

Creating Digital Divas – scaffolding perception change through secondary school and university alliances

Catherine Lang,
Swinburne University of Technology,
Hawthorn, Victoria, Australia
+61 3 9214 5884
clang@swin.edu.au

Annemieke Craig
Deakin University
Geelong, Victoria, Australia
+61 3 5227 2172
acraig@deakin.edu.au

Julie Fisher, Helen Forgasz
Monash University
Caulfield, Victoria, Australia
+61 3 9903 2621
Julie.Fisher@infotech.
Helen.Forgasz@education.
monash.edu.au

ABSTRACT

Over the last 20 years much has been done to encourage female students to choose computing courses and computing careers. Some instances of positive effects have been reported, yet the proportional disparity in gender in this discipline continues to grow. This paper reports on a program called 'Digital Divas'. Digital Divas aims to scaffold positive perceptions around computing in the early years of secondary school by involving female students in upbeat computing experiences over a semester. It introduces university undergraduates to the secondary classroom to provide informal role models and mentors, as well as interactions with young computing professionals. This classroom environment enables computer applications to be more strongly linked with future careers. The commitment to a semester length unit was influential in changing perceptions about girls and computing, and the program was supported by the wider school community. We posit that this type of curriculum intervention is needed and has the potential to build technical human capital in female students.

Categories and Subject Descriptors

K.3.2 [Computers and Education]: Computer and Information Science Education - *Computer science education, Curriculum, Information systems education.*

General Terms

Human Factors.

Keywords

Gender and diversity; Students attitudes; K-12 education

1. INTRODUCTION

There has been a continued decline in the enrolment of women in bachelor degree computing courses this century. In fact the number of female students has almost halved from 11,566 in 2001

to 6101 in Australia [1]. Similarly in the US statistics provided by the Taulbee Survey indicate a 34% decline, and UK statistics, published by e-Skills, show a 33% drop in female enrolments during the same time frame [2]. This trend is contrary to the overall increase of female rates of participation in higher education, where women are now in a majority on campus in Australia. There is a similar under-representation of women in the computer workforce reported by the Australian Computer Society (ACS): 'Of the 348,200 ICT workers in 2005-06, 85% (295,000) were men. The number of male ICT workers increased by 6% between 2004-05 and 2005-06 ... ICT industry data and ABS data does not show any significant variation in female participation in the ICT Industry, or at professional levels, over the last six years'[3]. The acronym ICT refers to Information, Communication and Technology and ABS is the Australian Bureau of Statistics.

Currently there are many organisations world-wide whose main purpose is to encourage women to consider computing careers. For example *NCWIT* is the National Center for Women and Information Technology in the US, and *ECWT* is the European Centre for Women and Technology. Industry bodies such as the Association for Computing Machinery (ACM) also support initiatives to increase the representation of women in computing. The ACM has a council with the mission of celebrating, informing and supporting women in computing [4]. The Australian Computing Society (ACS) has a policy to 'bring about economic, social and intellectual benefits through a higher participation of women in ICT ... the ACS commits to create and support initiatives that encourage the entry, development and retention of women in ICT professions.'[5]. The Victorian ICT for Women Network is another such organisation that has a mission to support entry, retention and progression of women in ICT professions in the state [6]. Both the ACS and the Victorian ICT for Women Network support the Digital Divas program and have contributed financially to the running of the program.

This paper reports on a program developed in an Australian University, an outcome of the University's Women in ICT (WICT) group, which attracted a Telematics Trust Grant in 2008 to work at the secondary school level to encourage young women to consider a future in IT. The grant enabled the development and implementation of a computer-club elective program for female students, now called 'Digital Divas'. This elective had two primary aims: to expose Year 8 students to a variety of computing applications and experiences in a female-only club environment;

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

Conference '04, Month 1–2, 2004, City, State, Country.
Copyright 2004 ACM 1-58113-000-0/00/0004...\$5.00.

and to make a connection between the various applications with courses and careers in computing by employing university students as classroom facilitators and inviting recent graduates to be guest speakers. An unpredicted consequence of the trial was a change in the wider school perception of girls' interests and skills in ICT. This has resulted in an ongoing commitment by the school leaders and parent groups to offer the program in the regular timetable each semester.

