The Girls Creating Games Program: An Innovative Approach to Integrating Technology into Middle School

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Abstract

The Girls Creating Games program is a demonstration project designed to increase the number of girls who become producers, rather than just users, of technology. The activities and instructional approach are aimed to increase girls' expectations for success with computers and the extent to which they value computer work and the support they receive. In over 23 sessions after school and in the summer, middle school girls worked in pairs to design and program a computer game that was supposed to help other students. Two hundred fourteen girls participated in a study of the program. Data from surveys and interviews suggest that compared to girls not in the program, participants increased their computer skills, knowledge about computers, and perceived social support. They decreased their negative stereotypes about girls and information technology workers. Implications for applying aspects of the program to middle school classrooms are discussed.

Introduction

Although men and women *use* computers at equal rates, there are vast gender differences in who *designs* and *produces* new computer hardware and software technologies (U.S. Department of Education, 2000). Women, Latinos, and other minorities are the least likely to be interested in or aware of high-tech careers (Kearney, 2002), and women make up only 27% of workers in the areas of computer and mathematical operations (U.S. Department of Labor, 2005). Barriers include a lack of confidence, negative attitudes toward computers, lack of social support, and the belief that computers require solitary work with little social relevance (American Association of University Women, 2000; Goode, Estrella, & Margolis, 2006; Zarrett, Malanchuk, Davis-Kean, & Eccles, 2006).

Middle school may be a key time for intervention. In these years, students make critical choices regarding their identity and perceived ability, which shape their educational and career paths (Brickhouse, Lowery, & Schultz, 2000; Tang & Cook, 2001). However, most middle schools and high schools still focus on building computer literacy rather than promoting higher order thinking (Goode, Estrella, & Margolis., 2006), even though hands-on experiences that include programming can engage students with information technology (IT) (Tucker et al., 2004). In the last decade, hundreds of after school programs have tried to increase gender equity in science, technology, engineering, and math (National Science Foundation, 2003), but few collect the kind of data needed to determine whether and why (or why not) the program had the desired impact (American Association of University Women, 2004; Dryburgh, 2000). This paper presents findings from a study of an out-of-school program where girls work in pairs to create computer games.

Only two other published studies (with elementary and high school students) have used game creation as a strategy to increase girls' interest in IT as part of a research-driven agenda (Kafai, 1995; Miller, Chaika, & Groppe, 1996). Although controversial, computer games have an early influence on the skills and attitudes that are the best predictors of later technology-related behavior (Greenfield & Cocking, 1996; Levine & Donitsa-Schmidt, 1998; Subrahmanyam & Greenfield, 1998). Computer game design is an exciting way to put girls in the role of producers of technology, rather than simply as consumers. Game design is also innovative in that it involves identity exploration as a way to transform, not simply respond to, existing gender roles (Cassell & Jenkins, 1999).

This study is designed to examine the effects of the Girls Creating Games program on the participants and to identify ways to strengthen the program in future implementations. Two research questions are addressed:

1) Did participants increase their capacity to pursue and persist with computer technology?
2) What aspects of the program can be improved?

The evaluation of this program is grounded in the expectancy-value model developed by Eccles and colleagues (1983). This model suggests that achievement-related behaviors can be explained by expectations for success and subjective task values. In other words, girls are more likely to pursue and persist in IT careers if they believe they will be successful and enjoy and see value in doing well in the field of IT. Previous studies suggest that girls' interest in computers, including their perceived value and relevance to other parts of their lives, plays a role in decisions to pursue computer courses and careers (Dickhauser & Stiensmeier-Pelster, 2003; Goode et al., 2006; Zarrett et al., 2006). Also, expectations for success, including confidence and self-efficacy, play a critical role in whether a girl chooses a non-traditional career path (Nauta & Epperson, 2003; Zarrett et al., 2006). The current study builds on findings that show the importance of support from peers in whether or not girls participate and persist in computer science (Goode et al., 2006; Margolis & Fisher, 2002). Below, we describe some of the activities in the Girls Creating Games program and present data that suggests this approach can help to prepare girls to pursue and persist in computer science courses and careers by increasing their expectations for success, subjective task value, and perceived support.

