

IF GIRLS AREN'T INTERESTED IN COMPUTING CAN WE CHANGE THEIR MINDS?

Complete research

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Abstract

Despite significant efforts and many intervention programs over the years to encourage girls to study computing we continue to see a declining interest in computing by girls. Girls' lack of engagement with technology at school is resulting in fewer women interested in an information technology (IT) career and entering the IT workforce. To address this declining interest of girls we implemented a longer term intervention program called Digital Divas. The program ran in secondary schools over four years. It included specifically designed teaching modules intended to engage girls and excite their interest in IT and included role models for the girls. Data were collected through pre-and post-surveys, focus groups and classroom observations. In this paper we describe how, through Digital Divas, we were able to increase girls' interest in IT as well as increase their confidence with IT. We conclude with a model which identifies the components for implementing a successful school based intervention program. Our research highlights that a long-term intervention such as Digital Divas can result in a more sustained change in girls' perceptions of IT. A key finding is that girls will enjoy studying IT if it is presented in a way that resonates with them.

Keywords: gender and IT, education, curriculum design

1 Introduction

Almost 20 years ago, Camp (1997) wrote about the ‘incredible shrinking pipeline’ referring to the declining numbers of women studying computer science. Eighteen years on little has changed. Despite the ubiquitous application and use of information technologies (IT), girls are still significantly underrepresented in IT courses and in the IT workforce. In 2013 in Victoria, Australia, where our research was undertaken, just 15% of students who satisfactorily completed the Information Technology subject in their final year of school were female (VCAA, 2014). With fewer girls showing an interest in IT at school it is not surprising that fewer women are going on to study IT and then undertake an IT career.

The lack of diversity in IT in western developed nations is well recognised internationally (Organisation for Economic Co-operation and Development (OECD)), 2007). There are many documented cases on the negative impact this has on the IT industry and on companies more broadly (Leyden, 2004). For example, a recent report from the National Centre for Women in Information Technology (NCWIT, 2014) found that work teams with equal male and female membership have been shown to be more experimental and more efficient than single-sex teams, all male or all female. Additionally when women have engaged in IT, they have been able to create high-tech start-ups with less funding and fewer failures than the average (NCWIT, 2014).

When girls do not engage with IT curricula at school, they do not build IT expertise; they do not move on to IT tertiary studies and therefore are not joining the IT workforce (Ashcraft et al., 2012). The IT industry is missing out on the potential and perspective women bring to IT. Adya and Kaiser (2005), recognised the problem and proposed a research agenda which included longer term studies looking at the role of schools. Consistent with this, and also informed by a larger United Kingdom program (Fuller et al., 2009) to address the declining interest of girls in IT, the Digital Divas project team designed a school based program for Australian middle school girls (14 to 16 years old). The program was implemented in 10 Australian schools and ran for four years. In this paper we address two of our research questions which were: Could a curriculum designed specifically for girls change their attitudes to IT and increase their confidence? Would the change be sustained over the longer term?

2 Girls, IT and intervention programs

While studies have shown that girls generally use IT outside of school in similar numbers to boys (MORI, 2001), girls have quite defined and limited purposes in IT-use, focused primarily around communication. Four themes emerge from the literature in relation to the teaching of IT to girls. These are:

- The school, which is one place where girls can be encouraged to think and work positively with technology particularly in a positive learning environment and with effective teaching practices (Ahuja, 2002; Ashcraft et al., 2012;). It is recognised that formal classrooms are the most important place for stimulating interest. Early seminal research by Rosenthal and Jacobson (1992) highlighted the influence of teacher expectations of students which is known as the ‘Pygmalion effect’, that is, “...when teachers expect students to do well and show intellectual growth, they do; when teachers do not have such expectations, performance and growth are not so encouraged and may in fact be discouraged in a variety of ways” (Rheem, 1999, p. 1). However, a recent report by Ashcraft et al., (2012) found that computing classes are often not welcoming or comfortable for girls. Other research findings highlight, that teachers and counsellors can have a negative effect, discouraging girls when it comes to IT (Adya and Kaiser, 2004).
- How IT subjects are taught impacts on girls’ attitudes towards the discipline. Australian researchers found that the barriers to girls contemplating IT careers are established by lower secondary school, (Anderson et al., 2008). Newmarch et al., (2000) found that many girls considered IT subjects to be “too theoretical, rigidly structured and boring” (p. 9). Girls are more positive towards IT when the

curriculum incorporates group work or cooperative assignments rather than individual projects. Computing curricula are often not relevant to girls and reinforce stereotypes that IT is for boys and involves working alone (Ashcraft et al., 2012). Coupled with this are the stereotypical views relating to IT that it is ‘masculine and geeky’ (Ashcraft et al., 2012).