Digital Divas evolved after a trial of a UK based program, Computer Clubs for Girls (CC4G) in 2007. In assessing the outcome of the trial a critical analysis of curriculum and factors that influence career-choice was undertaken [7] and the Digital Divas program was born. Its multi-layered aspect proved to be critical in changing perceptions of computing, gender, and future careers. The program is a product of over 20 years of research, by the authors, into intervention programs to encourage girls to consider computing courses and careers [8].

The strategic approach behind Digital Divas and the relative advantages of each aspect of the program are summarised in the following table:

Table 1. Approach to Digital Divas

Curriculum	Focus on what interests girls (e.g image, fashion, diet), THEN introduce programming through storytelling (Alice). Group and collaborative projects encouraged. Embed the program in the school timetable, not as an add-on or one-day event.
Informal role models	At least one under-graduate student in the classroom with the teacher each week. Informal role-model, showing by example that girls do choose computing in university. Invited guest speakers with a focus on recent graduates showing the breadth of technical, creative and business careers.
Showcase / Celebration	Create, print and display colourful posters, produce an item with logo (keyring, lanyard) to identify as their own. End of semester celebration with principal, media and, of course, parents

In this paper we argue for the need for such an elective, and why the lack of diversity in the computing discipline needs to be addressed. The effect of the Digital Divas elective environment and curriculum is described in some detail followed by a discussion on students' changed perceptions. The sustainability of such a program has potential education advantages both for students and for building university connections to secondary schools. The outcomes of the localised project described here contribute to the body of qualitative studies in this area. Benefits evident to date advocate the need to extend the program to more schools, an outcome the research team has achieved and gained funding to support the program for the next 3 years.

2. THE NEED FOR 'DIGITAL DIVAS'

It is interesting to consider the history of computing that has led to the need for a program like Digital Divas. Over 40 years ago when computing started as an independent discipline some thought that it would be a gender-neutral field unencumbered by historic gender stereotypes [9]. According to Stewart Miller 'the term 'computer' itself was coined to describe the function of women who performed calculations and who wired hardware for the first

digital electronic computer, the Electronic Numerical Integrator and Computer, or ENIAC.' [10]. It was suggested that the profession would be ideal for women, who were thought to possess the qualities of problem solving, attention to detail, accuracy, and patience to a greater degree than men. Seligsohn mused that 'the feminine mind and psychological makeup may give the girl programmer an advantage over her male colleagues' [9]. However, in the 21st century there is now less than 20% female representation in computing courses and careers in Australia.

The declining proportion of females attracted to the computing disciplines and careers is not solely an Australian phenomenon, but appears to be an issue in most westernised nations [11]. According to US researchers there are at least four reasons why increasing diversity, and particularly women in computing, should be of concern to all [12]. First they suggest that increasing the number of women in computing will increase the qualified labour pool to drive innovation and development. Second, many computing jobs pay very well, yet women occupy less than 1/5th of these quality jobs and that making computing more gender inclusive will open many opportunities for the financial well-being of a large sector of the population. Third, the value of a diverse workforce adds to creativity, and brings new and innovative solutions to problems; at the base level, women, men, ethnic minorities, racial minorities experience the world differently. The final reason given is that the computing discipline needs to include the voice of all who intend to use computers, to avoid mistakes such as the early voice recognition software that only recognised the male voice [13].

Trends in Australia mimic those reported by Papastergiou [14] as existing in Greece. An increasing number of girls are excluding computing from their study options as early as the middle years of secondary school. In Victoria, the state where Digital Divas was trialled, the senior secondary school enrolments in Information Technology (IT) courses declined significantly this century. The total number of satisfactory completions of the final semester IT units dropped from over 16000 in 2001 to 5285 in 2008 [15, 16]. By the final year of secondary school, female students studying computing are already in a minority of only 16.5% of the student cohort. Recently explanations for this downturn in interest have been ascribed to the school curriculum. ICT subjects in secondary school are often 'fragmented and at times ambiguous' partly due to the fact that they are not aligned to an historically recognised academic discipline' [17]. This ambiguity and inconsistency in the delivery of ICT units in secondary school may be a contributing factor for putting girls off pursuing further study in this discipline [18]. The ambiguity is a product of ICT teachers' 'bricolage pedagogy' where they bring their own mix of perceptions, experience, backgrounds and teaching styles to the IT classroom [18]. Many teachers in Australian secondary schools teach computing without having completed a subject specific methodology in their teacher education programs. It has been suggested that computer literacy is really computer fluency, and that the downturn in enrolment in senior secondary school ICT units is related to confusion around the relevance, role, and purpose of the subject [19]. Lynch suggests that the pedestrian focus of IT units in primary/elementary school curricula, such as typing and working with spreadsheets, contributes to a lack of interest in senior school units [20]. Interviews conducted with male and female students at three levels of their secondary school education (Year 8, 10 and 12) found that many young men and