The Girls Creating Games Program

The Girls Creating Games (GCG) program was implemented in its entirety six separate times over two years. The curriculum contains 23 sessions, each lasting two hours. The program was held four semesters after school for 12 weeks (two days a week), and over two summers for six weeks (four days a week). The program design employed some of the techniques used in Intervention Mapping (Bartholomew, Parcel, Kok, & Gottlieb, 2001) which starts by identifying specific program objectives, linking them to theoretical models and evidence-based interventions, and developing practical strategies that lead to specific program activities. This process increases the likelihood that a program is research-based, will appeal to participants, and will have the desired impact. Also, a clear theoretical model allows for a closer examination of why a program succeeded or failed. The program in this paper builds on previous research-based approaches that involve learning by design, collaboration with peers, female role models, and a focus on the practical applications of what is being learned (Campbell et al., 2002; Clewell & Campbell, 2002; Cohen et al., 1996; Lee, 1997).

Program activities were organized within four strands that build on the four critical design features identified by the Cognition and Technology Group at Vanderbilt University (2003). The strands are designed to link the activities and expected outcomes, based on previous research. In the first strand, *Learning by Design*, instruction is organized around a meaningful problem: how to design and create a computer game using Macromedia's Flash MX software. Girls were encouraged to create a game that would help incoming students adjust to middle school. In the second strand, *Scaffolding and Modeling*, instructors support the development of conceptual understanding by providing students with the resources to create their games and to solve problems independently. *Collaborative Learning* is the third strand and involves activities that build a community of learners, such as having students work in pairs to both design and then program their game. Instructors support the development of effective relationships within and across pairs by role modeling behaviors and leading fun activities designed to strengthen communication and mutual decision-making. In the final strand, *Identity Formation*, girls explore careers in IT, interact with female role models who challenge gender stereotypes, and get public recognition to promote their "tech savvy" identity.

The strands run concurrently over the course of the program. All activities are designed to make working with computers fun and to link technology to real-world applications. For more information about the instructional approach and specific activities in each strand, see Denner, Werner, Bean, and Campe (2005) and the program guides and lesson plans at http://programservices.etr.org/gcgweb/. The 45 games created by the girls can be played at this website, and an analysis of the games can be found in Denner, Werner, Bean, and Tyner (2005).

The evaluation reported here can inform efforts to integrate technology into middle school classrooms. To that end, we report 1) whether participants in the GCG program increased their expectations for success, subjective task value, and perceived social support, compared to non-participants, and 2) what the students liked and disliked about the program.

Methods

Participants

A total of 126 girls enrolled in the GCG program. They were recruited from two middle schools in a small city and a nearby recreational club by offering pizza parties, posting flyers, asking teachers to nominate students, and mailing information to parents. The first school serves 650 students and has 200 computers. The student population is 67% White (non Hispanic), and 26% are eligible for free or reduced fee lunch. The second school serves 590 students and has 113 computers. The student population is 57% White, and 26% are eligible for free or reduced fee lunch. Participants were in the 6^{th}-8^{th} grades, and at pre-test, the average age was 11.70 years (SD = 1.03). Most (94%) were born in the U.S., and slightly more than one third reported speaking a language other than English at home at least some of the time. Most (87%) of the students had access to a computer at home, and they used it on average one to two times a week for games or accessing the Internet. Girls of the same age from different schools who were either in, or wanted to be in, an after school program that involved computers made up the comparison group (n = 88).

Procedures

A quasi-experimental, pre-post test design was used to evaluate the program. Most surveys were administered on the computer. However, due to logistical challenges, 17 students in the comparison group completed paper surveys, and these students reported significantly higher skills at post-test than those who completed the survey on the computer ($p < .05$). Since that was the only difference between the groups, the data were combined for subsequent analyses.

Two sources of qualitative data were collected. Interviews were done with 31 girls who were selected to represent the range of grade levels, computer expertise, and race/ethnicity. Interviews lasted between 20-40 minutes and were conducted with individual girls at the school or club after the program was completed. Electronic notebooks were used to collect data on satisfaction with the program. During one of the last program meetings, students were asked to open their password- protected notebook on the computer and type a response to various questions, including what they liked about the program.