- A lack of visible and appropriate female role models in IT has been recognised as contributing to the gender imbalance of the profession (Ahuja, 2002). The literature shows strong support for the strategy of providing appropriate role models to girls (Ahuja, 2002; Ashcraft, et al., 2012). The literature frequently claims that role models can have a positive impact on encouraging and supporting women in their IT careers, as is the case in other disciplines (Bandias and Warne, 2009; Klawe et al., 2009). Many reported interventions reveal that women who are invited to speak to girls in schools do serve to encourage the girls to study IT (Klawe et al., 2009); however, there is little empirical data on the impact that talks from role models have on stimulating girls’ interest in IT over the longer term.
- Reinforcing that IT is a good career for women through the provision of more information about IT careers to girls. For more than two decades intervention programs have been run to address the lack of girls’ interest in IT. Klawe et al. (2009) detailed and categorised many of these programs. They reported that most assumed that the reason for girls not being interested in IT was because they did not know about IT careers or how exciting such a career can be. This is consistent with previous research by the authors which also found that many of the Australian based intervention programs focused on promoting IT careers (Craig et al., 2008). We reported that between 2001 and 2008, for example, there were six large scale one day ‘Go Girl Go for IT’ programs run across Australia, with a specific focus on exposing girls to IT career options and included women working in IT presenting to participants. A similar one day program focusing on IT careers, ‘Technology takes you anywhere’ ran in Queensland four times during this same time period (Clayton et al., 2012). Such interventions are common elsewhere (see Heo and Myrick 2009; Klawe et al., 2009;). Despite these large scale programs the majority of girls continue to self-select out of IT classes in Australian secondary schools.

There are other factors aside from those discussed above, that have been reported in the literature which impact on a girl’s interest in IT and influence their later decision-making with respect to further IT study. These include the influence of parents, family and peers, the availability and use of technology at home, early exposure to IT and the media (Adya and Kaiser, 2005; Ashcraft et al., 2012; Clayton et al., 2012;Lang 2010;). However, in designing our intervention program these factors were considered outside of our control and were therefore not included as part of the study. Our focus was on what impact we could have with a school based program. Figure 1 is a model of the different school-based factors likely to increase girls’ confidence in using IT and their interest in IT that is based on the literature discussed above. This model formed the basis for our research.

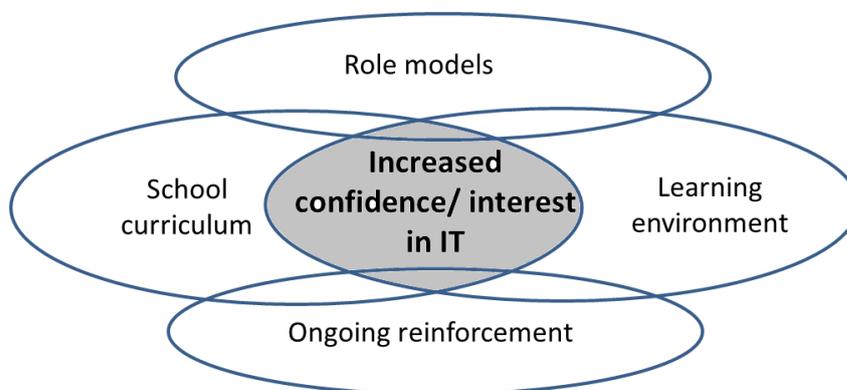


Figure 1 Influences on girls’ confidence and interest in IT

The school curriculum in our model (Fig. 1) relates to how IT is taught in schools, specifically curriculum designed to encourage girls' interest. The learning environment includes the attitude to technology of the school and the teacher, and how supportive the classroom environment is for girls. Role models are women (preferably near-peer age) who actively engage with, and promote IT in the classroom. Ongoing reinforcement refers to continual reinforcement that IT as a career is suitable for women.

2.1 IT intervention programs for girls

The majority of intervention programs in Australia and elsewhere have been short term, typically one to five days in length (see Clayton et al., 2012; Craig and Horton 2009; Doerschuk et al., 2007). Research indicates however, that these types of short term events are ineffective in addressing the longer term challenge of keeping girls interested in IT beyond secondary school and into an IT career (Craig, et al, 2008). Our previous research suggests that programs run in Australia were considered successful by the organisers; however, only limited evaluations were conducted so it was difficult to identify what constituted success. Often success was defined as the girls enjoying the program (Craig, et al, 2008). Where more substantial evaluations were undertaken the results have been less conclusive.

An eight week long summer camp program, reported by Pollock et al., (2004) involved twenty girls who were paid to participate. It focused on teaching programming but also included career information and speakers, women from industry. The participants completed pre and post surveys and feedback was collected two years after the camp. Results indicated that the girls enjoyed the program and the format, they appreciated the all-girl environment and learned about IT careers. Seventeen of the twenty girls who participated completed a survey two years after the event, the researchers found that those responding to the survey continued to have a more positive view of IT, they had increased their confidence and they were more likely to study IT further.

