The Gendering of Information Technology

Book Section

The Gendering of IT

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Abstract

In this chapter, we adapt the model of curriculum change in relation to gender reform proposed by Lewis (1996) to highlight significant shifts in the discussions of gender and IT. At the first stage the absence of girls and women from the domain of computer-use no longer goes unnoticed. In stage two, the spotlight moves to the promotion of interventions that aim specifically to change girls and women such that they will have more productive interactions with technology. At stage three, the prevailing paradigm of what it means to use a computer in school is challenged. We suggest a further development which moves attention away from initiatives in school to the influence on the curriculum of IT-use at home. We present a case study to illustrate how girls and boys, with appropriate technology, can shape 'the computer' to suit their own goals and in the process begin to problematise the prevailing computer culture.

Introduction

Recent years have seen a massive expansion of computer technology in schools. This is the case throughout the world, but also in the UK, the context of this chapter. The scale of the expansion of computer provision in the UK is highlighted in a chapter by Gill (1996), who drew on Department for Education and Employment (DfEE) statistics to show the increased computer provision within the compulsory school sector. As Gill reported: in UK secondary schools in 1985 there were 60 pupils for every computer, as compared to 10 pupils for every computer in 1994 (DfEE, 1995). Over the same period, the total expenditure on information technology in secondary schools alone rose from £9.8 million to £86.9 million. In primary and special schools the picture was much the same with fifty-six percent of teaching staff in primary schools using computers at least twice a week (DfEE, 1995). A more recent survey investigating computer provision in the UK in March 1999 indicated a continuing upwards trend in provision and access. Expenditure on computer equipment has increased, particularly in the primary sector, as illustrated in Table 1. The total number of computers in schools rose from 238,000 in 1998 to 292,000 in 1999, and the average number of computers per school rose from 13 to 16. This has resulted in a decrease in the ratio of pupils per computer from 18 in 1998 to 13 in 1999 (DfEE, 1999).

Insert Table 1 here: Expenditure on computers for teaching and learning in England.

In the current political climate, where the government is promoting the development and use of a National Grid for Learning (NGfL) to ‘Connect the Learning Society’ (DfEE, 1997), the trend of increased computer provision and usage is set to continue and even to accelerate. The NGfL was launched as part of a rolling programme of investment totalling more that £1.6 billion up to 2002 which underpins Government targets for ICT in education and lifelong learning. These targets include: teachers to be confident and competent to use ICT for teaching, all schools, colleges and universities connected to the NGfL, enabling some 75% of teachers and 50% of pupils to have their own e-mail address, and most school leavers to have a good understanding of ICT.

Against this backdrop of burgeoning computer-use, the idea that computers could influence ‘the shape of minds to come’ has considerable currency, and much is being written about the potential of the computer to offer new educational environments, new learning and new ways to learn (Crook, 1992, 1996; Scrimshaw, 1993; Littleton & Light, 1999). Government ministers match the earlier rhetoric of Seymour Papert (Papert, 1980) and that of educational researchers (Hoyles, 1985; Noss, 1997) and now talk of a knowledge revolution (Wills, 1999). However, hand in hand with enthusiasm for computer-use in the classroom is a growing awareness that the social and educational effects of the technology could be divisive (e.g. Laboratory of Comparative Human Cognition, 1989; Light & Littleton, 1999; Olson, 1988). Computer technology can open access to a range of 'abstract' disciplines such as mathematics and science, by making them more manipulable and engaging, but it can also enhance pre-existing patterns of social inequality, widen the gap between the 'haves and the have nots'. Different digital under-classes are emerging who are denied access to computers at home, either through lack of information, or because of cost or attitude. We will argue that this exclusion can be exacerbated in schools by the nature of the computer activities on offer.

Clearly issues of class and poverty are relevant to the discussion of exclusion from computer-use, but here we focus on gender. A growing body of research reveals that males and females differ in terms of their expressed enthusiasm for, their access to, and participation in computer-related activities (see Brosnan, 1999; Littleton, 1996; Littleton & Bannert, 1999; Light, 1997). There are now serious claims that the increasing deployment of computers at school level could place girls at a disadvantage relative to boys unless more attention is paid to how the computers are used and how computer expertise is judged (e.g. DES, 1989; Evans & Hall, 1988; Hoyles, 1988; Littleton, Light, Joiner, Messer & Barnes, 1998).

