Computer programming, ICT and gender in the classroom: a male-dominated domain or a female preserve?

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Abstract

This paper describes a small-scale empirical study grounded in teaching experience which draws upon two principal areas of research: psychological gender and attitudes towards programming and ICT (information and communications technology) in primary schools. The sample group for this study comprised 24 Key Stage 2 pupils who undertook two computing tasks using applications that align with the current UK Primary Computing National Curriculum (DfE 2013a). All children completed a Children's Sex Role Inventory (CSRI) questionnaire to determine their psychological gender, as well as a computer attitudes (CA) instrument to ascertain their views on computing and ICT. The children's responses to both instruments were then tested for internal reliability. The pupil participants involved in this research undertook two tasks, which involved the use of programming software, Microsoft Windows LOGO (MWL), and a desktop publishing (DTP) program, Microsoft Publisher. Work samples were then graded to a set of criteria and awarded an overall mark. Although boys marginally outperformed girls overall, the difference between the means did not achieve significance. However, when Pearson product moment correlations were taken between the performances of boys' means and girls' means, respectively, across the programming and DTP tasks, they indicated different tendencies. The findings of this small-scale study are limited, but would appear to demonstrate that gender differences do exist in terms of performance across different applications.

Keywords: computing; gender; ICT; programming.

Introduction

It is interesting to note that the very first computer programmers of the 20th Century were all females, and that it was this team of 80 women who calculated ballistics trajectories on a computer during World War II at the University of Pennsylvania. Their job title was simply 'Computers' (Sanders 2005). However, by the late 1950s and early 1960s, just under half of the programmers and systems analysts were women, and by the mid-1980s that figure had further declined to about one-fifth (Newton & Beck, 1993: 130). Quite how or why this happened could be due to one or any number of different factors, although Newton & Beck refute the notion that it was due to changes in technology or that women lacked the requisite intellectual faculties. They suggest, instead, that it is very much a social factor and that it is the acutely male culture pervading this field which is 'likely to alienate girls' (1993: 132). More recently this pattern still exists and, as Palmén (2011) notes, only 18% of information technology (IT) professionals in the UK are women. This gender imbalance is also reflected in the education workforce, with only 22% of IT teachers in UK secondary schools being female (Johnson, 2008).

Female 'computer anxiety'

Back in the 1990s, Brosnan (1998) observed that not only was computing a male-dominated activity but that both sexes perceived IT to be masculine. The notion that technology is made by men for men ('boys and their toys') and that the world of computing is not female-friendly is supported by Sanders (2005: 6) who draws attention to research which has suggested that:

> 'The violent language of technology may be invisible to males but can be a problem for females. Consider hard disc, hard drive, reboot, cold boot, hits, permanent fatal error, and so forth. Recreational or even educational software for children often includes title words such as "attack" or "war"'.

The view that information and communications technology (ICT) is stereotypically a male domain is acknowledged by Johnson who notes that 'ICT and gender stereotypes are perpetuated regardless of

gender' (2008: 3). Hennessy & Dunham (2002) also cite this as being a factor in perpetuating this perception, as it further reduces female interest in technology. It is not surprising, therefore, that Rockett (2006) reports that young girls from an early age begin to associate computers with activities that are stereotypically male and, subsequently, they often develop anxiety when it comes to computers in general. However, at pre-school age, many of the gender differences associated with older children would appear to be far less pronounced. A paper produced by Learning and Teaching Scotland (2002) suggests there is no gender difference in the way that children four to five years old engage with the computer in the playroom, although it was noted that girls become less involved with computer activities as they get older.

Female computer anxiety, or aversion to computers, is also reported elsewhere in the literature. Todman & Dick (1993) note that female attitudes to computers tend to be less favourable than those of boys, and Brosnan (1998: 206) found boys 'significantly' more positive towards computing than girls. More recently, evidence that these tendencies and attitudes persist would appear to exist. For example, in secondary schools, boys are more likely 'to dominate computers when available in mixed classrooms' and girls remain 'underrepresented' in lunchtime or after-school clubs (Johnson 2008: 3). Ofsted (2011: 4) echoes this landscape by identifying that 'fewer girls choose to continue to study ICT in Key Stage 4 and beyond' and recommends that they need to be encouraged to do so. Although Palmén observes that 'attempts have been made to address. . . these objectives' through UK school initiatives, such as Computer Clubs for Girls, these strategies 'needed to be embedded and maintained' in order to afford 'broader gender equality' (2011: 408).

As early as 1983, as Sanders (2005) noted, there was concern that computing had become a male enclave in education. The introduction of computers into secondary schools in the 1980s, although a positive initiative, was unfortunate in the sense that their usage was linked to maths and science, i.e. areas where, traditionally, girls are less likely than boys to have positive attitudes (Newton & Beck 1993). Initial policies for computer use and allocation of computers in the late 1980s would also suggest that girls were far more likely than boys to miss out on experience with computers (Newton & Beck 1993: 135).