The only other longer term program we are aware of was Computer Clubs 4 Girls (CC4G) which was conducted in the UK. The program was aimed at changing girls' perceptions of IT as a career, and ran in schools with teachers as facilitators in the form of an after school club (Fuller et al., 2009). It was assumed that an after school program running for an extended period of time (a term, semester or year), would result in changing girls' attitudes to IT. In particular, Fuller et al. (2009) identified how CC4G could influence this change through the inclusion of activities which were fun, and introduced the girls to new IT programs. Localised improvements, dependent on the structure and frequency of club activities, impacted on student interest in computing. A recommendation from those who implemented CC4G was that it was important "not to rely solely on extra-curricular activities... but also to consider more the role of the IT curriculum and how such activities can link with it" (Fuller, et al, 2008, p. 81). The model adopted by CC4G influenced the design of our Digital Divas intervention program.

2.2 The Digital Divas Program

The four authors of this paper designed, implemented, ran and evaluated a longer term intervention called Digital Divas from 2008 to 2012. Schools were invited to participate in the program and over four years, ten schools implemented Digital Divas, typically as an elective subject for between 10 and 20 weeks in duration usually for lessons of 2-4 hours duration per week. Five schools ran the program more than once in consecutive semesters, or years. Classes were comprised only of girls (even in co-educational schools), a condition set by the research team for participating schools. The classes varied in size from 13 to 24 girls.

The schools varied in type, geographic location, and socio-economic background of the students. Some participating schools were co-educational (with boys and girls), others were single sex (girls only) schools; some schools were in economically deprived areas, others in wealthier suburbs. One school was a select entry school where the girls had to sit a competitive entrance examination. Another school was an all-girls independent (non-government) school.

The first stage of the project involved the creation of a number of teaching modules for teachers to use in their classrooms. Each module consisted of teaching activities which typically took students between four and five weeks to complete; these modules were termed ‘challenges’. The modules were designed with the help of an educational specialist, with the aim of capturing the interest of girls aged 13 to 16. Although we recommended the order in which they might be taught, it was left up to the teacher of each class to decide. To engage the girls fully, the modules focused on their interests, encouraged creativity, and group work; for example the first module, ‘Branding’, required the girls to design a logo for Digital Divas using the Flash or Photoshop software packages. Ahuja (2002) noted that most entertainment software is designed to meet boys’ not girls’ interests, and the same can be argued of the contents of school IT curricula. It should be noted that the teaching modules were not designed to teach a particular flavour of IT (e.g., computer science), but were designed around the Australian curriculum requirements with a focus on developing in the girls a broad knowledge of and skills in IT. The Digital Divas curriculum focused on building computing self-efficacy, while ensuring the activities were as collaborative as possible. Other modules included filmmaking, the use of standard applications such as Excel, and programming using Alice (free software developed at Carnegie Mellon University incorporating visual programming designed to capture girls’ interest – see Kellehar, 2007). Specific details of the modules can be found at www.digitaldivasclub.org.

During the running of the Digital Divas program, each school was visited regularly by the researchers and the girls were observed in class. Each class was visited by a guest speaker, a woman from industry who spoke about her experience working in IT, to serve as a role model. We also provided a current female IT student, called an *Expert Diva*, who worked with a class once a week and was paid for this role. The visiting speaker was an important component of the program to reinforce that women do work in the IT industry; the Expert Diva reinforced the pathway that students could take into an IT career.

3 Research approach

Our research is within the information systems [IS] and education domains. Our methodological stance was interpretivist, that is, we focused on people and the ‘social world’ rather than the natural world and, as such, we did not set out to test hypotheses (Cecez-Kecmanovic and Kennan, 2013; Shanks, 2002). Interpretive research approaches are particularly valid when looking at rich phenomena that cannot be easily described or explained by existing concepts or theories (Walsham, 1995). Our philosophy in designing our data gathering was that one approach would not provide us with the depth of understanding we sought about the Digital Divas program, as well as to effectively evaluate the intervention. In the words of Miles and Huberman (1994), “we have to face the fact that numbers and words are both needed if we are to understand the world” (p. 40). For the study, a mixed methods approach was used, that is, one in which both statistical data and qualitative data are gathered and analysed (Venkatesh et al., 2013).

Program evaluation involves carefully collecting information about an intervention program in order to make necessary decisions about that intervention. An important reason for conducting program evaluation is to assess its effectiveness for both the program designers/organisers and future program organisers (Rossi et al., 1999). In designing the Digital Divas program we were cognisant of the criticisms expressed of other intervention programs such as: “Too much of the research into the gender composition of computing includes only formative evaluations (participant satisfaction with aspects of the program) rather than summative evaluations that measure whether predicted outcomes and impact were achieved.” (Cohoon and Aspray, 2013, p. 144). Our evaluation therefore included not just pre- and post-surveys, interviews, and focus groups, but also focus groups held 12 to 24 months after the girls had completed the program.

