

Computing Gender Wars – A New Hope

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ABSTRACT - The dearth of females in computing continues to be of considerable concern worldwide. Much of the previous research in the area concludes that young females hold negative attitudes and experiences toward computing and consequently choose not to study or work in the area. Many initiatives have been put in place in recent years to attempt to address the gender divide. In light of these activities this research seeks to provide a timely measure of the potential future computing career ambitions of secondary school pupils and provides a comparison with a group of similar aged members of a voluntarily attended computer coding group (Code Club). It finds that female intent to pursue a computing career remains worryingly low yet attitudes towards computing are generally positive. It also provides an insight in gaming experience and relates the significance of this and potential computing exposure to computing career choice.

Keywords - Computing; Gender divide; Careers; Gaming; Attitudes;

I. INTRODUCTION

The worldwide scarcity of women studying or employed in computing, or in computing related disciplines, continues to be a topic of considerable concern for industry, the education sector and governments. Within Europe, while females make up 46% of the workforce only 17% of IT staff are female [1]. Ashcraft [2] reports that while 57% of all Bachelor's degrees were awarded to females in all disciplines in the USA in 2012, the percentage awarded to female students in computing was only 18%. This is an important issue since, as Camp claims "a lack of diversity in our student body leads to a lack of diversity in our workforce developing future computer technology" [3]. This is further illustrated with top technology employers in Silicon Valley, including Facebook, Google, Twitter and Apple reporting that only 30% of the workforce is female [4].

There is a substantial body of research into the computing gender divide that suggests which young women in secondary level education display a more negative attitude towards computing than their male counterparts [5]. Maoi [6] relates attitudes to an influence on how we process information and how we behave. Baser [7] reports that young females tend to develop negative attitudes towards computing and this consequently leads to fewer

females enrolling in computing courses. Roger and Duffield [8] suggest that the barriers to girls contemplating computing careers are established by the time they are in lower secondary school (age 12 – 16) and how computing subjects are taught also has a major impact on girls' attitudes towards the discipline. This negative perception in early education towards computing has subsequently led to a lack of representation of females in the computing industry. There are a number of factors that have been heavily researched in an attempt to comprehend the suggested negative attitude held by females.

Computing is for geeks and males!

A stereotypical view of computing as geeky and anti-social was reported by Cohoon [9] and Cheryan [10]. Hill [11] concludes this negative stereotype affects who chooses, works and studies computers, coding and technology. Socially, computer scientists are still regarded as geeks [12] and the discipline in both education and industry is seen as both segregated and male-dominated [13]. Indeed, computing classes are generally male dominated ([14]; [15]); as illustrated by the 95% male dominance of secondary education computing qualifications in Northern Ireland [16]. Newmarch [17] reports that many girls regard computing as being "too theoretical, rigidly structured and boring". The prospect of being "the only girl in class" [18] is a reported negative factor for females not choosing computing or dropping out of university computing courses. This is a self-fulfilling attitudinal obstacle to female enrolments. Another important factor suggested by Master et al [19] is the design of the computing teaching rooms "classroom design matters, it can transmit stereotypes to high school students about who belongs and who doesn't in computer science". They found that girls were almost three times more likely to say they would be interested in enrolling in a computer science course if the classroom looked like the non-stereotypical one.

Gaming

Gorritz [20] and Wilson [21] strongly link the significant under-representation of women among computing students and current graduates to the direct result of the early

experiences of computer games. One of the main attitudinal barriers suggested has been the consequence of the historical marketing of computers as “toys for boys” [22]. Traditionally many of the most popular games such as the *Call of Duty* franchise are designed for and marketed to males. As such, historically females have tended to game less than males.

II. RESEARCH OBJECTIVES

The substantial body of research in the computing gender divide has identified common factors that can lead to negative attitudes within young females. Actions by government, industry and community to attract more individuals and especially females to the computing industry have been in place worldwide for the past number of years. These have included new school level computing qualifications, teacher upskilling, targeted advertising for computing careers, intervention programmes and club programmes. Yet, the numbers of females recently participating in computing education and industry has not proportionally increased. In recent years the regional government of Northern Ireland has heavily promoted the development of a knowledge based economy and has been particularly active in endorsing computing in local education together with other computing initiatives.