Let us consider a situation where men are outperforming women consistently over time in a particular educational discipline. Evidence suggests that at first these differences are hardly noticed, but gradually people become aware of 'the problem' and set about solving it. Lewis (1996) has suggested that it is possible to distinguish stages of curriculum intervention to tackle poor female participation, which can be summarised as: noticing the absence of females, changing females so as to improve participation to finally re-thinking the discipline itself. We will adapt this framework to help structure our discussion of female involvement in IT and to provide an analytical tool to trace the developing relationship of females to IT. Our claim is that in IT we have potentially more opportunity than in other domains, such as mathematics, to reach the third stage and build a more gender-inclusive curriculum. School mathematics has a long history and its content is remarkably consistent across the globe making it hard to re-conceptualise and change. IT is different: it is new, ill-defined and in a state of rapid transition. As there are few entrenched positions in terms of curriculum content to circumvent, it would seem possible that the meaning of IT activities could be shaped to be more gender-inclusive. But to achieve this goal we need to clarify the nature and extent of the 'problem of female participation' in IT.

Stage 1: Noticing the absence of females

Women have long made valuable contributions to 'the development and application of computers' (see Lockheed, 1985, p.177), and computer-technology has never been the exclusive preserve of men. However, young women and girls became increasingly 'absent' from the domain of computing throughout the 1980's and early 90's. As a result, many researchers attempted to assess the level of girls' participation in IT and IT-related activities (see Sutton, 1991 for a review). The sheer volume of research addressing the issue of gender differences in computer-related behaviour makes the task of identifying consistent patterns difficult (Kaye, 1992). Having said this, however, some clear trends have emerged from this literature.

First, during the early years there appears to be little difference between girls and boys in how they see computers, their liking for computer technology, or their involvement in computer-based activities (Brosnan, 1999; Williams & Ogletree, 1992; Bergin, Ford & Hess, 1993; Landerholm, 1994). As they grow older, however, girls' engagement with IT begins to decline (e.g. Lage, 1991) and data spanning the full age range of compulsory schooling indicate that overall computers are used more by boys and male teachers than by girls and female teachers (e.g. Bannert & Arbinger, 1996; Durndell, Glissov & Siann, 1995; Kay, 1992; Millard, 1997; Podmore 1991; Straker, 1989).

Computer-use in school: During the primary school years, boys tend to dominate computer and teacher resources in class-time, monopolise machines during free-periods and take over the newest software or most powerful machines (Carmichael, Burnett, Higginson, Moore & Pollard, 1986). This study (though now rather old) still seems to paint a true picture of the gendered nature of IT use. When small groups of girls and boys work together on computer-based activities, boys are inclined to dominate the discussion and joint-activity (e.g. Keogh, Barnes, Joiner & Littleton, 2000; Barbieri & Light, 1992). It is perhaps not surprising therefore that many girls become hesitant computer users in their junior school years (e.g. Somekh, 1988).

During compulsory secondary education the low levels of female participation in IT and IT-related activities has become increasingly evident, as the relative numbers of girls and boys being entered for public examinations in computer studies and computer science testify. In the UK at least, there is marked gender bias in the numbers of girls and boys being examined in these subjects (Hughes, 1990; Culley, 1993) and the gap has become more pronounced over time as the proportion of girls studying computer-science declines (Buckley & Smith, 1991). In higher education, applications by girls to study computer science at university dropped by 50% between 1978 and 1988, as did acceptances (Hoyles, 1988; Dain 1991; Newton & Beck, 1993). The proportion of female student admissions onto computing courses reached an all time low of 11% in 1987. While these figures have improved a little, 18% in 1995, 20% in 1997 and 19% in 1999 (Coolican, 1997; UCCA, 1989; UCAS, 1995; UCAS, 1997;UCAS, 1999) there are still relatively few female computer science undergraduates in the UK.