Since raising awareness and igniting girls’ interest in IT and IT careers was one of the main aims of the Digital Divas program, Eccles’ (2005) model of “academic choice”, was also considered an appropriate theoretical framework to consider. The model highlights the impact of stereotyped gender

roles on goals, expectations of success, and self-efficacy in relation to future academic studies and career choice.

Evaluation of the Digital Divas program was conducted throughout the program. The research team adapted an evaluation framework designed earlier by one of the authors (Craig, 2015). The key elements of the framework were the evaluation planning, identification of the underlying assumptions about the impact of the program, and designing the evaluation to test those assumptions; the evaluation design was strongly influenced by the logic models developed by the University of Wisconsin (2003).

3.1 Data gathered

Quantitative data were collected through pre- and post-surveys. The surveys were used to identify and explore girls' views and perceptions of IT, IT careers, and stereotypes before and after they had experienced the Digital Divas program. The purpose of the surveys was to understand the extent to which the Digital Divas intervention changed the girls' perceptions of IT. Questions were drawn from a number of previously validated survey instruments (for example see Dawson and Rakes, 2003; Fogarty et al., 2001). Given the space limitations we present results for only a few of the questions/statements. These are:

- Questions requiring a Yes/No response 'Did you enjoy being in Digital Divas?', 'Has your confidence with computers improved?', 'Have your ideas about girls and computers changed?', 'Would you choose IT to study further?'
- Items using a 5-point Likert-type scale (1 = weak, 2 = below average, 3 = average, 4 = good, 5 = excellent) included 'I feel confident using computers at home', 'If something goes wrong on the computer I panic', 'I want to study computing'.

The qualitative data included focus groups with the girls, qualitative survey responses, and observations. Focus groups were conducted before and after the program in each school and in four schools further focus groups were conducted one to two years after the girls had completed Digital Divas. The focus groups each had between 4 and six girls participating. The issues explored through the free text responses in the survey and focus groups included how confident the girls felt with computers, their perceptions of an IT career, what they thought of women working in IT, their responses to the program and their future interests in IT as a subject and/or career. Table 1 details the number of surveys collected and girls participating in focus groups.

Data type	Participants
Pre-survey	265
Post-survey	199
Pre-focus groups (31 conducted)	134
Post-focus groups (30 conducted)	108
Follow-up focus groups conducted one to two years later (11 focus groups), 4 schools	33

Table 1 Summary of the data collected

3.2 Data Analyses

For the analysis of the quantitative data we used the Statistical Package for the Social Sciences [SPSS]; we report on the results of only a limited number of statistical tests for reasons of space.

NVIVO was used to code and then to assist with the analysis of all qualitative data including the free-text responses in the surveys. We used a grounded theory methodology, described by Bryant and Charmaz, (2007) and Urquhart (2013), to categorise the responses. Saillard's (2011) interpretation of this is that "Categories are grounded in the data thanks to the line-by-line coding, but the categories derived are part of the analytic thinking of the researcher."

Our research began with defined assumptions around which the survey and focus group questions were built. We therefore had some ideas of the likely categories which guided the initial coding

decisions; we then allowed the data to 'speak for themselves'. Three of the researchers coded all the data, an inter-coding reliability test was conducted and indicated a 90% agreement on the codes.

4 Results

It should be noted that bringing together the results of qualitative and quantitative data from a mixed methods study is challenging, as recognised by Bryman (2007). Given the significant quantity of data collected throughout this project, in this paper (for reasons of space) we are only able to report a small subset of the data and results. We have focused primarily on the qualitative data but use some quantitative data where relevant to support our findings.

One recommendation in the design of formal evaluations for program designers is the early identification of the program assumptions. We articulated a number of assumptions at the start of the project and these are discussed in the results. Next we discuss the impact the program had on girls' confidence with and interest in IT. This is followed by a discussion of the four factors identified in Figure 1 and finally if the changes in attitude in the girls was sustained over time.

4.1 Increased confidence with IT

One assumption we made was that participating in Digital Divas would increase girls' confidence in IT. To determine if girls' confidence with using computers increased, a paired t-test was conducted on the pre- and post-survey results. The results showed an increase in girls' confidence. In the post-survey the girls were asked if their confidence with IT had improved and to explain further if it had. The majority of the girls who answered this question (128: 76%) indicated that their confidence had improved. Of the girls who said 'no' (67: 34%), 17 (26%) wrote they were already confident before they participated in the program. Further, after Digital Divas the girls indicated they were significantly less likely to panic if something went wrong ($p < .001$) with a computer. At the focus group interviews held after the Digital Divas program, the girls were also asked if they were more confident with computers after experiencing the Digital Divas program; the majority said they were. A matrix coding query found 42 instances where the girls self-reported that their confidence had increased as a result of Digital Divas. Examples of comments from the girls highlight this *"I felt more confident after the course. Most of the stuff was on Word, and Excel, and Photoshop, and my dad, all my family members use those applications, so I teach them a whole lot of stuff, it makes me feel smart."*, *"If I found something was wrong in my computer I got like scared, but here I think I know how to fix it."*