In light of these activities and other recent substantial industry and community computing initiatives, this research seeks to provide a timely contribution to the area of understanding of the computing gender divide. It seeks to provide a current measure of the potential future computing career ambitions of secondary school pupils. In addition it seeks to measure and baseline the attitudes and experiences of the group towards computing and analyse any potential gender differences. Additionally, it also aims to expand on previous work by comparing the results from the pupils with another group of similar aged secondary school pupils that are committed members of a voluntary attended computer programming group (Code Club). The members of the Code Club are expected by the nature of their computing interest to have a positive regard for computing. Any significant differences between these groups and the baseline secondary school group in regard to career aspirations, computing experience or attitudes may help expose specific factors that contribute to form barriers to entry to computing for the pupils and specifically for females. A grounded understanding of the barriers could then be used to better design targeted intervention programmes to address any negative attitudes. The researchers are unaware of any other investigation involving a baseline understanding of general population secondary pupils and a comparison with Code Club groups.

Research aims

The primary aims of this study are to 1) establish a baseline understanding of the career aspirations, experiences and attitudes of secondary level education pupils in regard to computing. The study also 2) seeks to

establish if the secondary level education pupils’ career aspirations, experiences and attitudes are reflective or consistent with regard to another similar aged group that has a self-selected involvement with computing.

III. METHODOLOGY

In order to measure potential computing career ambitions, attitudes towards and experiences of computing, an anonymous electronic survey was presented to a group of secondary school pupils and Code Club members (Table 1).

Group	Male	Female	Total
Secondary school group (aged 12-16)	92	55	147
Code Club members (aged 12-16)	46	14	60

Table 1 - Gender distribution within the sampled groups

The schools (n=15) and the school pupils that participated in the survey were chosen at random. Furthermore, no specific reference to the purpose of the survey as a gender study was made, other than to state that it was a survey on ambitions, experiences and attitudes toward computing.

The Code Club was an openly advertised, voluntarily attended, two week 80 hour event aimed at introducing 12 to 16 year olds to general computing and specifically to programming. The students self-select to join the club and although a parental consent form was required it is unlikely in most cases that the parents unduly influenced the pupil’s choice to enrol. The survey was designed to provide a quantified measure of experiences in gaming and future education and computing career ambitions for each respondent. The respondent’s attitude toward computing based on the main negative factors identified from previous research in the area was also measured. These included sections on the social skills of people that study computing or work in the software industry and the perception of the gender breakdown of computing. The questions in each strand and the subsequent statistical analysis used, are detailed in Table 3.

Measures

The research used a modified shortened version of an established scale developed to study attitudes toward and perceptions of science and scientist by Mason and Kahle [23] and later adopted by Benamati [24] to measure attitudes to Computing Management Information Systems (MIS). The questions were changed to ask about computing students and software industry professionals. For example, “Management Information Systems professionals often work as a team to solve problems” became “Software industry professionals often work as a team to solve problems.” All items used a one to five scale where 1 meant strongly agree and 5 meant strongly disagree.

