Assessing Girls' Interest, Confidence, and Participation in Computing Activities: Results for Globaloria in West Virginia

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To date, girls and women are particularly underrepresented in technology — one of the fastest growing fields in the U.S. economy (U.S. Dept. of Labor, 2010a). Technology job opportunities are predicted to grow at a faster rate than all other jobs in the professional sector, up to 22 percent over the next decade (U.S. Dept of Labor, 2010b). Technology is also increasingly essential in the daily operation of other STEM fields and to the success and competitiveness of the U.S. economy. The persistent underrepresentation of girls and women in this rapidly growing and economically essential field results in costly consequences for women, the U.S. economy, and society, at large (Ashcraft & Blithe, 2010). First, underrepresentation of women in technical fields inhibits innovation by ignoring the diverse perspectives and life experiences women and other underrepresented groups bring to invention and problem solving. Second, disregard for girls' and women's participation perpetuates, and even exacerbates, existing economic disparities for women (e.g., salary inequities, access to desirable jobs).

To reverse the current tide, the National Center for Women & IT (NCWIT) aims to identify and promote technology programs with promising evaluative evidence for increasing girls' interest and confidence in technology and computing. As part of this effort, we have partnered with the World Wide Workshop to better understand the effects of their Globaloria platform and curriculum on girls' interests, confidence, and future plans in computing. Globaloria, created in 2006 and operating in West Virginia, Texas, California, and New York, is the first and largest social learning network of schools and community centers dedicated to developing students' digital literacies, STEM and computing knowledge, and global citizenship skills through game design and programming curricula. Students' participation in Globaloria ranges from 3-5 times per week, for 60-90 minutes per session, over two semesters. Globaloria aims to teach computational thinking,

computer programming, and educational game design, along with many other skills, such as teamwork, research, civic engagement, and self learning (see www.Globaloria.org and www.WorldWideWorkshop.org/programs/globaloria). Globaloria designers aim to make their course curriculum relevant, approachable, and meaningful so that girls might discover their talents in computing and become more attracted to computing academic study and careers.

To better understand the effects of Globaloria on girls' attitudes, confidence, and participation in computing, our research seeks to address the following questions:

1) To what extent do girls enroll in elective[1] (that is, non-mandatory) Globaloria courses, and how does this compare to the national average for computing/computer science courses?
2) Do girls and boys (in both elective and mandatory courses) change during the course of the program in terms of computing skills, computing interests, computing confidence, and future plans for computing education and careers?
3) Among Globaloria participants (in both elective and mandatory courses), are there gender differences in computing skills, computing interests, computing confidence, and future plans for computer education and careers?
4) How do girls (in both elective and mandatory courses) describe their experience in Globaloria, and what are the implications of these experiences for future curriculum development and efforts to increase girls' participation in technology?

To address these questions, we have begun and continue to engage in collecting the following types of data: 1) enrollment data in Globaloria electives (question 1), 2) pre- and post-survey data from students in Globaloria classes (questions 2 and 3), and 3) qualitative interviews with teachers

[1] Because one would expect enrollment in mandatory courses in co-ed high schools to be approximately 50% girls and 50% boys, determining enrollment in elective classes is important for understanding if these courses are attracting girls at rates higher than the national average (approximately 20-25%).

and students (Question 4). This report delineates initial findings from our first round of analysis of the Globaloria enrollment data and pre- and post-survey data.

The next stage of this study, will involve three components: 1) continued collection and analysis of enrollment data for the 2012-2013 school year, 2) using our initial findings to create and implement a pre- and post-instrument that will better capture data related to computing interests, attitudes, and confidence, and 3) conducting interviews with teachers and students to enhance and further explain findings from the quantitative portion of the study. We will interview teachers with higher female enrollment to identify efforts that may help improving the female enrollment rate. We will also conduct interviews with girls who are currently in Globaloria programs, as well as with girls who were Globaloria students and now are interns with Globaloria in order to gain deeper insights about students' motivation, learning experiences, and intent to persist in computing.

Methodology

Enrollment Data

In 2010-2011 and 2011-2012, Globaloria was implemented in a total of 104 schools, reaching 3,149 students, of which 1,168 were girls. Globaloria first started in West Virginia, and the majority of these schools and students, to date, have been in West Virginia (source: www.WorldWideWorkshop.org/programs/globaloria). As a result, we selected West Virginia as the focus of study for this initial round of analysis.