We recognise that focussing on the details of public examination and university entry provides only a partial indicator of the absence of females from school IT use. There are, however, other factors concerning the deployment of IT in the secondary school which also suggest that girls can become 'disenfranchised' users of computer technology: in mixed schools, as at the primary stage, boys dominate computer activities (National Curriculum Council, 1990) with the result that girls obtain less time on the machines than boys. When they do work on computers they typically receive less assistance from the teachers (Culley, 1988; 1993). Moreover, if during the course of a computer class the teacher requires help, it is usually boys who are chosen to give that assistance (Sanders, 1990). Boys are not only the key 'players' in classroom-based computer-activities, but also the major users outside the classroom, for example, they constitute over 90% of the regular participants in optional computing clubs (Culley, 1998;1993).

Computer use in the home: In addition to the disparities in school, gender differences disparities in home computer-use have long been noted. (Culley, 1988, 1993; Evans & Hall, 1988; Hoyles, 1988; National Curriculum Council, 1990; Busch, 1995; Bannert & Arbinger, 1996). Parents are more likely to encourage boys than girls to use computers (e.g. Hoyles, 1988) and parents more frequently buy computers for boys than for girls (Mohamedali, Messer & Fletcher, 1987; National Curriculum Council, 1990; Robertson, Calder, Fung, Jones, & O'Shea, 1995). Many parents still 'regard computers as a male rather than a female or common domain' (Busch, 1995, p. 155).

Boys make more use of computers in the home than girls (Doornekamp, 1993: Fife-Schaw, Breakwell, Lee & Spencer, 1986; Lockheed, 1985; Robertson, Calder, Fung, Jones & O'Shea, 1995) and, while this is primarily for games, a point we shall return to later, gender differences in use are reported in all home computer activities (Martin, 1991). These differences in home experience seem likely to impact on children's response to computers at school – an impact likely to grow as computer game playing becomes more sophisticated. As the National Curriculum Council (1990, p.B5) noted: 'Boys often see computing as an interesting hobby and so become familiar with the technology and use the jargon which is discouraging to those unfamiliar with it'. Thus 'Boys are far more likely to enter into formal schooling culturally and practically positioned to accept and be motivated by computer' (Beynon, 1993, p.167). It has also been that because of their lack of experience of computers within the home, girls are more likely to perceive themselves as lacking expertise and this in turn contributes to their relative passivity in the computing classroom suggested (Crawford, Groundwater-Smith & Millan, 1989). Familiarity with computers breeds confidence and confidence breeds more engagement and more familiarity. The spiral continues. But, if girls and young women are 'absent' from the domain of computing, what are their attitudes towards computer technology?

Attitudes towards computer use: There are conflicting results related to gender-related differences in attitude toward computers. The confusion arises first because computer use is itself ill-defined and second because there are diverse ways in which attitudes towards computers have been defined and measured. For example, Kay identifies at least fourteen different approaches to attitude measurement: 'with respect to acceptance, affect, cognitions, comfort, confidence, courses, interest, liking, locus of control, motivation, programming, training, case scenarios and stereotypes' (Kay, 1992, p 278). It is perhaps not surprising given this profusion of diverse measures, that gender differences favouring males in general attitude, interest in computers, liking of computers, the utility or necessity of computers and confidence in using computers have been reported in some studies but not in others (see Sutton, 1991 and Kay, 1992 for reviews). Thus, while data from the entire age range of compulsory schooling do sometimes reveal that girls are less positive about computer-use than boys (e.g. Martin, 1991; Todman & Dick, 1993; Shashaani, 1993, 1994), we must be cautious in interpreting these findings, particularly as once exposure to and prior experience of computers is controlled, gender differences in attitudes in many studies either reduce or disappear. For example, one of the earliest studies in this field demonstrated that gender did not explain any additional variance in attitudes towards computers after computer experience and mathematics anxiety had been entered into the regression equation (Gressard & Lloyd, 1987), whilst another showed that there were no differences in computer anxiety once effects due to computer access were controlled (Campbell, 1989). Other studies on attitudes and experience have also found that more experience is associated with lower anxiety and more positive attitudes (e.g. Colley, Gale & Harris, 1994; Martinez & Mead, 1988; Ogletree & Williams, 1994; Sutton, 1991; Williams, Ogletree, Woodburn & Raffeld, 1993; Dyck & Smither, 1994) and lower levels of anxiety (Maurer, 1994).