4.2 Increased interest in IT

The second assumption we made was that girls would be more aware and therefore more interested in IT as a result of the program. In the pre-survey there was a statement to explore if they would contemplate further studies of IT. The pre-focus group data indicated that prior to the girls undertaking Digital Divas the majority had a negative attitude towards computers and/or a career in IT. There were 99 negative comments relating to stereotypes and only 15 positive comments. This was also the case with the pre-survey results. The girls were asked what they would like about a job in IT. Of the 247 girls who answered the question, 53 (21%) indicated there was nothing they would like about working in IT, they wouldn't like a job in IT, or they did not know or were not sure. The results showed that 39% of the girls either disagreed, or disagreed strongly, with the statement, with only 14% agreeing, or agreeing strongly, that they wanted to study IT further. In the post-survey the girls were asked if they were interested in studying IT, and 17% said that they would.

A t-test was conducted on two of the statements relating to girls' interest in IT. Both statements were on the pre and post survey ('I like to play around with the computer', 'Using a computer makes learning more enjoyable'). The results did not indicate a significant change following the girls' experiences of Digital Divas. However in the post-survey the girls were also asked if their ideas about girls and computers had changed (Yes/No). Of the 193 girls who answered this question, 98 (51%) girls said 'yes'.

In the post focus groups questions relating to further study in school or after school were asked. A matrix coding query identified 36 positive comments to further study of IT, 12 negative and seven mixed. Further, the responses in the focus groups conducted one and two years after the program ran, indicated that for those girls who had changed their minds, their interest had been sustained.

The broad results presented above indicate that through Digital Divas the confidence with IT of many of the girls had grown, and there was an overall increase in interest in IT. We next detail the approach we took to address the factors in Figure 1 which contributed to our results. We describe the implementation of the program and the results.

4.3 The curriculum

Another assumption we made was that the curriculum would excite girls' interest in IT as discussed earlier. In the post-survey the girls were asked if they enjoyed being in the Digital Divas class (yes/no). Of the 198 girls who responded to this question, 172 (87%) said that they had enjoyed it, and 26 (13%) said they had not. It should be noted that although most girls elected to do Digital Divas some were put into the class to make up numbers or because there was no alternative class for them to take. Using an NVivo matrix coding query for the post-focus group interview data, 265 positive comments were identified relating to the curriculum, 38 *negative comments*, and 14 *mixed comments*. *Examples of positive comments included the following: "The new modules/activities. It was something new we could learn, so it wasn't boring but fun", "I enjoyed having a challenge sometimes, it made me have to try really hard to accomplish my goals", and "Being able to use my creativity while doing IT."*

The words the girls used to describe the Digital Divas curriculum highlights how the materials had excited their interest. An NVivo text search from the post-survey identified the words 'fun' or 'enjoy' used 249 times (in a positive way) to describe the program or its content. The text search conducted on the focus group data found that these words had been used 190 times. Examples of the comments the girls made included: *'I learnt more ways I can use the computer', 'Playing with computers', 'it was fun', 'I enjoyed learning what different tools could do', 'I learnt that it can be fun and involve girls', 'That IT isn't just for boys and that it's fun'.*

4.4 The learning environment

Apart from the curriculum, a school's views on the role of IT for learning, the teachers, and the classroom atmosphere/environment have a major impact on learning outcomes (Ashcraft et al., 2012). The schools participating in our program had an interest in promoting and supporting IT. This was demonstrated not just through their willingness to implement Digital Divas but also because they were prepared to run it as an all-girls class; many of the schools also ran the program more than once. The teachers were interviewed before and after running Digital Divas. Space constraints preclude us from discussing their responses in detail. Although the schools decided which teacher would take the class, all but one of the teachers was female, most wanted to teach Digital Divas and were willing to attend a training session during their school holidays.

The most significant impact on the girls' responses to Digital Divas was that the program was run as an all-girls class in all schools; usually as an elective. The reaction of the girls to all-girls classes was very positive, with 61 specific positive comments made by the girls. Four themes emerged from these comments, highlighting the impact of the all-girls learning environment. The themes that emerged and illustrative comments are presented in Table 2.