We collected enrollment data for all Globaloria classes in West Virginia for 2010-2011 and 2011-2012. We then took the enrollment numbers by sex for all *elective* classes during these two years and calculated the total percentage of girls enrolled in these courses each year. Because one would expect enrollment in mandatory courses in co-ed high schools to be approximately 50% girls and 50% boys, determining enrollment in elective classes is important for understanding if

these courses are attracting girls at rates higher than the national average (approximately 20-25%). We also identified the individual elective classes that had the highest female enrollments.

Pre- and Post-test Analysis

In collecting the pre- and post-survey data for this first round of analysis, we used extant data from pre- and post-survey instruments that were developed for another research project conducted by different researchers.[2] These instruments were not specifically designed to assess changes in computing abilities and confidence; however, some of the survey items did relate to computing interests and confidence, so we decided to analyze this existing data in order to gain preliminary information and, if needed, to inform the design of a future instrument that would measure computing attitudes and interest more specifically. For this analysis, we focused on the 2010-11 participants because the survey questions in previous years focused even less on computing and technology competencies.

In the 2010-11 school year, 1075 students participated in the Globaloria classes in West Virginia; 976 of these students completed the classes and took the surveys. After excluding the students who were not at middle or high schools and who didn't take either the pre-survey or post-survey or both, the final sample size was reduced to 539.

Because we are primarily interested in increasing girls' participation in the *creation* and *design* of technology and believe that it is important to distinguish this from increasing their *use* of existing technology (e.g., word processing, playing rather than designing games), we focused primarily on survey items that measured involvement in technology creation rather than just computer usage. Specifically, we examined three survey questions and nine survey items related to computing or technology creation. The three survey questions asked about students' frequency

[2] The survey instruments were developed to measure 6 Contemporary Learning Abilities with Technology (6-CLAs) that emerged through game design in the West Virginia program (Reynolds, 2012).

of computing activities at home and at school (e.g., how often do you think up an idea for a creative technology project?). The nine survey items included three items about interests in specific computing activities (e.g., interest in computer programming, software development, and game design) and six items about confidence in computing activities (e.g., confidence in learning game design computer programming, finding help with a technology problem online).

Two statistical analyses were conducted on these data:

1) Paired T-tests were conducted to examine changes in students' computing confidence, interests, and participation in computer activities at home and at school before and after they took Globaloria classes. We examined the changes by school levels (separating middle school students from high school students) and gender.
2) One-way ANOVAs were conducted to examine gender differences in computing confidence, interests, and participation in computer activities at home and at school before and after they took the Globaloria classes. We also further examined the gender differences based on school levels (separating middle school students from high school students).

Findings

Enrollment Data

In determining a national average, exact numbers on girls' enrollment in middle or high school computing courses are difficult to find. Some proxy measures, however, do help us fill this gap in order to come up with a rough understanding of national patterns. In 2011, approximately 19% of CS AP test takers were girls (College Board, 2011), and approximately 18% of 2011 undergraduate Computer Science degree recipients were female (U.S. Dept. of Education, 2011). In general, female completion of all CIS degrees (associates, bachelors, masters, and doctorates)

ranges from 18-27% (U.S. Dept. of Education, 2011). As a result, it is reasonable to consider computing courses with female enrollment levels above 25% as exceeding the national average (U.S. Dept of Labor, 2010b).

In total enrollment in elective courses, Globaloria exceeded the national average, with 33% female enrollment in 2010-11 and 37% female enrollment in 2011-2012. This picture becomes a bit more complicated when looking at individual elective courses.