Measures

Race/ethnicity was collected in a variety of ways. For students in the GCG group who participated after school, race/ethnicity was obtained from parent report in school records Students in the GCG group who participated during the summer, as well as the entire comparison group, reported their own race/ethnicity by checking one of five categories on the survey.

Survey items measured subjective task value and expectations for success as well as social support. Subjective task value was measured with three scales, which were adapted from previous studies or developed by our research team. The *Stereotypes about Computer Workers* scale was adapted from Lawhead, Wilkins, and Rheningas (n.d.). This scale includes seven items that describe people who work with computers. Examples of items include: “Works with other people,” “Is creative,” and “Does not have time for their family.” Responses ranged from strongly disagree (1) to strongly agree (5), with items coded so that a high number reflects endorsement of negative stereotypes. Cronbach’s alphas were .70 at pre-test (n=207) and .73 at post-test (n=170). Our team created four items to measure *Intentions to Study Computers*. Students were asked about their plans to take courses such as computer graphics and computer programming. Responses ranged from definitely not (1) to definitely yes (5). The Cronbach’s alpha at pre-test was .72 (n = 207) and at post-test was .79 (n = 171). The *Attitudes Toward Computers* scale was based on items from Todman and Dick (1993). The seven items included choices like, “I like using computers in my free time” and “Computers are a waste of time.” Responses ranged from strongly disagree (1) to strongly agree (5) with high numbers reflecting a more positive attitude. Cronbach’s alphas were .79 at pre-test (n = 210) and .78 at post-test (n = 172).

Five scales measured expectations for success. *Confidence with Computers* items were derived from Levine and Donitsa-Schmidt (1998) and from Todman and Dick (1993). The scale includes nine such as, “I find using the computer easy,” and “I get frustrated with all the different keys and computer commands.” Responses ranged from strongly disagree (1) to strongly agree

(5). Negative items were reverse-coded so a high score reflects high confidence. Cronbach's alphas for the confidence scale were.82 at pre-test (n = 206) and .84 at post-test (n = 166). The *Computer Skills* scale had eight items, including "Make a copy of a file" and "Burn a CD." Responses ranged from "I don't know what this means" (1) to "I can do this so well that I can teach someone how to do it" (5). Alphas were .87 at pre-test (n = 204), and .85 at post-test (n = 171). *Knowledge about Computers* was measured by four items that assessed what their teachers, other kids, people in their family, and they think they know about the computer. Responses ranged from nothing (1) to a lot (4). Many of the skills and knowledge items were from Rockman et al. (n.d). *Problem Solving* was measured by one item created by the research team. Students were asked to complete the sentence: "If I don't know how to do something on the computer at school, the first thing I do is…." Options included "try to figure it out myself," "ask for help," and "give up." *Gender Stereotypes* were measured by one item, which built on a survey by Levine and Donitsa-Schmidt (1998): "Boys my age usually do better than girls when using computers." Responses ranged from strongly disagree (1) to strongly agree (5).

Social support was measured using two constructs adapted from Mappen (n.d). Friends' computer use consisted of three items. Girls were asked to report separately what percentage of their male and female friends are interested in computers. Responses ranged from none (1) to all (5). Also, they were asked how often their closest friends use computers, from everyday (1) to never (5). Students were asked to report who they talk to the most about computers in the last three months, and one option was to mark "There is no one I talk to about computers."

In addition, quotations from the interviews provide examples of how students changed in their subjective task value, expectations for success, and perceived social support. We highlight responses to two of the interview questions: "Do you think you have changed at all from being in GCG?" and "Did you do anything in the program that surprised you or that you hadn't done before?"

Satisfaction with the program was measured by responses to prompts in the electronic notebooks. Questions included: "What is one thing you like about [the program]? What is one thing you do not like?" Most responded to the question as a pair, and there were 81 responses to this question over the six different implementations of the program.

Data Analysis

A series of t-tests were used to determine whether there was a significant level of change from pre- to post-test survey. Paired t-tests were used to assess change within the treatment group (GCG program participants) and within the comparison group. Independent group t-tests were used to assess whether the change within each group was significantly different from the other group. Due to the small sample size, we report and interpret changes at or near the $p<.05$ significance level.