women, while almost equal in their computer use and literacy, did not consider computing as a valid and independent discipline for future study or as a career [7].

A diverse computing workforce is essential to managing the exponential growth of knowledge in our culture and business environment, creating career paths and job types that now extend well beyond the technical. The computing career in the 21st century requires a depth of knowledge of management and communication skills to a much greater degree than ever before. Unfortunately while the industry may have changed, the perception in the minds of young people is still quite stereotypical, and many believe the career path is suitable only to 'geeky male programmers' [21, 22]. Coupled with this static perception is research in which it was found that girls use computers as much as boys, yet do not appear to translate this use into a career option [7, 23], and therefore unnecessarily preclude themselves from a very lucrative and influential career path.

There appears to be no inherent reason why IT should be such a masculinised area in the twenty-first century. However Robinson and Davies [24] discuss how hegemonic discourses of identity gender, class, and ethnicity influence the perceptions and landscapes of students. These constructions contribute to girls' ambivalence to ICT [24]. Researchers in this arena posit that in western societies 'a computer is not a 'dead' object, but an object interwoven with culture.' [25]. There is an expectation that males will have more interest and be fascinated by the technology. Corneliussen states that both men and women use the hegemonic discourse as a frame of reference [25], a position also espoused by Wacjman [26]. While it is difficult to combat such entrenched societal perceptions, it is not impossible. This body of research influenced the Digital Divas program described in this paper. The authors considered that Year 8, the second year of secondary school, was a critical time to introduce Digital Divas as an intervention program to change perceptions and eradicate outmoded cultural stereotypes.

3. STRATEGIC APPROACH ADOPTED

Digital Divas, a girls only computing elective in the Year 8 (12-13 year olds) curriculum is timetabled four teaching periods of 48 minutes each week for students to develop their computing efficacy in a structured environment. The program is designed to run over two teaching terms, or a total of 20 weeks of class time. Female students were invited to sign up for the class which was timetabled against at least one other elective that catered for male student interests, in this case one that focused on Formula 1 car-racing. The first offering of Digital Divas was oversubscribed. The successful application for a Telematics Trust Grant allowed classroom facilitators to be recruited among current female university students and allowed their time and travel expenses to be reimbursed. Specific professional development resources and technical equipment was also purchased with the grant money. A female computing graduate was employed two days per week to work at the school and set up necessary software, the server, student access permissions, blogs, and a web-site hosted behind the school firewall. The choice of a female computer support person was deliberate to counteract societal perceptions that males are best suited to these types of positions. The university students also were informal role-modes in the classroom, and encouraged to talk to the secondary school students about their reasons for selecting an ICT course at university.

The curriculum objectives for the elective were devised with the primary aims of capturing the interests of girls of this age and building on their computing self-efficacy while ensuring the activities were collaborative as much as possible, to maintain a club-type atmosphere. It was also necessary to adhere to the three strands of Thinking, Creating, and Communication, of the Victorian Essential Learning Standards (VELS) for this age group (Level 5). The unit was designed for one semester of the school year, divided into two school terms of 10 weeks length. After consultation with the classroom teacher who had a close relationship with school children of this age, a recommendation to capture girls' interest as quickly as possible was to start with the theme 'Image Makers'. As researchers we acknowledged that this could be reinforcing gender stereotypes, however we deferred to greater experience. This unit of work incorporated aspects of design, fashion, diet, make-up, and advertising, and was launched with a task for students to design a club logo and motto using multimedia software. Research has shown that there is a strong link between perceived self-efficacy and its effect on confidence and persistence in the education and career choices of females in science[27]. It was extrapolated from this research finding that self-efficacy is important to student experiences when being introduced to computing in a classroom environment. The use of the Image Makers topic in the curriculum was designed to promote early successes and positive experiences to influence self-efficacy and persistence with computing courses and career decisions. In designing the club logo the issue of copyright was introduced and explained. The Digital Divas brand and slogan were voted on within the group, and the winning two entries were used to create key chains and lanyards distributed to all participants in the elective, further promoting the club concept and also used for advertising in the wider school community.