Attitudinal strand	Rated statements or questions	Question Type	Statistical Analysis
Computing is Geeky - social skills of individuals that study computing or work in the software industry	1. Software industry professionals often work as a team to solve problems. 2. Software industry professionals must be able to talk with many different people face to face. 3. People who study computing or work in the software industry are geeks. 4. People who like computer science are only interested in gadgets.	Likert scale	Rated responses were coded and summed to create a score for the group of items. The statistical significance of the differences between the two genders was tested using a Mann-Whitney U Test.
Computing is male dominated - perception of the gender breakdown of computing	1. Computer science education is male dominated (i.e. there are more males than females who study it computing) 2. The software industry is male dominated (i.e. there are more males than females that work in the industry)	Likert scale	Rated responses were summed to create a score for the group of items. The statistical significance of the differences between the two genders was tested using a Mann-Whitney U Test.
Gaming activity	1. How many hours a day do you use a computer for gaming? 2. How many hours a day do you use a smart device (such as a tablet or phone) for gaming? 3. How many hours a day do you use a gaming console (e.g. PlayStation, Xbox) for gaming?	Open response question	The statistical significance of the differences between the two genders was firstly checked for distribution using a Kolmogorov-Smirnov Test. It was found to be not a nominal distribution therefore a Mann-Whitney U Test was used.
Future computing career aspirations	1. In the future I would like to work as a programmer. 2. In the future I would like to work as a software engineer. 3. In the future I would like to work in the software industry.	Likert scale	Rated responses were summed to create a score for the group of items. The statistical significance of the differences between the two genders was tested using a Mann-Whitney U Test

Table 3 – Surveyed stands and subsequent analysis used

Some additional questions that did not map directly to previous scales were also included.

IV. RESULTS

Baseline understanding of secondary school pupils

Computing is geeky

Within the secondary school group, no significant differences were found between males and females in relation to their perception of a lack of social ability of those studying or working in computing ($p=0.40$, Mann-Whitney $U=2307$, $Z = 0.834$) with the majority of both genders disagreeing or strongly disagreeing (male 74.8% and female 67.3%) with the view that computing is geeky.

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Male	35.2%	39.6%	16.5%	7.7%	1.1%
Female	29.1%	38.2%	27.3%	5.5%	0.0%

Table 2 Responses of secondary school pupils with regard to the view that Computing is geeky

Computing is male dominated

No significant differences were found between males and females within the secondary school group in relation to their perception of computing being male dominated ($p=0.99$, Mann-Whitney $U=2501$, $Z = 0.006$) with the majority of both genders in disagreement with the statement.

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Male	30.80%	34.10%	15.40%	17.60%	2.20%
Female	29.10%	36.40%	18.20%	12.70%	3.60%

Table 4 Responses of secondary school pupils with regard to the view computing is male dominated

Gaming activity

The distribution of the scale variable (hours), when analysed with a Kolmogorov-Smirnov Test, was found to be not normally distributed therefore a Mann-Whitney U

Test was used rather than the Independent Samples T Test. Significant differences were found between males and females within the secondary school group in relation to the time spent gaming ($p \leq 0.05$, Mann-Whitney $U=1404.5$, $Z=4.695$). On an average day, males report spending (2.6 hours) compared to females (1.1 hours) gaming.

	0 - 1 hrs	1– 3 hrs	3– 7 hrs	7–9 hrs	10+ hrs
Male	15.4%	47.3%	24.2%	4.4%	8.8%
Female	52.7%	34.5%	7.3%	1.8%	3.6%

Table 3 - Percentage within gender of average time (hrs) spent gaming per day in the school Group

Future computing career aspirations

Significant differences were found between males and females in relation to future educational and career aspirations in relation to Computing ($p \leq 0.05$, Mann-Whitney $U=1404.5$, $Z=4.695$). 48.4% of the males were attracted to computing careers in contrast to 14.6% of the females.

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Male	9.90%	22.00%	19.80%	22.00%	26.40%
Female	15.20%	29.10%	34.50%	7.30%	7.30%

Table 4- Responses of secondary school pupils with regard to the interest in future computing career

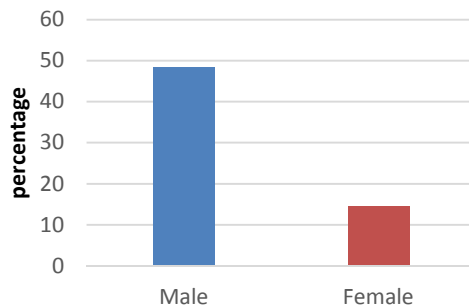


Figure 1 – Summary of responses of secondary school pupils with regard to positive interest in a future computing career

Further analysis of gaming and career aspirations groups within the secondary school group

Although overall the surveyed girls spent considerably less time gaming per day than the males, a closer look at the career aspiration subgroup (Table 5) in relation to gaming reveals a very different trend. It suggests that the girls who were positively attracted to a future computing career actually spend more time gaming than their male

counterparts in the same group. Also in comparison the girls spent significantly more time gaming than the girls and boys that did not wish to pursue the same career path (Figure 2).