Data from the interviews and electronic notebooks were analyzed using a multi-step process. Following guidelines for coding qualitative data (Auerbach & Silverstein, 2003; Miles & Huberman, 1994), we first identified our research questions and expected themes. For the interviews, two researchers separately read through the audiotape transcripts to identify sections where students talked about the variables in which we expected change. In subsequent readings, the researchers sorted excerpts of the text into key themes and entered these segments of text into a spreadsheet. Responses by participants from their electronic notebooks were coded by first reading the entries and identifying repeating themes, and then re-reading the entries to assign them to one or more categories. Each interview and each entry was coded separately by two researchers and discrepancies were resolved, resulting in 100% inter-rater agreement.

Results

Comparability Between Treatment and Comparison Groups

The two groups differed in their race/ethnicity and on their average scores on three variables. The percentage of White students was higher in the treatment group (60%) than the comparison group (36%), because some of the comparison group participants attended a club with larger numbers of African American and mixed race/ethnicity students. Representation of Hispanic/Latina students was similar: 31% in the treatment group, and 27% in the comparison. Three significant group-level differences on scales and individual items at pre-test were identified with t-tests. The treatment group reported lower levels of skill($p < .01$), but more positive attitudes toward computers ($p < .01$), and the comparison group reported more frequently that their teacher thinks they know about computers ($p < .05$).

Attrition

A total of 214 participants completed pre-tests (126 in the treatment group; 88 in the comparison group), and attrition varied between groups: 28% of the treatment group and 17% of the comparison group did not complete the post-test. T-tests determined that age, confidence, skills, and attitudes toward computers at pre-test did not explain this attrition. The salient factors contributing to attrition included computer accessibility and knowledge about computers. In the comparison group only, those with no computer at home were less likely to have taken a post-test (64%) than those who had a computer at home (84%), and in the treatment group, those who dropped out reported higher levels of knowledge about computers ($p < .05$) at pre-test.

Did Participants Increase Their Computer Technology Capacity?

The survey data indicate how program participants changed over time and if that change is significantly different from that in the comparison group. The analyses include students who completed a pre- and post-test (90 in GCG and 71 in the comparison group). The survey findings are described below and excerpts from the interviews are used to illustrate what that change looked like from the girls' perspectives.

Only one of the three measures of subjective task value was significant. As shown in Table 1, the intervention group reported virtually no change in their stereotypes about computer workers, while the comparison group reported an increase in negative stereotypes. An independent group's t-test approached significance ($p = .05$). The following quotations illustrate the participants' perspectives of the program's role in reducing their stereotypes.

> I used to, like, whenever I would think of a computer I would think of a nerd with glasses or whatever sitting in front of it, but I guess since I've done this, there are all different types of girls here and none of them were nerdy or anything. So like, I like sports and I like the computer too, so that's completely going against the stereotype of what people think (13-year-old, White participant).

> Now like I've got some feedback how you make the game and that people that make them aren't just lazy and … it's hard work and fun too (11-year-old, Latina participant).

There was no significant change within or across groups in students' intentions to take computer courses in the future or their attitudes toward computers. However, in response to the interview question, "Do you have any plans to take any more classes?" GCG participants said:

> Yes. This man that was with my dad, right now he's going to [local community college] and he's going to look for classes there for me, so I can do it with him, he said (11-year-old, Latina participant).

> I really now understand how important it is because I didn't know any of that stuff and now I know what I want to be; I want to be a computer animator (12-year-old, White participant).

Three of the five measures of expectations for success were significant across groups. As shown in Table 1, there was an increase in the GCG participants' confidence in using computers, and it approached significance ($p = .05$), but was not significantly different from non-participants. Comments from the interviews illustrate what their confidence:

> …thing I was most proud of learning about was how to do like buttons and stuff because we have the longest game on the whole thing and because we have two different story paths and I didn't understand how the whole button thing worked at all. I played the games that people had done before and I was like, how do we get the buttons to go to each click? But then I learned how to do the buttons (14-year-old, White participant).

Additionally, computer skill level increased among those in the GCG program ($p < .001$), and an independent groups t-test showed that the increase was significantly greater for the treatment than the comparison group, ($p < .001$). One girl described her skills:

> I know how to program now and I know how to go on the internet like Google and get the graphics and computer animation, like the time frame. And I also know how to put action scripting on a button (12-year old, White participant).

