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Rural Implementation of Girls' Programming Network (GPN)

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Abstract

A small-scale pilot study was conducted in north-west Tasmania to investigate adolescent girls' willingness to participate in informal STEM education, through exploring their perceptions and experiences of computer science (CS), and their future aspirations. This pilot study was funded by an Inspiring Australia Public Science Event Grant, enabling the delivery of two local Girls' Programming Network (GPN) workshops by the two Sydney-based GPN co-founders. The aim of this case study was to determine the viability of establishing an ongoing and sustainable north-west Tasmanian GPN, which would provide rural adolescent girls with opportunities to explore programming, connect them with mentors and role models, and show them what potential career opportunities exist beyond family and local contexts. Qualitative methods of data collection comprised focus group interviews and artefact elicitation with the participants, and individual interviews with the program co-founders. The results indicate that single-sex informal CS education opportunities are valued by adolescent girls, and that typical gender stereotypes can be changed due to the experience of engaging in them. The success of the pilot study indicates that establishing the GPN in a rural area to provide adolescent girls with free and fun CS experiences is worthwhile and viable.

Keywords: *STEM outreach and engagement; female; computer science; programming and coding; adolescent*

Introduction

The gender gap in science, technology, engineering and mathematics (STEM) has been well-documented. However, despite increases in women's involvement in some of these areas, there is still a significant gender gap within computer science (CS) (Ashcraft, Eger & Friend, 2012; Cheryan, Master & Meltzoff, 2015; Hur, Andrzejewski & Marghitu, 2017; Lamers & Mason, 2018; Master, Cheryan, & Meltzoff, 2017; Sax et al., 2017). This is demonstrated in university studies, with a strong decline in female enrolments in undergraduate Information Technology (IT) degrees in Australia, from 24.2% in 2001 to 14.1% of women enrolled in 2016 (Department of Education, Skills and Training, 2016). This impacts the industry employment rate, where fewer

women are engaging in IT roles, validating that IT is a male-dominated area (Workplace Gender Equality Agency, 2019).

To address the gender disparity, adolescent girls need access to opportunities which stimulate interest and create positive engagement in CS. Girls' Programming Network (GPN) provides a free programming experience for adolescent girls to inspire interest in CS and technology. Female role models, positive experiences in CS, and single-sex settings all increase adolescent girls' engagement in CS (Hughes & Roberts, 2019; Master et al., 2017; Stout, Dasgupta, Hunsinger & McManus, 2011), demonstrating the importance of offering coding workshops exclusively to adolescent girls. Outcomes of workshop participation include creating interest in CS, developing confidence and self-efficacy in knowledge and skills, and showcasing career pathways in the field. During GPN workshops, participants learn authentic programming skills through problem-based pedagogy (Stentoft, 2017), and female industry role models create direct links between workshop activities and real-world applications.

This case study explores piloting the GPN program in rural Tasmania via two 'taster' workshops based on the GPN format. This program is unique as it runs on the philosophy of engaging participants in activities that expose them to CS and the potential future opportunities that exist beyond family and local contexts. With a limited number of GPN nodes in Australia, creating one in north-west Tasmania is a new initiative for the State.

Method

In collaboration with GPN (affiliated with the University of Sydney), University of Tasmania researchers secured an 'Inspiring Australia Grants for Tasmanian Science Engagement Events 2018' grant, funding the operational costs of two pilot workshops in the north-west of Tasmania. A small-scale pilot study was conducted to investigate adolescent girls' willingness to participate in informal STEM education, through exploring their perceptions and experiences of CS, and their future aspirations. The aim of this case study was to determine the viability of establishing an ongoing and sustainable north-west Tasmanian GPN node, with potential to expand state-wide, extending access to engaging STEM experiences for more adolescent girls.

A qualitative research methodology was employed to explore participant perceptions, experiences and aspirations regarding CS, and any changes in these after attending the GPN workshops. Data were collected using focus group interviews and artefact elicitation (see Barrett & Smigiel, 2003; Hawkins, 2017; Leung & Savithiri, 2009). Insights from the two GPN co-founders on their experiences and perceptions of the program impacts were also collected via interviews. The qualitative approach enabled the 'insider's point of view' to be developed, a deeper understanding of perceptions and aspirations, and for rich descriptions about the program impacts (see Erickson, 2018).