- In 2010-2011, 31 out of 55 elective Globaloria game design courses enrolled girls at percentages higher than the national average. These percentages range primarily from 32-100% (9 courses = 32-39%; 7 courses 40-47%; 4 courses 50-57%; 4 courses 60-67%; 1 course = 78%; 1 course = 80%; 5 courses enrolled 100% girls, but these classes only had 1 or 2 students total).
- In 2011-2012, 21 out of 70 elective Globaloria game design courses enrolled girls at percentages higher than the national average. These rates range from 31-78% (9 courses = 31-39%; 3 courses = 40-44%; 4 courses = 50-57%; 3 Courses = 62-69%; 2 courses = 75-78%)

As is evident above, the range of female enrollment varies substantially across different elective courses, with some courses being substantially above and some substantially below the national average. This raises interesting questions for future research into the characteristics that contribute to these differences. Another interesting finding is that the number of courses with higher-than-average female enrollment fell substantially (-10 courses) from 2010-11 to 2011-12; however, overall female enrollment in all courses increased 4%. Teasing out some of the factors that contribute to these trends is also an interesting area for future research. To begin this effort, in the next phase of the study, we plan to conduct interviews with teachers whose courses had higher

female enrollment to elicit the possible reasons for these higher enrollments and to determine what, if anything, might distinguish them from Globaloria courses with lower enrollments of girls (see Appendix A for more information on next steps for future research). Meanwhile, we conclude that the overall higher female enrollment in Globaloria electives warrants the development of an NCWIT promising practice sheet.

Pre- and Post-Test Data

Change in girls' and boys' levels of *interest* and *confidence* in computing activities

Students' computing *interests* were examined in three areas: computer programming, software development, and game design. Overall, boys' and girls' self-reported interest in these three areas decreased after taking Globaloria classes. This finding is true at both middle and high school levels.

Students' computing *confidence* was examined regarding the following six aspects: "learning computer programming," "learning game design," "using software to create a game," "designing graphics for a game," "finding help with a technology problem online," and "learning game design using online tutorials." Overall, both boys' and girls' confidence in learning programming and in game design decreased from pre- to post-surveys, while their confidence in the following activities remained constant: "using software to create a game," "designing graphics for a game," and "finding help with a technology problem online." This finding is true for high school participants and also for middle school participants with one exception: middle school boys' and girls' confidence in "learning computer programming" also remained constant before and after taking Globaloria classes.

While decreases in confidence and interest may seem like a negative result, such decreases are quite common in introductory experiences in a number of fields. This is usually due to the fact that students learn more about what it really means to, in this case, "do computing," and

they become more aware of all of the things that they need to learn. This can function as a sort of "reality check" that can temporarily decrease confidence and interest. This may be particularly likely here since the Globaloria courses studied serve disadvantaged communities and underserved public schools where, before coming to Globaloria, students may have less exposure to computing activities than students from more affluent communities. Research into what happens in future classes and over time is necessary to determine whether these are lasting or temporary decreases.

Some of these findings also could be due to the fact that the existing survey instrument had a much broader focus and was not specifically designed to measure changes in computing. As a result, we are in the process of developing an instrument specific to computing that will better capture changes in computing interests, confidence and future plans, and we plan to implement this instrument in West Virginia, California, and Texas Globaloria schools during the 2012-2013 school year. The interviews that we plan to conduct with girls in current and past Globaloria courses will also likely provide useful information for explaining quantitative findings (see Appendix A for more information on next steps for future research).

Change in boys' and girls' computing activities at home and school

Globaloria courses appeared to increase both high school and middle school girls' and boys' participation in computing activities at school. It is difficult to tell to what extent this increase reflects their participation in Globaloria itself and to what extent this increase reflects increases in computing activity at school outside of Globaloria. Perhaps, more telling is the fact that Globaloria did increase some girls' and boys' participation in *home* computing activities.

When looking at the middle school level, taking Globaloria courses did not change middle school boys' frequencies of participation in computer activities at home, but it did appear to have a positive impact on middle school girls' participation in *home* computing activities, including:

1) making graphics or animation on a computer

2) making computer games

3) making digital music, video on a computer

4) programming on a computer

5) using online tutorials to help with digital design projects

Increasing girls' participation at home computing activities may be particularly important. A wealth of research shows that, while computer access and usage is fairly equitable for girls and boys at school, at home girls tend to have less access and are less involved with computers than boys (see Ashcraft, Eger & Friend, 2012 and Barker & Aspray, 2006 for reviews of this research).