There is research, however, that has found that even where girls and boys express equally positive attitudes, both believe that boys like and use computers more than girls (e.g Hughes, Brackenridge & MacLeod, 1987). However, while some studies have concluded that both boys and girls see the use of the computer as an activity that is somehow more 'appropriate' for boys than for girls (e.g. Wilder, Mackie & Cooper, 1985; Brosnan, 1999) and that in schools the computer tends to be regarded as a 'machine for men and boys' (EOC, 1983), this is not always the case. Sutton (1991), for example, reviews a large number of studies that have explored students' attitudes towards the computer 'as a male domain'. The students in these studies ranged from first graders to high school students in Canada, the UK and USA, and the overwhelming finding was that males hold more stereotyped views than females. This finding supports the contention that males are more susceptible to sex-role stereotypes than females (Durndell, Glissov & Siann, 1995; Fletcher-Finn and Suddendorf, 1996; Shashanni, 1993). So despite the rather weak theoretical discourse in the 'computer attitude literature', it does appear that while girls and young women may appear to be 'absent' from the domain of computer use, many may in fact be rather positively disposed towards computer technology.

Computing ability: At this juncture it is maybe worthwhile mentioning that what is not at issue here is girls' ability to engage with computer technology. Girls are frequently observed to be competent, skilful and successful computer users (Eastman & Krendl, 1987; Finlayson, 1984; Issroff, 1994; Light & Colbourn, 1987; Linn, 1985; Yelland, 1998; Webb 1984). However, what is equally clear is that many girls do not voluntarily choose to participate in computing and computer-related activities (Wood, 1998). This finding resonates with everyday experience, where men are seen to run the computer companies, dominate the computer services industry and all aspects of leading edge development in digital technologies. The question remains as to how best to foster girls' participation in computing? The answer to this question depends on how the problem is conceptualised, but clearly moves us into Stage 2 of our framework.

Stage 2: Changing female participation in IT activities

One approach to fostering women and girls' engagement with IT is to focus specifically on girls and women in terms of educational efforts. By implication the problem is defined as a 'problem of the female sex' and the relationship between males and IT is defined (more or less implicitly) as an ideal which girls ought to emulate. The problem is 'the girls' rather than the 'culture of computing'. Stage two initiatives for fostering female engagement with computer technology focus on strategies such as the presentation of positive role models and organisational provision of for example 'girls only' computer sessions.

Women Role Models: The need for positive female role models is frequently emphasised in any discussion of poor female participation. In relation to computers, Newton and Beck stress the need for new images of women working with computers that portray women as competent participants rather than as 'decorative sexual objects or as silly brainless creatures - incapable of understanding anything about computing' (Newton & Beck, 1993, p.143). They also argue that it is important to promote women with good communication skills who are already working in computing and can serve as realistic role models. (Newton & Beck, 1993). Others, for example, Reinen and Plomp (1993) emphasise the role that female teachers can play as positive role models for young girls. The potential value of this kind of role model is recognised by many female teachers: 'wherever we teach we need the confidence to act as role models for our students and sometimes our colleagues in the use of computers for writing....." (Beer, 1994, p.28). However, Reinen and Plomp use data derived from a large international study involving twenty one countries to demonstrate that such positive role models are typically few and far between. Female teachers are often less confident computer-users than their male colleagues and hold a low regard for their skills and knowledge. This finding was confirmed in a study using path analysis techniques which concluded that male teachers have a higher degree of self confidence in their knowledge about computer technology than female teachers (Hansen, 1993).