Classroom atmosphere
Everyone was really friendly, and everyone listened to the teacher, and it was all really, really, really good. fun and comfortable. really quiet. [No boys meant it was quieter] And guess what happened, in oral presentations you could hear them. I'm in Digital Divas and I'm in another IT that is co-ed, and I think I like it with the girls better because

<p>everyone’s talking about the same things and it’s more like everyone’s talking with each other. It’s like a more friendly environment and there’s not like boys mucking around and stuff so it was good. I’ve been in an IT class last year but it was mostly boys and you just sit there and go I don’t want to put my hand up to need help. Yeah, everyone was really friendly, everyone listened to the teacher, and it was all really, really, really good.</p>
<p>Learning was fun</p>
<p>It’s more fun with all girls It was just girls, you’d talk, they all knew what we were talking about, and everyone was just happy. It’s fun to escape from disruptive boys and have a laugh and work in a class of girls It was so much fun and I learnt lots of new things. I also liked a class all full of girls.</p>
<p>Increased confidence</p>
<p>They [boys] brag and like put you down. Because it’s all girls .. if it was boys, the boys will take over, say “Oh you’re doing this wrong” It gives us a bit more confidence to actually stand up and give our ideas. If guys were in the class they would just be talking and everything, and you wouldn’t be able to get your point across. Where it’s all girls, you’re more confident to do stuff. You’re more confident to put your hand up and say, “I need help,” because with the boys, they just go, “That person needs help. We’re still not going to do any work,” and “Ha, that person needs help.”</p>
<p>Better learning environment</p>
<p>I think it’s just to get more work done without the guys being there because they just tend to be loud and don’t really pay attention Most boys muck around in the class, and we actually got work done. Less distracting. Compared to a maths class, or a science class, there’s boys that keep on talking, and talking, and the teacher doesn’t focus on you. I reckon we get less done with boys. I’d probably get distracted more if the boys were in the class. I probably wouldn’t participate as much as I did. Being in an all-girls class it is easier to learn without disruptions.</p>

Table 2 Responses about all-girls classes

4.5 Role models

A lack of visible and appropriate female role models in IT has been recognised as contributing to the gender imbalance of the profession (Ashcraft et al., 2012). Additionally, a lack of mentoring can inhibit the progression of females along the pipeline to a successful IT career. The literature shows strong support for the strategies of providing appropriate role models (Ahuja, 2002; Klawe et al., 2009). In Australian schools, as elsewhere, girls are less likely to see female mathematics and computing teachers, and IT technical support will most likely be male; as well, girls’ general exposure to female IT role models will be limited (Adya and Kaiser, 2005).

In the Ashcraft et al., (2012) report it was suggested that role models for girls need to be ‘relatable’, that is someone who is similar to them. In our study, female university students (18-20 years old) studying IT were assigned to each school. They were paid for their participation and attended on a weekly basis. The aim was for them to be informal role models for the girls and help normalise the perception of a female IT expert. At least one industry speaker, a woman working in IT, presented a session to each class. Again, the idea was for them to reinforce that IT was fun and a great career for women.

The girls’ responses to the Expert Divas were overwhelmingly positive. Typically the Expert Divas would walk around the class helping the girls with whatever projects that were working on. The girls were impressed with the knowledge of the Expert Divas, exemplified by comments such as: “I realised she actually knew all the answers to the questions that I had so that was good”, “she knew

what she was talking about". A number of the girls made reference to the fact that their Expert Diva was young and they liked that. The girls also mentioned the types of discussions they had which included about university and IT as a career.

The speakers also had a positive impact. A matrix coding query found 16 specific positive comments from the girls about the speaker who came to their school. Even well after the speaker had been to the school, the girls remembered the messages conveyed. Comments from the girls highlight this:

- *By talking to Sally, she's the one who kind of gave us the bigger picture of careers in IT and what role women play and everything, and she's kind of the one who actually made me consider IT*
- *The most interesting things I learnt from Digital Divas were the speakers that came in and talked about what possibilities and opportunities there are in technology.*
- *When Alison came in, I didn't really know that you could do that and that was part of IT, what she did. But it was a change to what I thought about it and that girls can do it as well.*
- *I was amazed with some of the things I could do with IT. It was putting words into reality, seeing this person actually does this job and she's really enjoying it and all that.*

4.6 Ongoing reinforcement

A key element of our program was to continually reinforce the positive message that IT was fun, diverse and a good career for women, another of our assumptions. This was done in part by the Expert Divas' regular attendance in the classes throughout the semester of study and by the speakers who reinforced the messages. The main reinforcement, however, came through the teaching modules. Two modules focused on careers in IT. Using film making software the girls were required to make a movie about someone working in IT. Another module, 'Myth Busters' was designed for girls to specifically explore, document and bust myths around women and IT. The girls had to prepare a 5-10 minute multimedia presentation busting myths. A number of other modules also highlighted the types of work someone might do who worked in IT; for example, in teaching students Photoshop, girls learned about IT in the advertising industry.

When coding the data we created nodes around stereotypes for both the pre (negative and positive) and post (challenged, no change and reinforced) focus groups. From the pre-focus groups there were 99 negative comments relating to stereotypical views of IT. The post-focus group data showed a change, with 286 comments indicating girls' views had been challenged. Representative examples of comments from the girls in the post survey included: *"I just thought IT was like working behind a bench but now I know you can go places and do stuff"*, *"This program has shown me that computers are not only for men, but women can enjoy technology as well. I know this because I have enjoyed the program."*, *"Doing this subject I've learnt there's a lot of career opportunities in IT"*, *"I now know a lot of jobs involve women and computers"*.