Two GPN 'taster' workshops were offered, one in each city of the north-west region of Tasmania, aimed at girls in Years 7 – 10. Advertising was conducted through 10 local schools, community youth groups and the local newspaper. These were delivered as 'taster' workshops, based on the GPN model but altered to be offered during school hours to enhance participation, and therefore shorter in duration than the usual full Saturday or Sunday format. The workshops used the same structure and content as regular GPN workshops and were delivered in person by the two Sydney-based co-founders. These one-day workshops offered content that covered the basics of coding theory through practical and fun activities that enhanced the participants' knowledge, understanding and skills regardless of their point of entry to the workshop. A total of 21 girls attended the workshops, 11 at the first and 10 at the second. All consented to participate in the research project (n = 21) and had parent/carer consent (as required by ethics approval).

Data Collection Method and Analysis

Data were collected from the adolescent participants three times during the workshops. Open ended qualitative questions were posed in the morning as part of an introductory discussion,

asking about their perceptions and experiences of programming and CS, and their career aspirations. This data collection method involved creating shared experiences on themed boards using sticky notes (artefacts) for data recording. For each question, participants wrote their answers on a sticky note, along with their alias (for data collection anonymity), which were then placed on the relevant boards for each question. This method was used to ensure the responses of all participants could be captured without being influenced by others. The researchers grouped the responses on each board and completed a preliminary analysis for themes, whilst the workshop was facilitated with the co-founders. Based on the preliminary analysis, the participants were then asked further questions in a whole-group discussion to delve deeper into perceptions. Questions included, for example, 'why do you think the majority here think 'x' about CS?' and 'why do you think only a couple of you thought 'y' about programming?'. The responses were recorded for transcription purposes and covered the following themes: perceptions about programming and CS; future study intentions; career goals; and a description of a programmer or computer scientist.

Mirroring the initial data collection method after the workshop activities were completed, participants' responses to the same themes were captured. Another focus group was conducted to gain further elicitation on these responses. Additional questions were posed and recorded regarding the workshops, such as what was and was not enjoyed, and feedback for future improvement. After these questions, the first and second data collection boards were compared, and participants were asked to elaborate on the themes of the boards and any changes or similarities in answers prior and post workshop.

Individual interviews were conducted with both co-founders after the workshops using a semi-structured interview schedule. The co-founders were asked to share their perceptions of the effectiveness of the taster workshops, and the similarities to and differences between the taster and official GPN workshops. This data collection aimed to assist researchers to assess the impact and viability of GPN in north-western Tasmania. The co-founders were also asked to share their reflections of GPN's inception, implementation, evolution, and impact, to help further this aim as well as help develop a rich understanding of GPN.

Research Findings

Foundational Knowledge of Computer Science and Traditional Stereotypical Perceptions

Prior to the workshop, participants had been involved in some computer programming through school-related activities. The majority were therefore able to articulate that computer programming is "*telling a computer what to do*". Most of the participants associated programming with "*coding*", "*python*", "*binary*", and "*robotics*". However, they only had a foundational understanding of CS, and a shared perception that did not extend beyond traditional stereotypes. The following comments capture some of this shared perception about who participates in CS:

> *Likes computers and finding out how they work. Bit geeky. Intelligent. Glasses. Quick typers. [Participant 1]*
>
> *Smart people, geeks (not in a bad way), hackers, know it all, brainy, quiet. [Participant 2]*
>
> *Someone who is intelligent, and interested in knowing how things work and their processes. [Participant 3]*

At the beginning of the workshop, most of the participants had traditionally gender-specific study and career interests in fields such as teaching, nursing, law, and policing, with only two voicing an interest in science-related careers: computer graphics and design [Participant 4], and digital illustration or game design [Participant 5]. These findings directly correlate with Hur et al.'s (2017) argument that girls envision computer scientists as "*socially isolated nerds, who lack social skills*" (p. 101), a common stereotype, and furthermore that girls are often socialised into nurturing or practical roles, of which the above careers, particularly teaching and nursing, which

are listed as stereotypical by Hur et al., (2017). According to Master et al. (2014), girls' engagement in STEM can be affected by ability and identity stereotypes of who normally participates in STEM, where they can feel that failure will confirm the former stereotype, and not achieve a sense of belonging for the latter.