Also, there was a significant change in participants' perception of their knowledge about computers. The treatment group reported significant increases in what their family thinks they know ($p < .01$), what they think they know ($p < .001$), and what other kids think they know ($p < .05$). As shown in Table 1, the change in self-knowledge for the treatment group was significantly different from that reported by the control group (p < .05). The result of this change is described in the following quote. In response to whether she changed as a result of participating, one girl responded:

> Yes, a little because I could teach other people about computers and my mom and my dad and my brother and my cousin and my whole entire family want to learn more about the computer, but I want to learn too (12-year-old, Latina participant).

A significant difference emerged between the two groups in their view that boys usually do better than girls when using computers. Overall, the treatment group decreased their gender stereotypes (p < .01), while the comparison group increased theirs (p < .05). As shown in Table 1, the difference in change for treatment versus comparison group was significant (p < .01). None of the qualitative data specifically illustrated the students' views on this change, and there was no significant change in the other three items that measured gender stereotypes.

Problem solving was measured by asking students to respond to the following question: "If I don't know how to do something on the computer at school, the first thing I do is…" Students in GCG reported greater increases in first trying to figure it out themselves (from 38% to 61%) compared to those in the comparison group (from 39% to 50%). However, logistic regression shows that the change is not significantly different for the treatment versus the comparison group. The following two quotes illustrate independent problem solving:

> I like… now when I'm on the computer even if I'm not on the Flash program. I kind of can figure out things better, like I was doing my homework and it just all disappeared and I tried everything to put it on and I got so mad at myself that I didn't save it, and I checked a file thing and checked this one little skill in Flash where you check every place, you check on the desktop or document, because I did that a lot in Flash – and I found out I saved it to the other file (14-year old, Latina participant).

Another student also described how she changed:

> Well, a little bit. I never really used to like [sic] computers and now I don't like, really, hit the computer when I'm mad - I sort of try and find out what's wrong. So I guess that's something (12-year old, White participant).

One of the two measures of social support was significant. There was a decline in the numbers of girls in the treatment group who reported, "There is no one I talk to about computers," from 10% at pre-test to 2% at post-test. Among those in the comparison group, the change was from 11% at pre-test to 10% at post-test. A logistic regression showed that the difference at post-test between treatment and comparison groups was significant (p < .05), controlling for pre-test ratings. There was no significant change in students' report of their friends' computer use. This may be due in part to the high numbers who reported they do not know if their friends are interested in computers or how often they use them (15% to 38%).

What Aspects of the Program Can Be Improved?

Electronic notebook entries were coded for the positive and negative aspects of the program. Table 2 summarizes the results. There were a total of 130 comments about what participants liked, and only 74 comments about what they disliked, so the percentages do not reflect equal numbers of responses across the columns. What girls liked the best was using the computer and having mastery experiences. The following are typical examples of what the participants wrote about using the computer: “It is fun how we get to create games and then play the games that someone else made and to get ideas” and mastery experiences: “I love the feeling of accomplishing something.”

What the participants disliked the most was the amount of direct instruction and having to work with a partner. The following is an example of what they did not like about the instruction: “What I don’t like about [the program] is that we have to do a lot of work to make the games and when they explain the directions and how to do things it’s really boring listening to them talk.” In addition, a minority of the girls did not like the social aspects of the program, such as having to work with a partner. As one girl explained: “Well my partner she didn’t really do anything and she didn’t really like any of my ideas, but she didn’t come up with any of her own, so it’s kind of hard to mix those two.”

In summary, the survey data suggest that participants in the GCG program changed in several positive ways, and the interview and satisfaction data provide some insight into why these changes may have occurred. The findings are discussed in some detail below, along with suggestions for how to integrate technology into the classroom in a way that will increase the likelihood that girls will become more active participants in the IT workforce.

Discussion

This study adds to a growing literature on how to integrate computers into middle schools in a way that will enhance the long-term participation of a broader range of students in IT. In particular, in order to close the gender gap in the IT workforce, most agree that we need innovative strategies to prepare and engage girls early in their education. Although not all girls will choose to pursue a career in technology, it is important to level the playing field of opportunity so that when students make that choice, it is really is a “choice.”

