamers address this issue, calling for interventions much earlier in the pipeline, the funding and development of educational games that facilitate community learning, and computing to be further integrated into K-12 curriculum (Ito et al. 2020; Scholes, Mills, and Wallace 2021; Tekinbaş 2020).

CONCLUSION

Informed by evidence which emphasizes the importance of skills and computer efficacy in early computing paths, as well as the unique circumstances in which children learn digital technology, our analyses investigated the role of advanced gaming activities. Accounting for knowledge-based activities, social activities and gamer identity, we fully explain the gender difference in computer skill and half the variance in computer efficacy. We find that knowledge-based activities and gaming identity are likely a feature of early computing paths because they connect often socially distant activities into lines of practice, but that girls may be disadvantaged in the current social context of gaming.

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TABLES (1-5)

Table 1. Demographics of combined sample (*N* = 3868)

		N	Percent
Gender			
	female	1883	48.7
	male	1985	51.3
Race/ethnicity			
	White	1746	45.0
	Black/African American	634	16.4
	Hispanic/Latino	454	11.7
	Asian American	419	10.8
	Other	621	16.1
Receive reduced cost lunch (est)			36.0
Grade			
	6th grade	1113	28.8
	7th grade	1401	36.2
	8th grade	1354	35.0
Computer			
	own	1912	49.4
	share with others in home	1748	45.2
	no home computer	208	5.4
Cell phone (shared or own)		3305	85.4
Tablet (shared or own)		3078	80.5
Game console (shared or own)		3411	88.2

Table 2: Bivariate Analyses for Dependent Variables and Variables of Interest

Variable	Range	All N = 3868 M (SD)		Girls N = 1985 M (SD)		Boys N = 1883 M (SD)		
Dependent variables								
Task-based Computer skill	0-12	7.16	(2.81)	6.84	(2.61)	7.48	(2.97)	*
Computer efficacy	1-10	6.75	(2.60)	6.04	(2.62)	7.50	(2.35)	*
Controls (abridged)								
Math grades	0-4	3.40	(0.83)	3.40	(0.82)	3.40	(0.85)	
Science grades	0-4	3.46	(0.81)	3.51	(0.76)	3.42	(0.86)	*
eneral gaming measures								
Modes of play								
Cell & tablet game hrs/wk	(continuous)	6.29	(7.52)	5.75	(7.47)	6.86	(7.54)	*
Console gaming hrs/wk	(continuous)	6.06	(9.48)	3.12	(6.98)	9.16	(10.70)	*
Computer gaming hrs/wk	(continuous)	4.60	(6.70)	3.47	(5.83)	5.79	(7.31)	*
Gaming frequency								
Gaming frequency (never - every day)	0-4	3.00	(1.25)	2.63	(1.40)	3.40	(0.91)	*
Advanced gaming measures								
Knowledge-based activities								
Looks up game strategies, reviews & "cheats"	1-4	2.37	(1.08)	2.03	(1.03)	2.72	(1.01)	*
Uses game mods	1-4	1.89	(1.07)	1.62	(0.94)	2.18	(1.11)	*
Social activities								
Talks about games w/friends	1-4	2.49	(1.17)	1.91	(1.04)	3.10	(0.98)	*
Plays in person w/friends	1-4	2.43	(1.11)	2.04	(1.08)	2.84	(0.98)	*
Plays online w/friends	1-4	2.35	(1.26)	1.79	(1.09)	2.93	(1.16)	*
Gaming identity	1-4	2.36	(1.19)	1.81	(1.04)	2.94	(1.06)	*

Note: SD = standard deviation

*Statistically significant gender difference (*p*<.001)

Table 3. Correlation matrix - variables of interest (N = 3868)