Gender and performance in school

Despite a relatively 'gender-neutral' National Curriculum in 2002, uptake of GCSE ICT for girls was alarmingly low: 38% as opposed to 62% for boys (Ofsted 2004). Although by 2011 this gap at GCSE level had narrowed (Vidal-Rodeiro 2012: 11), the gender divide becomes even more pronounced with regard to uptake of computer science in schools. The Royal Society reports that 'in 2011, for instance, across the UK only 302 girls took Computing A-level (7.5% of the total entry), compared to 3,700 boys (92.5% of the total entry)' (2012: 23).

Given the scenario above, it comes as no surprise to discover that boys spend more time at home using computers and playing games than girls (Palmén 2011), although girls tend to be more prolific users of social networking sites than boys (Johnson 2008). So, thus far, it would be logical to assume that even though fewer girls engage with ICT than boys, boys would still outperform girls in computing; but this is clearly not the case.

In a small-scale study, Brosnan (1998) reported no sex difference in computer-related attainment. Hellsten (2006: 15) points to evidence suggesting that seven- to nine-year-old girls had the same if not better level of ICT skills as boys of the same age. Another piece of evidence to support this, although for older children, comes from an analysis of GCSE results for ICT (see Table 1).

A cursory glance at the data in Table 1 shows that girls outperform boys at every level (apart from grade C), with a higher percentage of girls achieving an A* or an A and with 77% of girls achieving an A*–A as opposed to 69% of boys, meaning that a greater percentage of boys fail the exam – a pattern almost unchanged since having been reported ten years previously by Ofsted (2004). A possible explanation for this is that girls are more competent at a wider range of applications than boys although, as Sanders (2005: 14) points out, there has been little research on gender and software.

Unlike much of the literature quoted above, the findings reported in this study are not based on physical gender, but on psychological gender. As Boldizar (1991) recognises, the use of a Children's Sex Role Inventory (CSRI) allows researchers to examine sex typing from a multidimensional perspective. It also provides a more accurate picture when making gender comparisons, as it allows for androgynous (high levels of both femininity and masculinity) and undifferentiated (low levels of both) individuals (Brosnan 1998: 203).

Table 1. Information technology GCSE results,
England 2013 (DfE 2013b)

	A*	A	B	C	D	E	F	G
Boys	5.7	16.7	23.7	23.3	12.8	7.1	5.2	3.2
Girls	9.2	21.7	25.5	20.7	10.2	5.6	3.3	2.3

Methodology

This study focuses on a cohort of Year 6 pupils (aged 10–11) at a mixed inner-city junior school. The purpose of the study was to determine whether masculine gender types were more competent with the programming aspect of ICT than feminine types and conversely whether feminine gender types were better at communicating information (word processing/DTP).

Both classes (50 children in all) completed Boldizar's CSRI and Todman's computer attitudes (CA) instrument in one session. The basic aim of administrating the CSRI was to use an age-appropriate instrument to gauge early manifestations of sex typing in children of this age phase as well as to establish gender-related behaviours for this cohort. The Todman CA Instrument was used in much the same way, as it provided an age-appropriate set of questions upon which to establish beliefs, views and trends.

The children were given instructions on how to record their responses and were asked to complete the questions independently. Questions were read out to those who were not fluent enough to read themselves. The completed sheets were then collected in. There were 2 spoiled papers, which were removed, leaving a total of 48 responses (22 boys and 26 girls) to the CSRI and CA instrument.

The children's responses to the Todman CA were subjected to a test of internal consistency which resulted in an alpha coefficient of α 0.7892. Their responses to Boldizar's CSRI feminine and masculine scales were also subjected to tests of internal consistency: the feminine scale achieved an alpha coefficient of α 0.8753, and the masculine scale achieved an alpha coefficient of α 0.7219. The alpha coefficients were all deemed to achieve a 'good' level, i.e. between α 0.7 and α 0.9.

The median values for the masculine and feminine scales were calculated for the sample.

Thereafter, consistent with Boldizar's (1991) procedure, participants were assigned to four categories:
- *androgynous* – above median femininity and masculinity – comprising 16 pupils (3 boys and 13 girls)
- *feminine* – above median femininity and below median masculinity – comprising 8 pupils (1 boy and 7 girls)
- *masculine* – above median masculinity and below median femininity – comprising 8 pupils (8 boys)
- *undifferentiated* – below median femininity and masculinity – comprising 16 pupils (10 boys and 6 girls).

