‘tell me more about programming’: The PC4G Intervention

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ABSTRACT

One initiative designed to address New Zealand’s shortage of female programmers is an early intervention aimed at high school students aged 14-15 years. The Programming Challenge 4 Girls (PC4G) is a one day event designed for those who know nothing about programming.

A 2013 pilot study indicated that 82% of the participants were more interested in programming as a consequence of participating in the PC4G and so in 2014, this study was repeated and some aspects were explored further. These small studies confirm that the PC4G as a tool for intervention is highly effective. All participants were proud of their achievements and would encourage others to take part in the PC4G. With the majority wanting to know more about programming careers, this indicates a successful intervention.

Keywords: programming; careers; gender; girls; school; PC4G; generation Z

1. INTRODUCTION

1.1 An intervention called the PC4G:

The Programming Challenge 4 Girls (PC4G) is an annual New Zealand initiative that offers Year 10 (14-15 year old high school girls) a short and sharp, no programming experience required, one day programming event.

The PC4G has three aims: to provide a fun introduction to programming to girls before they choose their examination subjects; to provide teachers with an opportunity for professional development and lastly it aims to introduce the girls to successful role models who may positively influence the girls towards a programming career.

The intervention was designed prior to the new New Zealand Qualifications Authority (NZQA) Digital Technologies syllabus being introduced, and at that time there was little opportunity for schools to offer programming to students. Some schools may have had a teacher who was passionate about the subject and was willing to put in their own time to introduce the students to programming, but this was rare. Generally, there were few schools, if any, that offered a ‘girls only’ experience.

The theses behind the initiative were that before girls could choose programming as a career, they first had to experience it. Then, if the experience was positive and interesting (and they succeeded at it), programming would be on the girls’ career radar and therefore they would choose further study in the subjects that the discipline required. In addition, if the girls could be introduced to programming in a supportive environment specifically catering to their gender interests/needs, then this might result in more girls being attracted to a career in programming.

The design of the PC4G combines collaboration with competition (Boersen & Phillips, 2006; Phillips, 2006). It provides sociability in that the girls work in teams of two, and competition in that it is a challenge with gold, silver and bronze medals awarded to any teams that meet the required criteria. Teams are deliberately not ranked from first to last. The language used in describing the problems to be solved is inclusive (we, us, our) i.e. is female oriented, and the topic areas around which the problems are based, are chosen to appeal to the girls’ likely interest areas (e.g. people, animals, social good). The teachers are expected to attend with the girls and in doing so they also extend their own programming skill set and career knowledge. The programming language currently used is ALICE, a visually orientated, drag-and-drop tool that enables quick learning and solutions developed quite speedily.

The PC4G was developed in 2008 and today the event is held in 22 sites across six countries and has involved about 650 high school girls. Although the event has continually been evaluated for quality/feedback purposes, the first academic research into the event’s effectiveness was not undertaken until 2013 when a small pilot study was conducted.

1.2 2013 Pilot Survey Findings

Findings from the 2013 pilot study showed that 82% of the girls were more interested in programming as a result of participating in the PC4G, 91% indicated that they wanted to know more about careers in programming, and 61% said that they would consider programming as a career option (Hunter and Boersen, 2014). This data gave some indication that the PC4G is successful in prompting girls to consider a programming career, but the researchers felt that if the research was repeated then further profiling of the participants would be beneficial.

2. RESEARCH QUESTIONS

Building on the 2013 pilot study, the 2014 study sought answers to the following questions:

- Is there further evidence that the PC4G is a positive intervention which could result in greater numbers of girls considering programming as a career option?
- Is there evidence that stereotypical thinking might be limiting the girls from entering a male-dominated career?

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3. LITERATURE REVIEW

3.1 Interventions

There have been many interventions organised by private individuals, professional organisations, educational institutes, and IT companies to improve the recruitment of women into the IT industry (Hunter & Boersen 2014). In addition to New Zealand, interventions have been held in the USA (Google, 2014), Canada (Mueller, 2013), Australia (Craig, 2014) and the UK (Griffiths and Moore, 2010).

3.2 Participants

The participants in this study are aged 14 or 15 years and are therefore classified as Millennials or Generation-Z or Gen-Z girls. McCrindle (2013) describes this age group as 'digital integrators' and 'visually engaged' people. They interface with a number of social media tools and communicate with many and varied social groups. Millennials are comfortable using a variety of electronic devices and move comfortably between them McCrindle (2013). Their attention spans are quite short and they are comfortable swapping between tasks and devices every eight seconds (National Center of Biotechnology Information, 2014). These are important characteristics to be aware of when communicating with Millennial girls.