The educational values of Thinking and Creating were incorporated in this activity. Other activities were designed around a product or output, rather than teaching any computer application in isolation. Students were assigned tasks and challenges to complete individually and in groups. For example, spreadsheet software was used to develop a healthy restaurant menu. A guest speaker came and discussed how magazine images were digitally enhanced, and girls used video cameras and digital editing software to produce their own 3 minute commercial which was later showcased as an end product. At all times the process of being engaged in the activity overrode the teaching of specific computing applications. During the term break students were encouraged to research changing technology used on the World Wide Web, such as wikis and blogs. This led to the introduction of 'blogging' in the club environment. During the second half of the semester each of the four university students was allocated 5 or 6 girls to mentor informally through a blog.

The second main theme of the elective was titled 'A day in the life'. The objective of this theme was for the girls to deliver an oral presentation after researching computing careers or computer use in a career of their choice. Parallel to the investigation the girls were introduced to the concepts of programming via the Alice programming language. This free software incorporates visual programming methodologies designed to capture the interest of girls through story-telling [27]. Several of the introductory programming sessions were led by the university student facilitators. This collaborative teaching approach contributed to the desired image that no-one needs to be expert in all areas of computing, not even the classroom teacher. There

were introductory activities involving objects (e.g., hats, umbrellas) to explain methods in object-oriented programming, as well as an algorithm session that was hands-on with jelly and peanut butter sandwiches, allowing the students to be introduced to elementary programming concepts via an interactive and collaborative activity. Initially it was thought that the Alice programming language could be used to create the 'Day in the Life of an IT professional' story, but the researchers soon realised that this was beyond the scope of the Year 8 students. However concepts such as iteration, selection, and sequence in programming were introduced. Students used the objects within the program to create their own story with a moral. They learned how to add music to Alice and presented their final product to their parents and fellow students at the end of unit celebration event. It is anticipated that another unit will be created to offer students in later years that will focus solely on using the Alice programming tool for the whole semester, therefore offering students more in-depth programming experiences.

4. RESULTS AND DISCUSSION

The Digital Divas elective was evaluated by the classroom teacher, who herself was then interviewed. The students filled out a two page feedback survey, and participated in 'vox pops' in small groups led by the university student classroom facilitators. The classroom facilitators each kept their own 'blog' and made this available to the researchers to provide rich qualitative feedback on the program. The program proved to be strategic in changing perceptions because it moved beyond the computing applications aspect; the mentoring and invited guest speakers proved to be integral in this aspect. The girls-only class environment was also perceived as being a positive aspect evident in this student comment: *'It was just girls so it was easier to get along with other people'*.

4.1 Informal mentoring by university students

The students involved in the Digital Divas elective reported that one of the most beneficial outcomes was the informal interactions that occurred with the university students employed as classroom facilitators. Many of the girls in the class had not previously met anyone who had chosen to pursue an academic degree in computing. Structured e-mentoring was implemented in the latter half of the program. Immediately the interactions proved beneficial in increasing student understanding of computing as an academic discipline, as well as combating perceptions that computing careers were only suitable for male 'geeks'.

Another benefit was the growth and empowerment provided to the university students. These young women gained personally from working in the classroom each week. The teacher supported their development and allowed them to introduce activities and explain concepts in their own words (and in some cases via actions) to the students. This comment in the reflective blog kept by the classroom facilitators is an example of this growth: *'My favourite thing is that you watch the kids grow, and ... working in front of those girls who were basically walked into the room thinking they are strangers, and they are university students, and they do not think about us changed now. We are walking into the room now and they get excited when they see us, and tell us what's happening at school, and what's happening between their friendship groups. So there are still interactions, but the girls are pretty comfortable with telling us that they've got problems,*

or something, so we are really growing together as a group'.