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Female indicator	1																
2.	SES	0.00	1															
3.	Math grade (1-4)	0.00	0.37 *	1														
4.	Science grade (1-4)	0.06 *	0.39 *	0.49 *	1													
5.	Own computer (0-1)	- 0.01	0.21 *	0.08 *	0.08 *	1												
6.	Grade in school	0.01	0.01	0.01	- 0.02	0.09 *	1											
7.	Cellgame hrs/wk	- 0.07 *	- 0.20 *	- 0.20 *	- 0.16 *	- 0.04	- 0.10 *	1										
8.	Console hrs/wk	- 0.32 *	- 0.25 *	- 0.24 *	- 0.23 *	- 0.01	0.02	0.38 *	1									
9.	Compgame hrs/wk	- 0.17 *	- 0.10 *	- 0.15 *	- 0.12 *	0.15 *	- 0.07 *	0.36 *	0.28 *	1								
10.	Gamefreq (0-4)	- 0.31 *	- 0.05	- 0.08 *	- 0.04	- 0.01	- 0.11 *	0.31 *	0.27 *	0.30 *	1							
11.	Lookup reviews (1-4)	- 0.32 *	- 0.08 *	- 0.11 *	- 0.09 *	0.06 *	- 0.04	0.20 *	0.31 *	0.30 *	0.39 *	1						
12.	Mod games (1-4)	- 0.26 *	- 0.06 *	- 0.10 *	- 0.09 *	0.11 *	- 0.06 *	0.17 *	0.26 *	0.37 *	0.31 *	0.56 *	1					
13.	Talk games (1-4)	- 0.50 *	- 0.04	- 0.05 *	- 0.05	0.05	- 0.07 *	0.18 *	0.35 *	0.34 *	0.44 *	0.58 *	0.51 *	1				
14.	Play in person (1-4)	- 0.36 *	- 0.00	- 0.02	- 0.05	0.03	- 0.06 *	0.16 *	0.30 *	0.20 *	0.37 *	0.41 *	0.39 *	0.59 *	1			
15.	Play online (1-4)	- 0.45 *	- 0.07 *	- 0.07 *	- 0.08 *	0.10 *	- 0.01	0.18 *	0.39 *	0.35 *	0.40 *	0.50 *	0.51 *	0.66 *	0.50 *	1		
16.	Gamer identity (1-4)	- 0.47 *	- 0.07 *	- 0.09 *	- 0.06 *	0.05	- 0.08 *	0.19 *	0.40 *	0.39 *	0.47 *	0.58 *	0.53 *	0.71 *	0.49 *	0.61 *	1	
17.	Task-based skill (0-12)	- 0.11 *	0.18 *	0.12 *	0.13 *	0.23 *	0.21 *	- 0.02	0.03	0.13 *	0.10 *	0.19 *	0.27 *	0.18 *	0.13 *	0.24 *	0.21 *	1
18.	Comp efficacy (1-10)	- 0.28 *	0.14 *	0.15 *	0.14 *	0.12 *	- 0.04	0.01	0.06 *	0.15 *	0.17 *	0.26 *	0.27 *	0.31 *	0.20 *	0.27 *	0.35 *	0.41 *