Meanwhile, taking Globaloria courses appeared to increase both high school boys' and girls' participation in several home computer activities, including:

1) making graphics or animation on a computer

2) making computer games

3) programming on a computer

4) using online tutorials to help with digital design projects

In general, these increases in computer activities seem to be a positive result, especially for girls. It also is promising that these increases in computing activities included activities related to creating rather than simply using technology, such as programming and making graphics or animation. These increases in the creative adaptation of technologies may potentially influence students' abilities and plans to pursue further technology education. However, we also know that computing activity does not always translate to increased interest, confidence, or plans to pursue education and careers in technology (see Ashcraft, Eger & Friend, 2008 for a review of research related to this connection). As a result, further research is needed to determine the nature of these

increases in computing activity and how they relate to interest, confidence and future plans related to computing.

Gender Differences: Comparing girls' and boys' interest and confidence in computing

The previous section examined changes in girls' and boys' interest, confidence, and computing activity before and after their participation in Globaloria. This section investigates gender differences, comparing girls' and boys' levels of interest, confidence, and computing activity, as well as changes in these levels. All gender differences reported are statistically significant.

When looking at the overall sample of both middle and high school students, boys were more interested than girls in computing activities both before and after taking Globaloria classes. Consistent with much prior research, boys were also more confident than girls in most computing activities before beginning Globaloria. The two exceptions were in "designing graphics for a game" and "learning game design using online tutorials," where boys and girls had similar levels of confidence before taking Globaloria classes. After taking Globaloria classes, however, girls became less confident than boys in "learning game design using online tutorials"; their confidence level in "designing graphics for a game" remained similar to boys. Finally, while boys had higher levels of confidence than girls in "finding help with a technology problem online" before taking Globaloria classes, this gender difference disappeared after they finished Globaloria classes. However, this appears to be primarily because both boys' and girls' levels declined slightly with boys' levels declining a bit more.

When looking at middle and high school students separately, some interesting similarities and differences emerged:

- Middle school boys and girls had similar levels of computing confidence before and after taking Globaloria classes. This is an interesting finding, since in the high school sample, boys reported higher levels of confidence than girls before beginning Globaloria.
- Middle school boys had higher levels of interest in "computer programming," "software development," and "game design and creation" than girls before taking Globaloria classes. Gender differences in two of these – interest in "computer programming" and "game design and creation" – disappeared after students took Globaloria classes. While this appears to suggest that Globaloria classes help minimize gender differences among female and male middle school students, most of this gap disappeared because of the decline in the boys' interest levels, bringing it closer to the girls' levels of interest.
- For high school students, boys were more interested in computing than girls before and after taking Globaloria classes. For the most part, they also had stronger computing confidence than girls before and after taking Globaloria classes. An exception to this was that no gender difference showed in confidence in "designing graphics for a game" in both pre and post-surveys. Another exception is that boys and girls had similar levels of confidence in "learning game design using online tutorials" before taking Globaloria classes; however, after taking Globaloria courses both boys and girls' become less confident, with girls becoming less confident than boys.

Gender Differences: Comparing boys' and girls' participation in computing activities at home and school

Gender differences in computer activities at home and at school were also investigated in the analysis. At the middle school level, before students took Globaloria classes, gender differences existed in most *home* computer activities except "making graphics or animations on a

computer." Gender differences in three of these areas disappeared after they took Globaloria classes: "thinking up an idea for creative technology project," "making computer games," and "making digital music or video on a computer." This appears to suggest that Globaloria classes have a positive impact on reducing the gender gap in some home computing activities, most notably "thinking up an idea for a technology project" and "making computer games." The other area of increase – "making digital music or video with a computer "– is also a positive result, but it is important to note that this measure is potentially more indicative of computer usage rather than participation in creating new technologies. The fact that gender differences in some home computing activities decreased also may be important because, as noted earlier, a wealth of research shows, boys' and girls' home access and use is usually more inequitable than their use at school (Ashcraft, Eger & Friend, 2012). Overall, this is a positive result but requires further investigation because, again, increases in computing activities do not always translate to increases in girls' interest and confidence in computing or their plans for technical careers.

At the high school level, gender differences were identified in four home computer activities both before and after Globaloria classes: "thinking up an idea for creative technology project," "thinking up an idea for an interactive game," "making computer games," and "programming on a computer." Meanwhile, no gender differences were shown in the following three home computer activities before and after Globaloria classes: "making graphics or animations on a computer," "making digital video on a computer," and "using online tutorials to help with digital design project." According to this data, in high school, gender differences exist in some home computer activities but not others; in either case, however, these differences, of lack thereof, remain the same after taking Globaloria classes.