	Male	Female
Interested in computing career	3.47 hrs	3.50 hrs
No interest in computing career	1.80 hrs	0.70 hrs

Table 5 - Comparison of average hours per day spent gaming and computing career aspirations

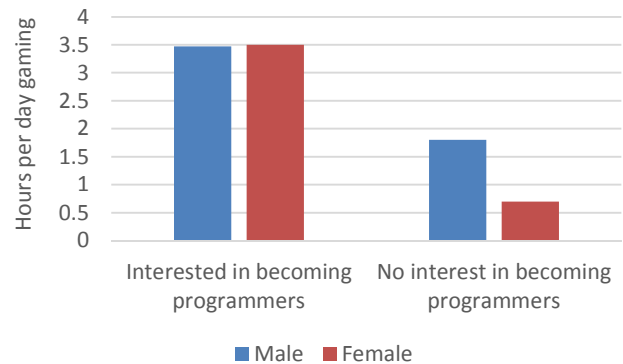


Figure 2- Comparison of average hours per day spent gaming and career aspirations

Discussion of baseline attitudes of secondary school pupils

Are attitudes changing?

The research did not find evidence for the normally reported negative attitudes towards computing held by female secondary school pupils. In fact 66% of pupils reported a positive regard for the social skills of computing professionals and did not recognise computing as male dominated. It is encouraging that the stigma of computing being nerdy or geeky was not evidenced among the pupils in this study. Additionally, neither gender reported they view computing education or industry as male dominated.

Gaming and computing exposure

Significant gender differences were discovered on daily time spent gaming. On average males spend 1.5 more hours per day gaming than the females. However, it is telling that the girls that hold a preference for a career in computing report that they game much more than either the girls or boys that do not have the same career aspirations. In fact, of the groups attracted to a computing career path it is actually the girls that game more than the boys.

	Computing is geeky		Computing is male dominated		Future computing aspirations		Gaming activity (Hrs per day)	
	Male	Female	Male	Female	Male	Female	Male	Female
Secondary school pupils	8.70%	5.45%	19.57%	16.36%	26.09%	8.70%	2.62	1.10
Code Club members	15.21%	14.29%	32.61%	42.86%	73.91%	35.71%	3.59	2.36

Table 6 – Combination of Agree and Strongly Agree responses for each strand and gaming activities

Females are still not attracted to software careers

Of alarm is the difference between the genders with intent to work as software developers, with significantly fewer females (14%) indicating they would like to work in the software industry. It is of no encouragement that this is actually less than the current 17% female representation in the software industry. If this aspiration is achieved, then it would follow that there will be less females in the industry in the coming years and the gender divide will widen.

Baseline understanding of Code Club and comparison with secondary school pupils

In order to establish if there are gender attitudinal differences within the Code Club and between the club and the secondary school group a further analysis was conducted. Table 6 shows a combination of the Agree and Strongly Agree responses from both groups.

Computing is male dominated

Within the Code Club group more of the females (42.86%) compared to the males (32.61%) agreed with the statement relating to the male dominance of the computing. Also of note is that significantly more of the Code Club members compared to the secondary school group held this opinion. The cause of this is likely to be centred on Code Club members increased exposure, via the club activities, to the computing industry.

Computing is geeky

Within the Code Club group there were no significant differences between genders in regard to their view of computing being geeky (Table 6). However, similar to the trend exhibited in perception of male dominance there is a difference between the Code Club group and the secondary school pupils (Figure 4). While on average 7.08% of the secondary school pupils group consider computing to be geeky this increases to 14.75% for the Code Club members.