4.7 Sustained interest in IT

A key assumption of the Digital Divas program was that the motivation and enthusiasm the girls expressed after taking Digital Divas would be sustained over time. There would appear to be no literature documenting how successful an intervention program such as this one has been over the longer term.

We conducted 11 focus groups in four schools involving 33 girls who had participated in Digital Divas one or two years previously. We acknowledge that we cannot draw any hard conclusions from these data because of the limited number of girls we were able to contact and invite to participate in the focus groups. The responses, however, do provide some insights into how sustained the learnings from Digital Divas were. The results indicate that the program has had a sustained impact on those girls. Predominantly they remembered the class was fun and they remembered the different classroom activities. They also recalled information on the different IT career possibilities. It was clear that the

message that IT is not just for boys had made its mark and that any stereotypical views of IT they may have held had changed. For example: “*girls can do it too, not just the guys. And it’s not always boring and sitting in front of the computer screen, you can go travel and all that*”. “*I think that females can bring more of a difference...they can contribute a lot to that field*”. A number of the girls expressed an interest in continuing in IT and were considering an IT career. Their confidence in using IT also appeared to have been sustained. “*It extended my interest. It brought it up a bit more, now that I know how to use certain programs. I can just, I think, be a bit more specific in what it is I want to learn.*”

The sustained effect of the program is also evident in its lifespan in different schools and the wider community. In 2014 and 2015 schools were still contacting the research team to gain information about the program and how they could implement it. One of the teaching modules (Healthy Menu using Excel) is now available on a government funded website (Scootle.com) it demonstrates innovative and interesting ways to engage all students in computing through the curriculum.

5 Discussion

The Digital Divas program was unique because it focused on girls in schools and was incorporated into the school curriculum, something that, as far as we know, has not been done before. Two assumptions of the program were that girls’ confidence and interest in IT would be increased through a carefully designed curriculum. The results demonstrated that these goals were met. Another assumption was that girls’ enthusiasm for IT would be sustained over time and this, too, was found to be the case.

Our research sought to understand more about each of the four factors described in Figure 1 which are the most frequently discussed in the literature as having an impact on girls’ interest in IT. These were the school curriculum, role models, learning environment, and ongoing re-enforcement. We sought to investigate what these meant in the context of a school based intervention program. We wanted to identify the important components associated with each of the factors. Understanding these better should serve as guidelines for building more successful school based intervention programs in the future. A model summarising the components is presented in Figure 2.

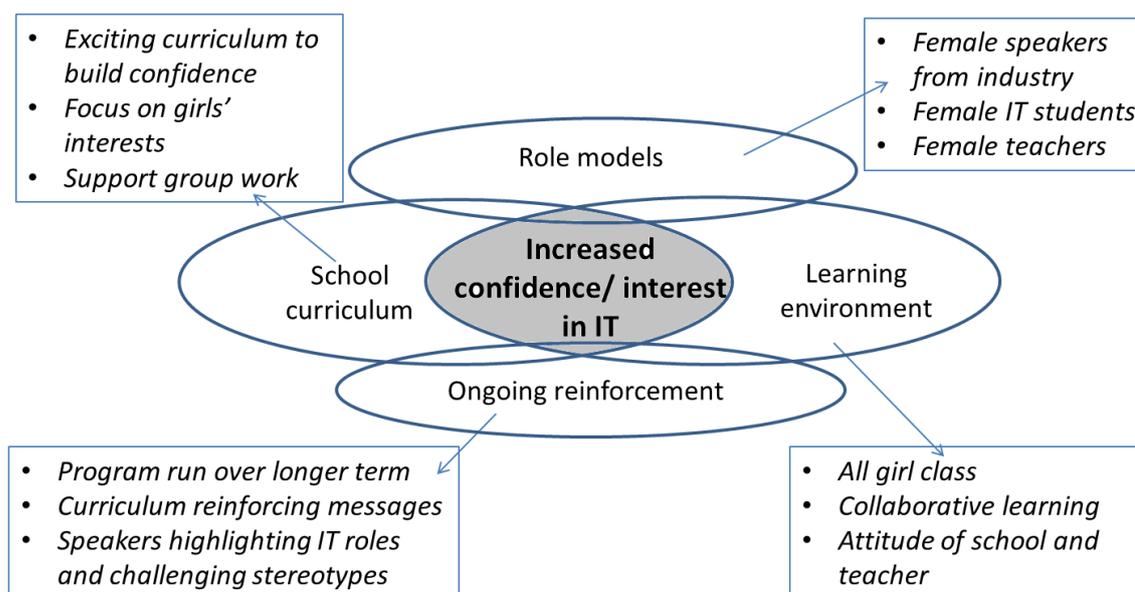


Figure 2. Key components for a successful school based intervention program

The school curriculum: Not surprisingly, the curriculum for teaching about technology is frequently mentioned in the literature as important. Anderson et al. (2008) found that the reasons girls gave for not taking IT subjects included that the content was not for girls, the way the subject was taught was not interesting, and IT subjects were boring. Our curriculum was specifically designed around what we understood to be the interests of girls, the modules were designed to encourage group work and, as far as possible, to incorporate a level of creativity. This approach, while still ensuring key skills were included, helped build the girls' confidence in using computers. The girls' responses to the curriculum were overwhelmingly positive.