This study also builds on the expectancy-value model to assess the impact of and satisfaction with the program. The data suggest that there were small increases in participants’ expectations for success and the extent to which they value work that involves computers, as well as in their perceived level of social support to work with computers. The findings suggest that the program activities hold promise for increasing the participation and persistence of girls in courses and careers. While the findings from this small study are modest, they provide some indication of the potential benefits of computer game design as a strategy to integrate technology into the classroom. This evaluation is a first step toward a larger and more methodologically rigorous study of the activities that make up the GCG program.

Research Findings

The strongest findings were that participants' expectations for success increased, in terms of both perceived ability with specific computer skills and general knowledge about computers. Previous research suggests that these self-perceptions play a critical role in girls' occupational choices (Zarrett et al., 2006). However, the more in-depth measure of confidence in the study (the nine-item scale) did not detect an increase among participants that was significantly different from the comparison group. This may be partially due to the fairly high levels of confidence at pre-test, as well as some girls' views that there was too much instruction and not enough time for independent problem solving.

In contrast to previous research (American Association of University Women, 2000; Dryburgh, 2000), the girls in this study did not endorse negative stereotypes about who works with computers, nor did they believe that boys are better at computers. The accessibility and widespread use of technology by the participants and in national samples (Fairlie & London, 2006) may have changed some of these negative stereotypes. While program participation was associated with a drop in the perception that boys do better than girls with computers, the average ratings were still in the center of the scale, suggesting that most neither endorsed nor rejected the statement. Clearly, there is more that needs to be done to strengthen girls' critical assessment of gender stereotypes regarding who is good with computers.

The program activities did not lead to a change on two measures of values. There was no change in girls' reported attitudes toward computers. Although the girls in the program did report a slightly greater increase in positive attitudes, the ratings at pre-test were so positive initially that the change was not statistically significant. Despite the fact that what students liked most about the program was making a game on the computer, girls did not increase their intentions to take computer courses. This may be a function of their developmental stage, but certainly is a concern. Longitudinal studies have found that middle school girls who believe they will enjoy a computer-based job are more likely to have plans for an IT career three years after high school (Zarrett, et al., 2006).

Notably, the girls' perception of social support increased over time; at the end of the program, girls were less likely to say there is nobody they talk to about computers. This is not surprising, since they had recently participated in a graduation ceremony that was attended by family members and friends. There was, however, no detectable change in their number of friends who are interested and/or use computers, so it does not appear that exposure to other participants changed friendship structures outside the program. This finding may be due in part to the dislike that some expressed about working with a partner on the computer or to the limited outreach of the program into the classrooms.

Limitations

Some limitations of this study are the small sample size, differences in the treatment and comparison group composition, and the lack of attention to context. With a larger sample size, it would be possible to verify the findings and to examine which types of girls benefited most from the program. Similarly, to attain comparable samples and to determine whether change was a result of the program, the participants would need to be randomly assigned to conditions. In addition, this study faced challenges described by others as an inherent part of evaluating after school programs, which include the difficulty of finding an appropriate comparison group and instruments that are sensitive enough to detect change (Fancsali, 2002).

Another limitation is that the data focused on psychological and social factors and did not address the family or the structural factors that mediate the effects of programs. For example, Goode et al. (2006) describe the importance of supportive learning environments to increase girls'motivation to participate and interest in IT. To examine the effects of a set of program activities, we must consider the broader context, such as whether there is an environment that is supportive of girls' participation in IT endeavors.

Implications for Practice

There are several implications of this study for classroom teachers. First, the satisfaction data suggest that students most enjoyed creating games on the computer. Despite the fact that computer labs were available to all students at the school and club where the program was implemented, few participants used them as part of a regular class, and even fewer used them during their own time. Using the computer to make a project that was posted on the Internet appeared to be the greatest source of satisfaction for program participations. Although the games in this program were focused mostly on social factors, others have had students make games about mathematics (Kafai, 1995) and other subjects. Teachers can incorporate aspects of game design and construction into their classroom by using our program guide and lesson plans (see http://programservices.etr.org/gcgweb/).