4.2 Invited guest speakers

This aspect of the program was exceptionally important to allow the students to hear the stories of young professional women who had decided on an IT career. A conscious effort was made to bring in speakers who had different roles in the computing industry. There was a Business Information Systems university graduate working for a large corporation, a Network Administration expert who had gained a technical computing diploma qualification after a Health Science Bachelor's degree, and a software programmer who worked in a well-known multinational company that the students were all familiar with. The speakers were encouraged to talk about their secondary school experiences and what influenced their career choices. The sessions were held informally in the classroom, and the girls captured the talks on hand-held digital cameras. The videos were then placed on the Digital Divas portal to be used later as a reference tool for the 'A day in the life' unit. Previous analyses of similar girls' computer club programs (e.g. CC4G) revealed that while beneficial, they did not appear to build a connection between use of various computing applications and future careers. The Digital Divas guest speakers, combined with the research project around 'A day in the life', went closer to linking the two areas. Student comments on the unit survey reflect the benefit of the invited guest speakers, for example: *'she was talking about her experience in IT, and obviously how she's become successful. She's on channel 7, channel 9? She does the morning show, and does all the related IT work. And just her coming and speaking to us, like.... Even though some people say there are not a lot of jobs in IT, she actually made us realise there's heaps, and heaps, and heaps. And that you can be really successful out of it one day. That's what I liked.'*

At the end of the unit two-thirds of the class commented that they would now consider an IT career, and when asked why wrote *'Every day is different apparently. I love fixing things and helping people'; 'the travelling'; 'being creative and everyday would be different'; 'Programming games or animation'; 'Just learning about and using computers for many different things'*. These comments verify that this aspect of the program had succeeded to some extent in changing student perceptions about the career path.

4.3 Encouraging Creativity

The engagement of students in creative and interesting activities was achieved through a curriculum that spanned multimedia applications, research, and spreadsheet applications, and was designed in a purposeful manner to create activities that were perceived as engaging by the majority of the students. The programming language focused on storytelling using a tool that was created specifically to capture the imagination of young girls. A comment on the feedback survey reflected the positive aspect of using Alice, when asked what was the best aspect of the course one student wrote, *'Doing the Alice project, I feel that I have found something that I am good at'*. The club atmosphere was reinforced with the key-rings and lanyards that the students had created themselves, termed their 'bling'. One student commented *'I liked that we all got to design our own logo, how the symbol of Digital Divas was created by the Digital Divas'*. This contributed in showing students many different computing applications, and allowed them to experience creative successes in the process thereby building on their own technical self-efficacy.

5. CONCLUSION – FACILITATING PERCEPTION CHANGES

One outcome of this program is that of the 24 students who participated, 16 responded positively that they would now consider an IT career path in the future. Another strong indicator of success was that while the elective had been set to meet the criteria for VELS Level 5, typical for Year 8 students, the majority of the students were assessed to be performing at Level 6, which is at a substantially higher level than expected, suggesting increased computer self-efficacy. The data indicate that the Digital Divas elective positively affected the attitudes towards IT held by these young women. When they were asked what they would like in the future, responses such as more time on each task, slower steps, and more excursions were received. It would appear that there had been a shift in perception for the majority of the girls; however it will take a few more years to determine if this has an ongoing effect. A strategic evaluation of the measurement of success needs to be conducted over a longer period of time, however we know that actions implemented by the school leadership to timetable this elective in both semesters each year is a first step towards perceptual change. Successful tendering for an Australian Research Council (ARC) grant to implement the Digital Divas elective in more schools across Australia over a longer period of time will allow for a longitudinal evaluation of any changes in perception about females and their contributions to the discipline of computing. The responses from this trial were integral to the success of the ARC grant application. Strong links have been built between the university and the secondary school in which Digital Divas was implemented. An inspiring offshoot of the program is that two of the undergraduates involved in the elective have started their own research studies and have contributed a presentation to a national Women in Computing conference.