3.3 Stereotypical thinking

Although gender stereotypes are still prevalent, some researchers have shown that Millennial girls are less vulnerable to these than other age groups as they consider themselves more as individuals and more impervious to stereotypical thinking (Clayton, Beekhuyzen, & Nielsen, 2012; Denner, 2011). The earlier negative label 'geek' now appears to be a term to be proud of. The 2013 pilot study (Boersen and Hunter, 2014) showed that 96% of the girls would be happy to be considered a 'geek', a label that is now worn with pride rather than derision (Bailey and Kent, 2007).

4. METHODOLOGY

The 2013 pilot study collected both qualitative and quantitative data using a written survey. Participants were drawn from 12 schools attending the PC4G at one Auckland site. In total 23 girls participated, giving a response rate of 58%. While this was a small number it was felt sufficient for the purposes of the pilot study.

In 2014, participants from four sites were expected to participate in the research. Unfortunately due to circumstances beyond the control of the researchers, girls from only two sites (Auckland, and Hawkes' Bay, New Zealand) (both with multiple schools being represented) were able to complete the online quantitative survey. Instead of the expected larger number of participants, only 13 girls completed all the required ethical consents and then the survey. A small incentive was given to one randomly drawn response. Due to the small number of participants, the findings must be considered as indicative only and a much larger data set would be required before the findings can be extrapolated.

Setting up the survey involved many ethical steps as the participants were 14-15 years old and attending high school. The principal first had to give permission for their students to participate, then the girls' parents/caregivers and the girls themselves also had to give consent to participate. The teachers were the point of contact with the girls so they also needed to be willing to support the work. They distributed the documentation to the girls and also collected and forwarded it to the researchers. It is possible that the many ethical hurdles and geographical distances contributed to the low response rate.

The survey had five sections, the first about the participant, their family and school, the second about their participation in the PC4G, the third their perceptions about programming, the fourth about career decision influencers and the last section more specifically about the participants and a programming career. The majority of the survey sections required participants to respond to continuums such as

- yes/no/don't know/unsure
- strongly disagree/disagree/agree/strongly agree
- never/rarely/sometimes/almost always/always

Two questions asked the participants to rank factors.

5. OVERVIEW OF THE PARTICIPANTS

The research participants in 2014, represented eight high schools and five ethnic groups. All except one girl had programmed before they participated in the PC4G, so programming was not an entirely new experience for them. Most had spent anything from a few hours to a few months programming. Their experience was primarily with Scratch and Python. Alice, the programming tool used in the PC4G was new to all of them. Although 75% of the girls had been taught programming by their teachers, almost half of them considered that they had also taught themselves. Only one girl attended a single-sex high school, and all girls aspired to gain a university qualification. Most girls had family members who were already qualified with a degree. They saw themselves as primarily being leaders, assertive, strongly determined, mainly confident, always focussed on what they wanted to achieve, ambitious and wanting to be with other people most of the time.

Almost all the girls intended to select subjects the following year (their first 'examination' year) that could lead to a career in IT.

This level of detail was not asked of the 23 2013 participants however almost all had programmed before undertaking the PC4G.

6. FINDINGS & DISCUSSION

The findings compare the 2013 data with that of 2014 and then in each area, further findings are detailed where new information was available.

Although the number of participants is small, for the sake of comparison with the previous study (Hunter and Boersen, 2014) percentages have been calculated. The researchers are aware that the figures are not statistically significant. To compensate for small numbers, data has been collapsed as follows: strongly agree/agree is reported as Agree, and strongly disagree/disagree is reported as Disagree.

6.1 How effective is the PC4G in raising interest in programming?

From Table 1, it can be seen that there is consistency between the two sets of data and therefore it can be assumed that the model is not only highly effective as a tool to introduce students to programming, but it also is an effective tool that stimulates an interest in programming. From this it can be concluded that the design of the teaching component, i.e. experiential, guided study, plus the design of the problems to be solved are effective. Having a multi-part problem that is staged in terms of complexity, plus one part allowing the girls to design, storyboard and code their own problem to solve, has created buy in and interest from the girls.

Table 1: Effectiveness of the PC4G

	2013		2014	
	Disagree	Agree	Disagree	Agree
The PC4G has made me more interested in programming	17%	82%	15%	85%
The PC4G helped me learn about programming	0%	100%	7%	93%
I will now look for opportunities to find out more about programming	9%	91%	27%	73%

The second point (the PC4G helped me learn about programming) was a significant finding given that of those who have programmed for at least a few months prior to the PC4G, almost half said that the PC4G helped them learn more about programming. There could be many reasons why the PC4G stimulated their interest.