Mixed gender groups and computer use: Observations of male dominance as described earlier in the chapter, have led some researchers to conclude that girls' lack of engagement with computer-based activities may, at least in part, stem from their often unsatisfactory experiences of computer-use in the classroom. At the same time positive engagement with computers has been noted among pupils in girls-only schools. These twin observations have prompted enthusiasm in some quarters for segregating girls from boys for computer classes. The hope is that girls in girls-only groups will be less inhibited and will learn more. However, while experimental research has sometimes indicated that girls are particularly disadvantaged by working with boys (e.g. Underwood, McCaffrey & Underwood, 1990), this is by no means always the case (e.g. Hughes, Brackenridge, Bibby & Greenhough, 1988; Littleton, Light, Joiner, Messer & Barnes, 1992).

The effectiveness of single gender groupings for IT is still a matter of debate. Some, for example, Willis and Kenway (1986), point to potential problems with such a course of action. They explain, for example, that it is possible teachers would regard the girls' classes as of lower interest and ability than the boys' groups and consequently have lower expectations of them:

> 'separating out girls from boys (boys from girls) will not, in itself, change the perceptions of the teachers and administrators in the schools, any more than it will automatically change the attitudes of the students themselves.' (Willis & Kenway, 1986, p. 145).

So while the strategy of segregating boys and girls for computer-based work holds the superficial appeal of side-stepping potential male domination over resources both physical and human, it could result in attention being diverted away from the important issue of curriculum reform. Willis and Kenway maintain that if schools are to consider adopting single sex classes, they must ensure that this organisational change is not a substitute for the examination of curriculum content, teaching methodologies and assessment practices – all stage three concerns. In any event, any decision to implement changes to the gender structure of classes within a school necessitates sensitivity to the children's socio-emotional experience of separation and segregation and ultimately careful management of the transition back to mixed-sex teaching (Kruse, 1996).

Culley (1993), mindful of the comments of Willis and Kenway, is tentative about advocating segregation as an effective intervention strategy for lesson-based computer work. She sees the need for teachers to develop an understanding of classroom dynamics and the ways in which boys may come to dominate the computer classroom. Classroom management strategies, she argues, need to involve girls more centrally and pupils must be made aware of the likely patterns of gender interaction. Culley does, however, believe that there is a strong case to be made for ensuring that girls have access to free-time use of computers in girls-only settings, where they can 'tinker' in a supportive environment.

She adds that any such girls-only sessions should be supervised by teachers who are both competent in computing and sensitive to gender issues (Culley, 1993, p.156).

Research in more experimental settings underlines the importance of careful design of tasks and pedagogy. In a study of the factors associated with learning mathematics in groups with computers, great care was taken in designing activities that exploited the computer interactions in ways that were integrated with learning goals and with group discussion (Hoyles, Healy & Pozzi, 1994). The research used a multi-site case study design in six schools and involved eight groups of six mixed-sex, mixed-ability pupils undertaking three research tasks using computers. Quantitative analysis of learning measures indicated positive learning gains as a result of the groupwork with no differences across gender and ability. The findings suggested that organising for balanced co-construction at the computer coupled with the co-ordination of others' perspectives was most advantageous for learning. This was unlikely to take place when there the task was technology-driven or the collaborative work disrupted by antagonism among the group participants which in these circumstances invariably split on gender lines (see also Healy, Pozzi & Hoyles 1995).

The potential problems associated with a reduction in the opportunities for interaction between boys and girls have been noted in recent experimental work conducted by Light, Littleton, Bale, Messer & Joiner (in press) (see also Light, & Littleton, 1999). They reported that gender differences in performance in mixed gender groupings did occur, but only when the children worked alongside one another without opportunities for interaction. When the group actually collaborated the same polarisation did not seem to occur.

Collaborative working with IT: The use of the computer is often regarded as a solitary and isolating activity involving mastery of a machine. There is evidence that girls find this mode of computer use alienating, particularly when coupled with competition (Hoyles, 1988). This way of working contrasts with the more collaborative project work encouraged in the constructionist tradition, where students help each other to build and debug their programs and models (Papert, 1998). Under these conditions, girls appear to be just as enthusiastic as boys in their response to computers (e.g. Hawkins, 1984; Hattie & Fitzgerald, 1988; Hoyles, Sutherland, & Healy, 1991). The study mentioned earlier on group-work with computers also supports this position.