6. REFERENCES

- [1] DEST *Students enrolled in Bachelors Pass, Information Technology courses*. Higher Education Statistics, Canberra, 2008.
- [2] Lang, C., Egan, M. A. and Peters, J. *Multi-level International programs working to change perceptions about IT courses and careers*. Proceedings of Grace Hopper Celebration of Women in Computing Conference, Tucson, 2009.
- [3] ACS. *The ICT industry report*. CIIER Inc. Melbourne, Australia, 2008.
- [4] ACM-W *ACMs Committee on Women in Computing*. New York, 2009. <http://women.acm.org/> (2 Nov 2009).
- [5] ACS-Women *Australian Computing Society Women's Board*. City, 2009. <http://www.acs.org.au/acswomen/> (2 Nov 2009)
- [6] VicICTforWomen *Web Page*. Melbourne, 2005. <http://www.vicictforwomen.com.au/> (8 Nov 2005)
- [7] Lang, C. *Why IT rarely enters students' schematic repertoire of future careers. A gendered analysis of student course and career choices related to IT in the 21st Century*. VDM Verlag Dr. Muller Aktiengesellschaft & Co. Germany 2010
- [8] Craig, A., Lang, C. and Fisher, J. *Twenty Years of Girls into Computing Days: Has It Been Worth the Effort?* *Journal of Information Technology Education* Volume 7, 2008, 339-353.
- [9] Seligsohn, J. *Your career in computer programming*. Simon & Shuster Inc, New York, 1967.
- [10] Stewart Millar, M. *Cracking the Gender Code: Who rules the wired world?* Pluto Press, Toronto, Ontario, 1998.
- [11] Charles, M. and Bradley, K. *A Matter of Degrees: Female Underrepresentation in Computer Science Programs Cross-Nationally*. MIT Press, Cambridge, Massachusetts, 2006.
- [12] Barker, L. J. and Aspray, W. *The state of research on girls and IT*. MIT Press, Cambridge, Massachusetts, 2006.
- [13] Margolis, J. and Fisher, A. *Unlocking the clubhouse: Women in computing*. The MIT Press, Cambridge, Massachusetts, USA, 2002.
- [14] Papastergiou, M. *Are Computer Science and Information Technology still masculine fields? High school students' perceptions and career choices*. *Computers & Education*, 51, 2 (2007), 594-608.
- [15] VCAA *Victorian Senior Secondary Certificate Participation and Completions*. Melbourne, 2008. <http://www.vcaa.vic.edu.au/vce/statistics/subjectstats.html> (30 Nov 2008)
- [16] VCAA *Section 2: Satisfactory Completion of VCE Units*. Melbourne, 2009. <http://www.vcaa.vic.edu.au/vce/statistics/2008/index.html> (9 June 2009)
- [17] Harris, C. *The social construction of Computing and Information Technology subject subculture*. Common Ground Publishing, Altona, Victoria, 2007.
- [18] Gannon, S. *Perceptions of changing pedagogies in Computing and Information Technology*. Common Ground Publishing, Altona, Victoria, 2007.
- [19] Downes, T. *The nature and purpose of Computing and Information Technology subjects in the senior secondary school curriculum in New South Wales*. Common Ground Publishing, Altona, Victoria, 2007.
- [20] Lynch, J. *Introduction: Exploring the gender and IT problem and possible ways forward*. Common Ground Publishing, Altona, Victoria, 2007.
- [21] Ho, V. *A long and winding road for IT women: women's career paths are often full of twists and turns*. *Computer World*, ACM Tech News, 2005 (1 April 2005).
- [22] McKay, J., Lang, C. and Lewis, S. *Geeks, Girls and IT Courses: Patterns of Participation*. Las Vegas, 2005.
- [23] MORI, M. O. R. I. *Image of ICT for e-Skills NTO*. London, 2001.
- [24] Robinson, K. and Davies, C. *Boy nerds, girl nerds: constituting and negotiating Computing and Information Technologies and peer groups as gendered subjects in schooling*. Common Ground Publishing, Altona, Victoria, 2007.
- [25] Corneliussen, H. *Women's pleasure in computing*. Middlesex University Press, Enfield, 2005.
- [26] Wajcman, J. *Reflections on gender and technology studies: in what state is the art?* *Social Studies of Science*, 30, 3 (June 2000), 447-464.
- [27] Kellehar, C. *Motivating Programming: Using storytelling to make computer programming attractive to middle school girls*. School of Computer Science, Carnegie Mellon University, 2007.