Future career ambitions

Perhaps unsurprisingly, as the members of the Code Club are actively involved with computing, they are significantly more attracted to computing careers compared to the secondary School group (Table 6 and Figure 3). However, of significance is that females (35.71%) in the

Code Club group are less attracted to a software industry career than the males (73.91%) in the group ($p < 0.05$, Mann-Whitney $U = 184$, $Z = 2.548$)

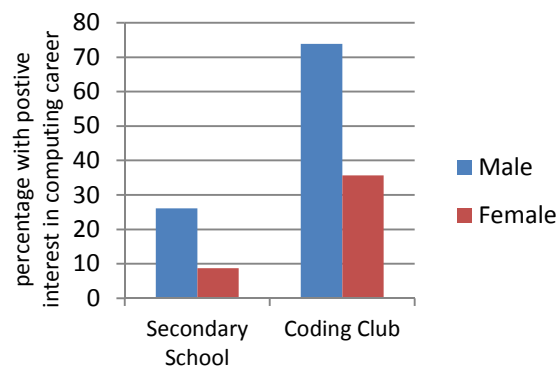


Figure 3 - Summary of responses with regard to positive interest in a future computing career

Gaming

As detailed in Table 6 and Figure 4 the Code Club members game more than the secondary school group. However, within the Code Club group there is also a significant difference between genders in gaming activities, with males gaming on average 3.59 hours per day compared to females 2.36.

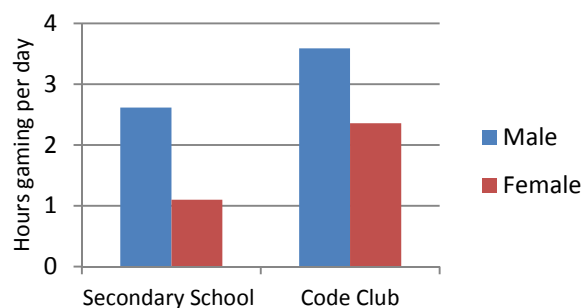


Figure 4 - Comparison of average hours per day spent gaming

Discussion on Code Club results

Similar gender divide patterns are found with Code Club and the secondary school pupils. The significant differences found were in the gaming activities and future programming career aspirations. The females in the Code Club lag behind the males in both areas. On the optimistic side, Code Club females (35.71%) are much more attracted to computing careers than either female (8.70%) or indeed the male (26.09%) secondary school pupils, however, this is still significantly less than the male Code Club members (73.91%).

The majority of Code Club members do not appear to hold negative attitudes towards computing. Nevertheless, it is noteworthy that they report stronger negative attitudes in relation to male dominance of computing and the geeky nature of computing compared to the secondary school pupils. A large number of the Code Club females (42.86%) stated computing was male dominated. Yet, for some of these females it would appear that this is not a sufficiently strong enough negative factor, as shown by their commitment to the club and coding career ambitions. That is not to say that it may well be an issue negatively influencing the (64.29%) females that did not express a desire to follow a software career.

Consistent with the secondary school group, the Code Club females report they game less than the boys in the club. However, the Club girls show both an increased desire to follow a software career pathway and game more than the respective secondary school females. This again suggests that gaming may be a factor influencing career choice.

V. DISCUSSION AND FUTURE WORK

Change without change

This research finds evidence that females at secondary school level do not hold negative attitudes to computing. This may well be as a consequence of the recent exposure to the sheer volume of local government and industry computing initiatives. Yet there remains no change in the computing career ambitions of secondary school females. Worryingly, females are still generally not attracted to software careers. Although females that are members of the Code Club are more interested in a computing career than the average secondary school pupil, they still are significantly less so than the males in the same club. The most identifiable factor of influence found in this research was gaming activity. Those individuals that game more were found to be more interested in computing careers.

Is gaming a game gamer?