Table 4. Linear regression of task-based skill (std) by gaming measures

	m1	m2	m3	m4	m5 Girls	m6 Boys	
	b/se	b/se	b/se	b/se	b/se	b/se	
<u>Controls</u>							
Girls	-0.209 **	-0.119	-0.002	0.016			
	(0.06)	(0.06)	(0.06)	(0.06)			
SES	0.073 **	0.087 **	0.088 **	0.089 **	0.093 **	0.099 *	
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	
Black	0.021	0.011	0.002	0.006	0.069	-0.063	
	(0.07)	(0.06)	(0.05)	(0.05)	(0.06)	(0.10)	
Hispanic	-0.057	-0.035	-0.063	-0.065	0.036	-0.144	
	(0.08)	(0.07)	(0.07)	(0.07)	(0.09)	(0.09)	
Asian	0.308 **	0.333 ***	0.276 **	0.269 **	0.286 **	0.240 *	
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.10)	
Other race	0.158 ***	0.158 ***	0.124 **	0.123 **	0.124 *	0.104	
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)	
Math grades (0-4)	0.031	0.05 *	0.058 **	0.059 **	0.072 **	0.048	
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	
Science grades (0-4)	0.084 *	0.088 *	0.092 **	0.088 **	0.056	0.111 **	
	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	
No home comp (omitted: own)	-0.430 ***	-0.346 ***	-0.307 ***	-0.315 ***	-0.279 ***	-0.340 ***	
	(0.06)	(0.05)	(0.04)	(0.04)	(0.06)	(0.07)	
Shared comp (omitted: own)	-0.322 ***	-0.282 ***	-0.240 ***	-0.242 ***	-0.204 ***	-0.269 ***	
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	
Grade 7 (omitted: 6th grade)	0.229 ***	0.245 ***	0.246 ***	0.251 ***	0.252 ***	0.250 ***	
	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.03)	
Grade 8 (omitted: 6th grade)	0.442 ***	0.484 ***	0.495 ***	0.501 ***	0.509 ***	0.486 ***	
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	
<u>General gaming measures</u>							
Modes of play							
Cell & tablet game hrs/wk (std)		-0.035	-0.022	-0.017	0.005	-0.032	
		(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	
Console game hrs/wk (std)		0.015	-0.031	-0.040	0.025	-0.044	
		(0.02)	(0.02)	(0.02)	(0.04)	(0.03)	
Comp game hrs/wk (std)		0.122 ***	0.046 *	0.037 *	-0.045	0.068 *	ɫ
		(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	
Gaming frequency (0-4)		0.065 **	0.019	0.012	0.013	-0.001	
		(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	
<u>Advanced gaming measures</u>							
Knowledge-based activities							
Looks up reviews (1-4)			0.035 *	0.024	0.058 **	0.000	
			(0.02)	(0.02)	(0.02)	(0.02)	
Uses game mods (1-4)			0.172 ***	0.163 ***	0.077 **	0.203 ***	§
			(0.02)	(0.02)	(0.02)	(0.02)	
Social activities							
Talks to friends re:gaming (1-4)			-0.018	-0.042 *	-0.002	-0.075 ***	
			(0.02)	(0.02)	(0.04)	(0.03)	
Plays in person w/friends (1-4)			-0.009	-0.010	-0.004	-0.023	
			(0.02)	(0.02)	(0.02)	(0.03)	
Plays online w/friends (1-4)			0.101 ***	0.093 ***	0.104 ***	0.103 ***	
			(0.02)	(0.02)	(0.02)	(0.02)	
Gamer identity (0-4)				0.075 **	0.061 *	0.095 *	
				(0.02)	(0.03)	(0.03)	
Constant	-0.591 **	-0.901 ***	-1.388 ***	-1.410 ***	-1.481 ***	-1.205 ***	
	(0.17)	(0.16)	(0.15)	(0.15)	(0.14)	(0.20)	
R-sqr	0.145	0.167	0.222	0.225	0.194	0.254	

* p<0.05, ** p<0.01, *** p<0.001; ɫ Stat. sign. gender difference at p<0.01; § Stat. sign. gender difference at p<0.0001