The design of the PC4G is specifically tailored to the girls' gender and the needs of millennials. The problems are multi-part to allow for shorter attention spans, teams of two meet sociability and connectedness needs, and the highly visual Alice programming language also matches millennial preferences. It could also be because the girls were using a language (ALICE) that was new to them and allowed them to compare, contrast and reinforce what they already knew, that made the PC4G an effective learning experience. The style of a short and sharp experience gives urgency, and as the event is held away from the girls' schools, it separates it from their usual classroom-delivered teaching environment and perhaps this too makes it more appealing. Or perhaps it is all of the above.

Almost all of the girls in 2014 like the idea of being 'challenged'. About two thirds wanted to be a programmer before the PC4G experience and half of all of the girls entered because they wanted to see how good they were at programming. Perhaps the opportunity to compete like this where the focus was on preparing the girls for the requirements of the challenge, then undertaking the challenge itself is a technique that sits very comfortably with the girls because they know what is expected of them.

There were slightly fewer girls in 2014, compared to 2013, who said that they now wanted to know more about careers in programming but at almost 75% this is still a high rating. Fifty per cent said that they had already talked to their IT teachers about a programming career and a third had talked to their careers advisors. Therefore an optimistic interpretation is that participation in the PC4G has stimulated an additional 25% of girls to now consider a career in programming.

With a high proportion of girls from both years stating that the PC4G was fun, that participating in it increased their level of understanding of programming and that all would recommend the event to others, indicates that the PC4G model is a consistently successful model for teaching programming.

6.2 How did the girls' respond emotionally to the challenge?

The data in Table 2 again shows consistency over the two years. Almost all girls thought the PC4G was a fun way to learn programming, that it was challenging but enjoyable, and although there is still some nervousness, all were proud of what they had achieved. This latter point is significant as it demonstrates the level of involvement and how positively the girls viewed the experience.

Table 2: Emotional Responses

	2013		2014	
	Disagree	Agree	Disagree	Agree
The PC4G was a fun way to learn programming	0%	100%	8%	92%%
Taking part in the PC4G was challenging but enjoyable	0%	100%	8%	92%
I was nervous before I started the PC4G	26%	74%	31%	69%
I was proud of what I achieved in the PC4G	4%	95%	0%	100%

Almost all the girls felt that the way the PC4G taught programming was 'cool', and the majority said that taking part in the PC4G has made them want to be a programmer. All would encourage others to take part in the PC4G and almost all felt that taking part had shown them that they could be a good programmer.

When we delved more deeply into the responses of those who won a medal versus those who didn't, all girls who won a medal thought the event was fun, whereas those who did not win a medal saw it as being slightly less fun. Both groups however were proud of what they achieved, indicating that receiving a tangible reward and sense of achievement are not related. Non-medal winners were all unanimous in that they felt that the PC4G had increased their understanding of programming, that how it was taught was 'cool' and that they would encourage others to take part. Often those who don't win are critical of an event they have competed in, but in this case the girls are still 100% behind the intervention, even though they were not 'successful'.

Of those girls who had not programmed before, the only responses that differentiated them from the others was that they were more nervous and they knew less about what programming involved, both of which are to be expected.

The fact that the girls were nervous beforehand but thought that the event was fun and enjoyable indicates that the PC4G model is successful in engaging girls aged 14-15 years old. The needs of the millennial generation are catered for implicitly and explicitly and this is reflected in the fact that

they all felt a sense of achievement and were proud of what they had accomplished. The researchers believe that this again affirms the effectiveness of the PC4G model.

6.3 What were the girls' perceptions of gender capabilities and stereotyping?

As can be seen in Table 3, the girls in both years were consistent in their opinions about whether boys should have been included in the PC4G. The majority preferred to not have boys included.

Table 3: Gender Capabilities and Stereotyping

	2013		2014	
	Disagree	Agree	Disagree	Agree
It was good that there were no boys competing in the PC4G	27%	72%	30%	70%
If boys had been included in the PC4G then most likely a boys' team would have won	82%	17%	70%	30%
I don't mind if people think I'm a geek (2013) / a 'nerd' is a positive label, to be worn proudly (2014)	4%	97%	15%	85%

In respect to whether boys or girls were perceived as being better at programming, there was a difference between the 2013 and 2014 cohorts. In 2013, the girls thought more strongly than the 2014 group that boys would not necessarily have won, had boys participated.

Being labelled a 'geek' or a 'nerd' was viewed a little differently between the two cohorts, but because of the different terminology used it is difficult to draw any conclusion from this except to say that either label is viewed quite positively by the vast majority.

Some of the girls in the 2014 cohort did not care if boys participated or not and didn't think they would win if they did. They were quite confident about this, while those girls who were glad there were no boys competing were less confident that the boys would not win. From the individualised data, a small proportion of the girls who wanted boys to compete did not think that the boys would win if they did. It can be seen therefore that some stereotypical thinking still exists amongst millennial girls as some still think that the boys would be better at programming than them, but this view is not prevalent.