When it comes to school computing activities, both middle and high school girls and boys increased their school computing activities, but the increases were similar so gender differences

did not change significantly. The only exception to this was that in high school, the gender difference in frequency in "making digital music and video on a computer" disappeared from pre- to post-survey. This is a promising result as both boys' and girls' levels of frequency increased, but girls' levels increased more rapidly, thereby eliminating the gender difference. As noted earlier, however, with all of these increases in school activities, it is difficult to tell to what extent this increase reflects increased participation by virtue of participating in Globaloria versus increased participation in computing activities in school outside of Globaloria.

Conclusion

The enrollment data for Globaloria courses in West Virginia are particularly promising. Overall, female enrollment in these courses was 33-37% during the 2 years studied, exceeding the national average. A number of courses were much higher than the national average, making these interesting sites for future research into how this higher enrollment was achieved. At the same time, a number of classes were significantly below the national average; teasing out the nuanced features that contribute to these lower enrollments is also worth attending to in the future.

The initial pre- and post-test analysis reveals that participation in Globaloria classes did increase middle and high school girls' *home* computing activities, and many of these activities involve creating and adapting technologies rather than simple usage of computers. For middle school girls, it also decreased the gender gap in some home computing activities – most notably in "thinking up an idea for a technology project" and "making computer games." Again, this is potentially promising given the research showing that at home girls' tend to have less access to computers or computing activities than boys (see Ashcraft, Eger & Friend, 2012 for more information on this research). These increases, however, did not translate to an increase in middle or high school girls' interest or confidence in computing. In fact, in many instances both boys' and girls' interest or confidence decreased slightly. As we noted earlier, however, increased activity

does not always lead to increased confidence and, in fact, some decreases in interest and confidence are not uncommon in introductory courses as it may simply reflect the fact that students are more realistic about what it means to "do computing" and are more realistically assessing their knowledge and abilities. Further study is needed to see how these trends play out over time.

Also, the lack of positive impact in these areas in the pre- and post-test findings are likely due to the fact that the pre- and post-survey were designed as part of a larger study attempting to measure a broader range of variables. As we noted earlier, while some of the questions addressed technology and computing outcomes, they were not specifically designed to measure these outcomes. As a result, we plan to address these issues by developing and implementing an instrument that can better capture these computing outcomes. We also recommend expanding the analysis to include Globaloria schools in Texas and in California. The Texas site, in particular, holds promising potential for longitudinal research because it employs a more comprehensive Globaloria curriculum over the course of several years from the 6th to the 12th grades for both boys and girls, which is likely to increase the opportunities for measuring changes over time and asking questions about the effects of mandatory, multi-year Globaloria courses. This expanded focus will also help us make comparisons across sites and between elective and mandatory courses (see Appendix A for proposed timeline for the next stage of this research).

As a number of scholars and practitioners, including educators in Globaloria (Harel Caperton, Oliver & Sullivan, 2010), have observed, there is an urgent need for computing courses that introduce students to computing in more engaging and relevant ways, and such improvements are particularly important for girls, youth of color, and youth from under-resourced areas (e.g., Margolis, Estrella, Goode, Holme & Nao, 2008). We believe that continued research of Globaloria will help enhance our understanding and implementation of efforts to reach this goal.

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Appendix A: Timeline for Future Research

Date	Task/Deliverables
August-September	--Practice Sheet development --Survey development and implementation
October-November	--Practice Sheet complete --Findings included in NCWIT Girls in IT report
Nov-Jan	--Pending IRB approval, begin qualitative interviews with WV girls and teachers
Jan-Feb	-- Update WV report with qualitative analysis

Proposed Future Research & Evaluation (would require additional funding)

August 2012	Work with Texas to develop and implement survey instrument
May-June 2013	Analyze 2012-2013 survey and enrollment data
June-August 2013	Conduct interviews with teachers and girls at Texas and CA, addtl WV interviews as appropriate
August-Sept 2013	Analysis of qualitative data
Nov-Dec 2013	Full updated report on all 3 locations qualitative and quantitative data