The learning environment: In their report, Ashcraft et al. (2012) noted that there is often an unconscious bias in the classroom; with teachers reinforcing that boys are better and more natural with computers than are girls. All schools participating in Digital Divas were required to run the program in an all-girl environment. The schools were very positive about the program and ensured all-girl classes. The most overwhelming response we had from the girls was with respect to the all-girl class, as the quotes in Table 2 illustrate. Our research highlights the importance of the classroom atmosphere; the all-girl classes made learning more fun, assisted in increasing girls' confidence, and contributed to improved learning. A number of schools ran the program more than once; this also suggests a positive attitude in these schools. All but one teacher was female and most self-selected to teach Digital Divas. Space constraints prevent a detailed discussion of the responses from the teachers; however it was found that most, but not all, were initially enthusiastic about teaching the program and all were very positive at the end.

Role models: Although there is limited discussion in the literature around the impact on girls of role models longer term, most intervention programs have incorporated women from the IT industry as speakers. Our approach provided not just industry women as speakers, but also female IT students (Expert Divas) close to the age of the girls in each class once a week. The girls' responses were very positive and their comments highlight the impact that the Expert Divas had in the classroom. The speakers were one element of the program that the girls remembered very clearly and very positively after they completed the program. Comments from girls in the focus groups that were held 1-2 years after they had participated in Digital Divas confirmed that.

Ongoing reinforcement: The literature discusses the importance of highlighting careers in IT as options for girls; however, ongoing reinforcement of this is not a factor mentioned specifically but it is one that we see as important for sustained change. We wanted to ensure that, as distinct from one off, short term events, the girls would have regular positive reinforcement that IT was for women and that they could do IT in the future, and this was incorporated specifically into one of the modules, 'Mythbusters'. The curriculum, the Expert Divas, and the industry speakers reinforced the idea that girls can and should do IT. We focused on breaking down the stereotypes and emphasising different careers in IT. Most importantly we wanted to ensure this message was sustained over a longer period of time and the comments from the girls in later focus groups told us that we had succeeded in this.

6 Conclusion

Implementing an intervention program designed to affect social change is not easy and it will take time to determine if, in the long run, it has been successful. In their report Ashcraft et al. (2012) argued that there is no single answer to changing girls' interest in IT. Change will involve many people including teachers and family. Measuring the impact of an intervention over the longer term is therefore difficult, given the number of factors influencing girls' decisions and career choices. Many of the IT intervention programs for girls reported in the literature provide limited details of the evaluations conducted (Craig et al., 2008). Most evaluations consist of pre- and post-surveys and describe success as the extent to which girls enjoyed the program. The longer term impacts of these reported interventions are largely unknown, as there have been few, if any, longitudinal studies (Ashcraft et al., 2012). It should be noted that few of those running these types of interventions publish the outcomes. For the development of new programs, it is therefore difficult for future researchers to

learn from previous programs that may have been effective, if the outcomes are not published and/or longer term evaluations are not conducted.

Digital Divas was a unique approach to the problem of the declining interest girls have shown in IT. There would appear to be only one other program implemented that has run for a similar length of time. Not only was Digital Divas evaluated throughout the program, but the extent to which changes that occurred were sustained was also examined. In essence, we sought to address the declining interest girls' display in IT through a longer term intervention.

There were some limitations associated with the Digital Divas research reported here. First, it was a program developed for the Australian school curriculum, and second, in setting up the research instruments a flawed assumption was made that the girls were starting from a negative base. This has affected some results. For example, some students were already confident IT users and chose to be in the Digital Divas elective class for reasons of enjoyment; thus they were already confident and held positive attitudes towards IT, thus creating a ceiling effect on some attitudinal measures.

The model shown in Figure 2 provides guidance for any group wishing to implement a similar school based IT intervention for girls. The Digital Divas program has been made freely available online and, through Creative Commons licencing, it can therefore be used and edited for local environments. We believe that our evidence-based research on the Digital Divas program demonstrates success in changing girls' attitudes towards and confidence in IT, and with some indication of sustained change. Digital Divas therefore has the potential to benefit girls' educational outcomes, as our research has demonstrated, by positively enhancing their attitudes to IT, and stimulating and expanding their career aspirations to include IT. In the longer term, the viability of the IT industry will be strengthened.

7 References

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