When we looked at the 2014 cohort to test the girl's thinking about the stereotypical view that one had to be very good at maths to be a programmer, the vast majority felt that they had to be 'ok' at maths but not 'really good' nor 'not good' to be programmer. Interestingly, about a third always enjoyed maths, a third sometimes enjoyed maths and a third never enjoyed maths. Of those who didn't enjoy maths much, half of them thought that boys would win. Perhaps this is because they perceive that boys are better than girls at maths and will therefore be better at programming.

7. LIMITATIONS OF THE RESEARCH AND FUTURE WORK

The biggest limitation of this research was the lack of participants, which was especially disappointing as the scalability of the pilot into a full survey was successfully completed. The difficulties of requiring multi-layered permissions and multiple ethical consents were not easy to manage and this hurdle would need to be overcome and there would need to be a large initial population if statistically significant research is to be undertaken.

One of the notable differences between the 2013 and 2014 cohorts was that in 2013, many of the teachers had introduced their students to Alice before the PC4G whereas in 2014, this was not evident. This may be because programming is more embedded now and there is more confidence that the girls can transfer their existing learning.

Future work would be to continue the longitudinal study especially if the girls could be followed through their high school journey, to investigate which programming related subjects they studied, how they performed at these and how long they continued with their programming studies and if they continued into an IT career (or not).

8. CONCLUSIONS

This small study, building on an earlier one conducted the previous year, showed consistent results. Unfortunately however the numbers participating do limit the study's statistical significance.

The participants all agreed that participating in the PC4G was fun, that they enjoyed the challenge of it, that it had increased their knowledge of programming, that they would recommend it to others, and most importantly, that the majority will further investigate what a career in programming entails. This would indicate that the PC4G is a positive intervention which could result in greater numbers of girls considering programming as a career option.

The 2014 participants were unanimously proud of their achievements. The majority of the participants believed that they would be as good at programming as boys, should boys compete. Some stereotypical thinking persisted but by a small minority only. There was consistency between the cohorts in that the majority believed boys should not compete with them. The stereotypical view that you have to be really good at maths to programme was not prevalent; instead the girls thought that you only needed to be 'ok' at maths.

It would appear that there is very little evidence that stereotypical thinking is stopping the girls from entering the male-dominated area of programming.

Further research which follows the girls through their high school choice of subjects, analysing if and when they firmed up their career choice and the relationship of this to a programming career would be beneficial.

9. REFERENCES

Bailey, J., & Kent, M. (2007). Revenge of the nerds: Geeks take over. Retrieved December 4, 2008, from http://www.stuff.co.nz/print/4321644a19716.html

Boersen, R., & Phillipps, M. (2006). Programming contests: Two innovative models from New Zealand. Paper presented at the Perspectives on Computer Science Competitions for (High School) Students, Dagstuhl, Germany.

Clayton, K., Beekhuyzen, J., & Nielsen, S. (2012). Now I know what ICT can do for me! *Information Systems Journal*, 22, 375-390.

Craig, A. (2014). Australian interventions for women in computing: Are we evaluating? *Australasian Journal of Information Systems*, 18(2), 91-109.

Denner, J. (2011). What predicts middle school girls' interest in computing? *International Journal of Gender, Science and Technology*, 3(1), 53-69.

Google. (2014). Women who choose Computer Science - What really matters. https://docs.google.com/file/d/0B-E2rcvhnlQ_a1Q4VUxWQ2dtTHM/edit?pli=1

Griffiths, M., & Moore, K. (2010). 'Disappearing women': A study of women who left the UK ICT sector. *Journal of Technology Management & Innovation*, 5(1), 95-107.

Hunter, A. (2012). *The professionalisation of computing work in New Zealand, 1960 to 2010: A feminist analysis.* (PhD Doctoral), University of Auckland, Auckland, New Zealand.

Hunter, A., & Boersen, R. (2014). *Short and sharp: Challenging girls to become programmers.* Paper presented at the Edulearn 14, Bareclona, Spain.

McCrindle, M. (2013). Generation Z defined: Global, visual and digital. http://mccrindle.com.au/SocialAnalysis/2012/Generation-Z-Defined-Global-Visual-Digital_McCrindle-Research-2013.pdf

Mueller, R. (2013). Attracting females into ICT in Canada. http://scholar.ulethbridge.ca/sites/default/files/mueller/files/attracting_females_into_ict_mueller_mar_2013.pdf

National Center for Biotechnology Information. (2014). Attention Span Statistics. Retrieved from Statistic Brain website: http://www.statisticbrain.com/attention-span-statistics/

Phillipps, M. (2006). A New Zealand initiative to encourage young women in information technology. Paper presented at the ISSEP Informatics in Secondary Schools Evolution and Perspectives, Vilnius, Lithuania. http://ims.mii.lt/issep/prog.html