Taken at face value this would provide considerable hope for the future. While in the past gaming was a male domain that is rapidly changing. Largely due to the surge in casual mobile gaming, that female gamers now make up about 48% of the game-playing public in the U.S.A.[25]. Many popular recent mobile games such as *Pokemon Go*

and *Minecraft* are not specifically male oriented. Also of substantial change is the marketing of console / PC games. One of the top three bestselling games in 2016 was *Star Wars: Battlefront*. Historically the film franchise and gaming spinoffs have been most attracted to males, yet, the 2016 game has a female default main player character. If gaming is a positive influence on potential computing career the currently increasing numbers of females gaming offers hope. Although the potential effect on the computing industry workforce may not be realised for a number of years, it is perhaps an encouraging sign.

Relationship between playing games and becoming a programmer.

The potential relationship between game playing and future computing careers was publically highlighted by Facebook founder, Mark Zuckerberg in 2015 in explaining that he would not have got into programming if he had not played games as a child [26]. However, it is not just about playing the game that may influence a future programmer but it is perhaps how the games are played. In Zuckerberg's case he also explains that "what I really did a lot when I was a kid was I made a lot of games for myself. They were terrible, but this was how I got into programming." It may be that the influence of programmable games such as *Minecraft* that are the real drivers stimulating future programming interest for the Code Club students in this research. It would be of interest in future research to further analyse how similar Code Club members actually game.

Negative aspects associated with gaming

The increasingly large research literature studying the overall effects of gaming consistently shows that video game effects are not trivial; significant effects of video game play are found in short-term and long-term contexts [27]. In this research the Code Club students tended to spend a comparatively large portion of their time gaming. While this may be an advantage to arguably improving their affinity to a computing career, due to the singular nature of many gaming environments it does run the risk of reducing their social or soft skills development which is highly sought after software industry skill.

Positive computing exposure

However, the factors influencing career choice are extremely complex and it is likely too simplistic to assume that merely getting girls to game more will lead to increased numbers of future female programmers. Nevertheless, a reasonable extrapolation would be to consider gaming as part of the theme of computing exposure. Indeed, increased computing exposure is the basis for the many Code Club initiatives. The theory being that increasing positive exposure to computing will positively influence computing education and career decisions. Code Club programmes include *Coder Dojo*, which continues to attract large numbers of children worldwide and has proved to be highly successful. Nonetheless, "approximately only 30% of attendees at

Dojos are girls” Cleary [28]. This suggests that generalised Code Clubs are not successfully supporting girls in computing, as acknowledged by the fact that there are now female specific interventions, such as *CoderDojo Girls*. An obvious question for future research is why the interventions appear to foster a gender imbalance and what can be done about it. It would be of considerable interest to survey attitudes of participants in these activities before and after the programme to determine if these programmes lead to more positive attitudes towards computing careers for girls.

Exposure to computing for all

Code Clubs traditionally attract young people who already have an interest in computing. Exposure to positive computing experiences in mainstream education is lacking, as reported in the ACM report, “Running on Empty”[29]. As suggested by Deyoung & Spence [30], facilitating female contact with computers from early years could reduce gender differences in computer attitudes. In a similar vein to potential research on intervention programmes, it may be of interest to policy makers to assess if the introduction of computing courses for all in mainstream education would make a difference in numbers, especially of females, opting for university computing courses. The results of this survey strongly suggest that gaming influences choice, it would follow that better designed targeted intervention programs to address students' negative attitudes should include gaming elements. The authors suggest that intervention programming with gaming but specifically with programming elements, such as *Minecraft* would be of significant benefit in attracting females and indeed more males to computing.

General conclusions

It is ironic that Ada Lovelace is widely acknowledged as the first computer programmer, yet historically females are severely underrepresented in the field of computing. This research finds that the gender fault line for computing careers remains in place. However, the rejection of the negative attitudes to computing is encouraging, as is the insight that positive exposure to computing, such as through gaming, can have an affirmative influence on career choice. While this does not open up a new front in the battle to reduce the gender divide, it does suggest that more work and resources need to be allocated in terms of further research and subsequent interventions in that area.

Limitations

As with many quantitative based studies the understanding of the responses would be further enhanced with a further qualitative study. The ability to probe further into the areas of concern, such as gaming and exposure to computing would provide a greater understanding of the findings.

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