A Sense of Accomplishment, Learning New Knowledge, Solving Problems and a Fun Experience

At the conclusion of the workshop, participants in the focus group interviews discussed their experiences of the workshop, and responses typically included positive expressions. The following extracts indicate some of these shared feelings:

> *I really liked it because it was new, it was different. It was definitely a lot of problem solving… gets you thinking about alternatives. [Participant 1]*
>
> *I enjoyed learning deeper knowledge about microchips and python and software and binary and code and things like that. I liked how when you picked up the patterns of the coding, how it became a lot easier. That was interesting. [Participant 6]*
>
> *I liked the satisfying sense of accomplishment once you finished it. [Participant 7]*
>
> *I just really enjoyed it because it was different, something that I wouldn't usually think of doing. But, I actually really enjoyed it and had heaps of fun. [Participant 8]*

Shared positive experiences included a sense of achievement, satisfaction, fun and enjoyment. Participants liked that workshop content was different, and that they were learning something new while problem-solving. Some participants noted becoming frustrated with the harder activities, but explained that this made them realise programming was more about persistence and problem solving rather than academic ability. This is an important finding which relates to Hughes and Roberts' (2019) Open to Challenge component of STEM Self-Efficacy. They argued that CS programs should provide experiences where girls are challenged yet can achieve success, building their self-confidence and self-perception in this area. Nurturing this enjoyment of challenge and consequent sense of achievement for adolescent girls, during what Hughes and Roberts (2019) term the crucial point in the STEM education pipeline where many girls stop participating in CS, is integral in helping to addressing the gender imbalance and typical stereotypes in the field.

Following the second workshop, Participant 6 said: *"[At the start of the workshop] I was more imagining males, like an awkward, shy, introverted male… but, now I'm thinking of females."* This generated conversation in the group, with all participants raising their hand when asked by one of the co-founders if 'post workshop' they now believed CS 'could easily be a female role as much as a male role'. Broadening the idea of who participates in CS, what this actually entails, and providing a more accurate picture of the field are potential ways to increase female representation in the field (Cheryan et al., 2015). The changed mindsets recorded from this case study are a strong indicator of the impact of positive CS experiences with female role models who challenge stereotypes.

An Increase in Interest and Investigating CS Pathways, with Changed Perceptions

After the workshop, seven participants said they would consider programming careers and explore study options based on what they had experienced. Eight indicated they were more interested than they had been; five of these said they might pursue it as a hobby rather than a career. This suggests that the workshops generated interest in CS, as only two participants initially said they were pursuing that path. Asked if they would attend another GPN workshop, all participants responded in the affirmative, as demonstrated by three examples:

> *I definitely would like to do similar things, yes, because it's actually quite interesting. I think now, learning this did kind of settle somewhat of the stereotypes that I had prior. And a lot of the jumping to conclusions that I had with IT and [related] opinions. [Participant 6]*

I think I'd quite enjoy learning a bit more about how these things operate and expanding on the knowledge. [Participant 3]

Any activity involving programming I would definitely be there. [Participant 9]

These results indicate that participants' experience of the GPN workshop positively impacted their desire to further engage in local programming opportunities. This also supported the idea that the workshop changed their earlier perceptions of STEM and their stereotypical views about who participates in CS.

Impact

The first key impact from this pilot study with rural adolescent girls suggests that exposure to science and technology increases interest, alters perceptions, and builds skills in CS. The findings from this case study investigating the implementation of GPN regarding the benefits and outcomes of positive CS experiences align with those of previous studies (Glover, Harries & Jones, 2018; Hur et al., 2017; Master et al., 2017). The positive results of this research are strong evidence to indicate that establishing GPN in north-west Tasmania would be successful. These workshops also have the potential to raise girls' aspirations regarding CS degrees and careers, responding to the current lack of women in these areas.