A total of 24 children were then selected with an even spread of 6 pupils from each of the following groups: androgyne, masculine, feminine and undifferentiated. Two tasks were then devised for the children which were undertaken in a computer suite where the computer-to-pupil ratio was 1:1. Pupils worked independently for approximately one hour without assistance. The tasks are outlined below.

MSW LOGO task

Using an interactive whiteboard, the children were shown how to create and save a procedure using the editor. They were shown how to use the necessary commands (Forward, Back, Left, Right, Pen Up, Pen Down, Set Pen Colour) and the code needed to create a circle. They were then asked to create a one-word procedure to draw three interlocking circles each of a different colour (see Figure 1).

Figure 1.
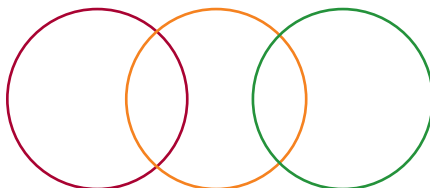
Pupils saved their work and a scoring system was then used to give their work a mark.

Microsoft Publisher task

Children were asked to design a fundraising poster for a charity event of their choice. They were asked to include the name of the charity, the purpose of the event as well as the time, date and venue details. They were also asked to include pictures and any other additional information about the event. Using an Interactive whiteboard, pupils were shown how to load a blank A4 page in Microsoft Publisher. They were also shown how to insert and add text frames, enter text, format font type, size and colour as well as import picture files and graphic objects to enhance their design. Pupils saved their work and a scoring system was then used to give their work a mark.

means; only the difference between the masculine and undifferentiated means approached significance ($t = 2.173$, $p = 0.0505$, 12 df).

Small groups' performance of discrete tasks
The performance of those pupils comprising the psychological gender groups were considered in terms of biological gender (see Table 3).

Thus, the boys marginally outperformed the girls, although the difference between the means did not achieve significance in two-sample t-tests. However, when Pearson product moment correlations were taken between the performances of boys' means and girls' means, respectively, across the LOGO and Publisher tasks, the correlation for boys' performances was –0.322 while the girls' correlation was 0.728.

Table 2. Comparison of psychological gender groups' performance of Todman (sd is standard deviation)

Androgyne	Feminine	Masculine	Undifferentiated
61.375	56.125	64.875	55.938
(sd 10.639)	(sd 10.639)	(sd 9.992)	(sd 8.418)

Table 3. Pupils performance by biological gender

	LOGO task	Publisher task
Boys	8.25 (sd 3.74)	6.92 (sd 1.56)
Girls	7.08 (sd 3.37)	6.33 (sd 2.84)

Findings

Data are presented concerning all pupil psychological gender groups' performance on the Todman instrument and, by selected subsamples, performance of the discrete tasks.

Psychological gender groups' performance on the Todman instrument. Means were calculated for each of the psychological gender groups' performance on the Todman instrument (see Table 2). The means were subjected to a series of two-sample t-tests: there were no significant differences between group

These correlations indicate quite different tendencies: for girls, performance on one task was largely consistent with performance of the other task; for boys, performance on one task indicated an inverse performance on the other task.

The performance of pupils within psychological gender groups was then considered: for each group, mean performances for each task were calculated and Pearson product moment correlations between tasks were calculated (see Table 4).

Table 4. Pupils' performance by psychological gender groups

	LOGO task	Publisher task	Correlation
Androgyne	6.17 (sd 4.26)	5.33 (sd 2.50)	−0.081
Feminine	8.17 (sd 3.13)	7.67 (sd 2.16)	0.928
Masculine	8.5 (sd 3.21)	7.33 (sd 1.51)	−0.248
Undifferentiated	7.83 (sd 3.92)	6.17 (sd 2.48)	0.435

Notably, while there were no significant differences between means, on the LOGO task the masculine group outperformed the feminine, undifferentiated and androgyne groups, while on the Publisher task the feminine group outperformed the masculine, undifferentiated and androgyne groups. The correlation between psychological gender groups' performances of both tasks disclosed that the feminine group had a very strong correlation between performances (0.928), the undifferentiated group had a moderate correlation (0.435), while the androgyne and masculine groups had weak negative correlations.

Conclusion

This small-scale study has revealed that girls seem to perform more consistently when working with varying types of application, whereas boys are not able to demonstrate parity between applications. The findings do support the notion that, on the whole, programming is a male domain and DTP a female one. The fact that girls display comparatively equal skill across applications might explain why they outperform boys at GCSE, where they are being tested on a wide range of applications.

However, given one of the main findings of this small-scale study (that boys appear to be significantly less able to demonstrate parity in terms of proficiency in different applications), it would be interesting to extend this study, both in terms of broadening the age range of cohorts and perhaps widening the range of applications. It would then be possible to determine whether this is a consistent trend.

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