All models include controls for cell phone, tablet and game console ownership

Table 5. Linear regression of Computer efficacy (std) by gaming measures

	m1	m2	m3	m4	m5	m6 Girls	m7 Boys
	b/se	b/se	b/se	b/se	b/se	b/se	b/se
<u>Controls</u>							
Girls	-0.546 ***	-0.462 ***	-0.314 ***	-0.276 ***	-0.281 ***		
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)		
SES	0.049 *	0.062 *	0.064 **	0.066 **	0.036	0.057 **	0.011
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Black	0.004	-0.003	-0.011	-0.002	-0.004	0.022	-0.048
	(0.05)	(0.05)	(0.05)	(0.04)	(0.03)	(0.06)	(0.07)
Hispanic	0.035	0.056	0.045	0.041	0.063	0.097	0.009
	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)	(0.07)	(0.09)
Asian	0.132	0.155	0.091	0.076	-0.014	0.045	-0.086
	(0.08)	(0.08)	(0.08)	(0.08)	(0.05)	(0.07)	(0.05)
Other race	0.027	0.031	0.000	-0.003	-0.043	-0.04	-0.051
	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)
Math grades (0-4)	0.086 *	0.103 **	0.111 **	0.113 **	0.094 **	0.135 ***	0.055
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Science grades (0-4)	0.108 **	0.111 **	0.112 **	0.104 **	0.075 *	0.044	0.097 *
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
No home comp (omitted: own)	-0.306 **	-0.227 *	-0.195	-0.212	-0.107	0.040	-0.247 **
	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.16)	(0.15)
Shared computer (omitted: own)	-0.177 ***	-0.140 ***	-0.109 **	-0.115 **	-0.034	-0.018	-0.061
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Grade 7 (omitted: 6th grade)	-0.124 *	-0.110 *	-0.106 *	-0.094 *	-0.178 ***	-0.234 ***	-0.117
	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)	(0.05)	(0.06)
Grade 8 (omitted: 6th grade)	-0.122 **	-0.083 *	-0.064	-0.051	-0.219 ***	-0.275 ***	-0.154 ** [a]
	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.05)	(0.04)
<u>General gaming measures</u>							
Modes of play							
Cell & tablet game hrs/wk (std)		-0.036	-0.025	-0.015	-0.009	-0.044	0.025
		(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Console game hrs/wk (std)		0.012	-0.033	-0.054 **	-0.040 *	0.001	-0.067 *
		(0.02)	(0.02)	(0.02)	(0.01)	(0.04)	(0.03)
Comp game hrs/wk (std)		0.115 ***	0.045 *	0.024	0.012	-0.012	0.023
		(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.03)
Gaming frequency (0-4)		0.063 **	0.008	-0.008	-0.012	0.008	-0.047 *
		(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
<u>Advanced gaming measures</u>							
Knowledge-based activities							
Looks up reviews (1-4)			0.078 ***	0.053 ***	0.045 **	0.062 *	0.035
			(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Uses game mods (1-4)			0.108 ***	0.088 ***	0.033	0.015	0.044 *
			(0.01)	(0.01)	(0.02)	(0.03)	(0.02)
Social activities							
Talks to friends re:gaming (1-4)			0.082 **	0.028	0.042	0.021	0.065 *
			(0.03)	(0.03)	(0.02)	(0.03)	(0.02)
Plays in person w/friends (1-4)			-0.013	-0.016	-0.013	-0.033	0.001
			(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Plays online w/friends (1-4)			0.038	0.020	-0.011	-0.007	-0.01
			(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
Gamer identity (0-4)				0.165 ***	0.140 ***	0.161 ***	0.128 ***
				(0.02)	(0.01)	(0.02)	(0.02)
<u>Computer skill</u>							
Task-based skill (std)					0.334 ***	0.367 ***	0.302 ***
					(0.02)	(0.03)	(0.02)
Constant	-0.323	-0.619 ***	-1.157 ***	-1.206 ***	-0.735 ***	-1.020 ***	-0.660 *
	(0.16)	(0.15)	(0.14)	(0.15)	(0.13)	(0.14)	(0.26)
R-sqr	0.130	0.149	0.194	0.209	0.292	0.212	0.273

* p<0.05, ** p<0.01, *** p<0.001 [a] Statistically significant gender difference at p<.05

All models include controls for cell phone, tablet and game console ownership

FIGURE

Figure 1. Measures of Academic Efficacy in Survey

51. Please rate how well you feel you are able to do each of the things described below.

(*Circle the appropriate number.*)

	Not Well at All				Middle					Very Well
a. Learn math	1	2	3	4	5	6	7	8	9	10
b. Learn science	1	2	3	4	5	6	7	8	9	10
c. Learn computers	1	2	3	4	5	6	7	8	9	10
d. Take good notes during class instruction	1	2	3	4	5	6	7	8	9	10
e. Concentrate on school subjects during class	1	2	3	4	5	6	7	8	9	10