Having positive, successful experiences in technology and meeting industry female role models is essential for helping girls to see the potential of CS as a career option. This sentiment is captured by GPN co-founder Nicky Ringland, who during her interview, reflected on her own studies when discussing its conception:

I thought about why I hadn't chosen to do a computing degree straight out from school, when obviously I had a lot of interest in it. And really, it boiled down to the fact that I didn't really know what computing actually entailed. And more than that, that my lack of experience and exposure prevented me from actually considering it as a career option and as a further study option.

This finding aligns with that of Hur et al.'s (2017) study in which they discussed that limited knowledge or experience of CS made the career "*unthinkable*" (p. 114), hence the importance of providing CS opportunities for girls. To address the low representation of girls and women in CS studies and employment, it is essential to dismantle the stereotype of CS being a predominately male career. If engaging social opportunities are not offered to enable girls to have positive experiences with CS, they will not enrol in these subjects during their secondary and tertiary education, and will not pursue careers in this field. IT will continue to be a male-dominated industry, and gender barriers will continue to prevent girls from envisioning themselves in this area. The single-sex setting has already been proved to be an important factor, and Wong and Kemp (2018) further highlight this need, reporting that "*boys are typically expected to be more vocal, risky and adventurous than girls*" (p. 303) and as such, are often considered (by themselves, girls and teachers) to be more competent in this area. They also argued that adolescent girls especially are more consumers of technology rather than creators (Wong & Kemp, 2018), which with its practical approach and focus on creating a project each workshop, is something that GPN specifically targets. Boosting self-efficacy by participating in these types of workshops and having small, successful coding experiences are critical to fostering a sense of positive self-belief in not only CS but other areas of life. Programs like GPN are essential in providing opportunities for girls to experience learning success while having fun, and not being overwhelmed with the idea of programming.

The next significant impact of GPN is the positive social and emotional benefits that extend beyond CS skills and aspirations. When reflecting on observed impact of GPN workshops, both co-founders highlighted the achieved intent of the workshops being more than just skills based. Renee Noble, co-founder of GPN, explained during her interview:

> *Girls with social anxiety have come along, who haven't wanted to go inside, who've been in tears in their mum's arms before coming in. By the end of the day they're walking out with their arms around two new friends that they've made, because they'd never really met people like them before. Because they're that girl at school that nobody really gets, and they've come to this place and there's all kinds of girls there that share this common interest.*

Regardless of future CS study and career aspirations, multiple benefits that all participants gain from the workshops include: the experience of having to think creatively to solve challenges; supporting, and being supported by, their peers; making new friends; embracing diversity; and feeling a sense of belonging. Many studies (Cheryan et al., 2016; Master et al., 2016; Stout et al., 2011) demonstrate the importance of belonging as a factor in adolescent girls' STEM interest and participation. While the focus of GPN workshops is on IT, and the positive potential outcomes of these career pathways have been highlighted, Nicky Ringland explained in her interview that the program is so much more than that: *"What I want them to do is be excited about what possibilities there could be, and know that this is a skill that they actually enjoy doing"*. This holistic development of adolescent girls, at a time in their life when they are subject to peer pressure, feeling the need to fit in and conform to society and the media's portrayal of girls and women, is also such an important aspect of these workshops, therefore promoting emotional well-being alongside technology skills. Experiencing success in a fun, social, and supportive environment is a very positive factor in the development of adolescent girls during this time of their life.

Conclusion

Challenging gender norms and stereotypes in this area has benefits for the wider community. Attending GPN will challenge girls' mindsets as to who participates in technology, and the establishment of these workshops will encourage the same impact on broader society. Challenging stereotypes in one area may encourage these girls to look more broadly at other norms and stereotypes, and encourage other young people to do the same. These youth will be the future community leaders, and if they have an open mindset, this will be beneficial for all sectors.

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