What students liked the least about the GCG program was the amount of direct instruction by the teachers. Opportunities to explore ideas on the computer while creating a project, balanced with some structure and support to have mastery experiences, may be the best way to integrate computer activities into a broader curriculum. We refined and tested several approaches for supporting students' independent problem solving and for building more fearless, or intrepid explorers on the computer (Denner & Bean, 2006). A teacher guide and lesson plans to support independent problem solving can be found on our website.

Since research shows the importance of peers in students' decisions to participate and the extent to which they benefit from extracurricular activities (Barber, Stone, Hunt, & Eccles, 2005), efforts to increase girls' participation in information technology will want to incorporate a stronger peer component. Specifically, activities can aim to build friendships that not only support girls' interest in computers, but also can be sustained outside the context of the classroom or program. We believe that allowing students to work together by pair programming is particularly helpful in this regard. Pair programming is a collaborative learning structure that was originally developed for use in software design (Williams, Kessler, Cunningham, & Jeffries, 2000). Paired students work together on all phases of game design and share time at the computer as the driver (working the keyboard and mouse) and navigator (providing guidance and monitoring mistakes) (Werner, Denner, & Bean, 2004). Previous research suggests that students benefit most from collaboration when partners have similar experience and ability with the subject area (Crook, 2000; Mercer & Wegerif, 1999). As our data suggest, not all girls liked working with a partner, and we, as well as others, have found that teachers must play an active role in selecting the pairs and guiding the work (Johnson & Johnson, 1999; Werner, Campe, & Denner, 2005). Thus, we created lesson plans and a video on ‘bad’ and ‘good’ pair programming etiquette to increase the benefits of this approach (See http://programservices.etr.org/gcgweb).

The findings suggest it is important to incorporate formal structures for supporting students when working on the computer. Most efforts to integrate technology into the classroom place individual students at a computer, despite the fact that few schools have a computer for everyone. The pair programming approach shows promise for overcoming limitations on access and for facilitating positive interactions while creating a computer game. Future efforts to engage girls with information technology should leverage their interest in peer interactions and should incorporate a stronger family involvement component, as well as activities that help students link their interest in computers to long-term career and educational goals.

To increase middle school girls’ expectations for success with technology, it is important to include activities that focus on identity exploration. If girls do not see themselves as the type of person who is good with technology, they are unlikely to pursue it. Instructional materials that describe how teachers can promote girls’ “tech savvy” identity can be found on our project website.

Conclusion

In summary, this article describes the findings from a theoretically-based evaluation of an out-of-school program to engage girls in IT. The data provide some support for using computer game design combined with identity-building activities as a strategy to increase the likelihood that girls will play a more active role in the technology of the future. These findings are consistent with studies of other programs that have created opportunities for girls to play an active role in relation to technology (Brunner & Bennett, 2002; Edwards, 2002). Also, they are consistent with the trend of engaging students with technology by allowing them to be content creators rather than simply consumers (Lenhart & Madden, 2005). As this trend continues, the activities in the GCG program can be used to leverage the participation of girls to change the face of technology.

About the Author

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Table 1

Means (Standard Deviations) on Pre- and Post-test Surveys

	GCG Program		Comparison	
	Pre-test	Post-test	Pre-test	Post-test
Stereotypes about computer workers+	2.08 (.55)	2.07 (.59)	2.21 (.54)	2.36 (.59)
Intentions to study computers	3.41 (.78)	3.26 (.92)	3.36 (.88)	3.16 (.96)
Attitudes toward computers	4.26 (.59)	4.14 (.67)	3.99 (.66)	3.94 (.58)
Confidence to use computers	3.86 (.62)	3.98 (.65)	3.78 (.65)	3.87 (.66)
Computer skills***	2.77 (.90)	3.59 (.91)	3.13 (.96)	3.34 (.95)
Knowledge about computers*	3.13 (.59)	3.39 (.59)	3.27 (.64)	3.31 (.67)
Gender stereotypes**	2.52 (.85)	2.23 (.90)	2.20 (.97)	2.48 (.94)

***p<.001 **p<.01 *p<.05 +p<.10

Table 2

Satisfaction Data

	What they liked	What they disliked
Using the computer	38%	5%
Mastery experiences	17%	7%
Program instruction	12%	47%
Program accommodations	12%	8%
Social aspects	8%	19%
Unspecified	7%	0%
Problem solving	5%	14%
Total number of codes	130	74