A similar picture emerges from a range of classroom accounts (eg. Burke, Edwards, Jeffries, Jones, Miln, Mongomery, Perkins, Seager & Wright, 1988) which together stress the importance of a collaborative mode of working for girls' effective use of computers. Indeed, Pryor (1995) argues that by establishing and nurturing collaborative groups, teachers can create a classroom culture that is liberating for both girls and boys. There are of course thorny issues concerning what makes for appropriate pedagogy (Head, 1996) effective working partnerships (Light & Littleton, 1994) how to promote successfully an ethos of collaboration (Watson, 1997; Underwood & Underwood, 1999; Littleton, 1999), what is valued as success by the teacher (Hoyles, 1988). Carmichael, Burnett, Higginson, Moore & Pollard (1986) found that boys enjoyed working speedily to achieve the challenges set, but that girls' interest declined as their more careful efforts were not acknowledged: 'Boys get commended for things that girls can do, but we complete it half an hour later and it doesn't matter then' (Moore, 1986, p.7). This leads us naturally to the discussion of what IT actually is. Is it about domination over hardware and software, is it about speed of response or is it more concerned with sharing information, building systems collaboratively and interacting with the technology in pursuit of learning goals?

Stage 3: Challenging the dominant paradigm of IT use in school

The interventions described under Stage 2 provide a basis for action to combat the gendering of IT, since they begin to question what the computer is and what computer activity should involve and start to problematise the prevailing culture surrounding computer use. We distinguish two foci that require attention in order to achieve more equality of access and performance, these relate to 'epistemological pluralism' and the 'embedding' of the technology.

Epistemological Pluralism: In her discussion of computer programming, (1984a; 1984b; Turkle & Papert, 1990) argues that many girls and women find the experience of computer-use uncongenial because it imposes upon them a 'top-down', formal-analytical method of working. Bringing females into the computer culture requires taking a critical look at the social construction of the computer and the ways made available to control computer activities: 'we must recognise that that which can be characterised as male mastery is not the only kind of mastery' (Turkle, 1984a).

Turkle discusses computer programming which she argues is often conceptualised as masculine, abstract, mathematical and only for the 'techies'. Clearly this is the case in some high level languages such as PASCAL. But with some languages and with some activities, it need not be conceived in this way. Programming can be bottom-up, flexible and intuitive – even convivial (Kirkup, 1992). This was the case in the 80's when Turkle wrote The Second Self. She identified the need for epistemological pluralism even when children were engaged with text-based symbolic languages. Now computer technology can exploit 'multiple representations' (including the visual alongside the symbolic) and diverse modalities of interaction including direct manipulation, speech, even gesture (Ainsworth, Wood & O'Malley, 1997; Noss, Healy & Hoyles, 1997). Systems effectively can now allow children to choose the tools they need to solve problems, build their own solutions iteratively through a process of learning from feedback. Epistemological pluralism is now an even more realistic goal that could be exploited to the advantage for females.

Embedding technology: The constructionist vision of computer use presupposes that IT is an integral part of classroom life with the computer regarded as a potentially powerful tool to be used as and when appropriate - one tool among many. The technology is embedded in ongoing classroom activities and avoids the danger that it is seen merely as an adjunct to them (Healy & Hoyles, 1999). Children need to develop a form of computer literacy that enables them to make informed decisions about what IT can and cannot do for them. They need to know when it is useful to use a spreadsheet or calculator, how to interpret the output from databases and of course how to search for information on the web. Once computers are separated from work in subject domains, the male computer lab culture can all to easily emerge.

This takes us to the latest and potentially most pervasive use of IT in schools - namely interacting with the web. Government figures in England show a dramatic increase in Internet access, as shown in Table 2.

Insert Table 2 here: Percentage of schools and teachers with internet access in England. HSMO, 1999.

As the web becomes more and more ubiquitous, the computer is rendered almost invisible. But new skills are needed. Not in this case the constructionist skills of building from feedback but sifting and interpreting information. As Baylis, 1998 (in the RSA report ‘Redefining Work’) suggests:

> ‘There will be no premium to be gained from the acquisition of information for (in the future) people will have easy access to quantities of information beyond our present ability to grasp. What will be important is the development of critical skills (in all senses) to use information and to evaluate it.’ (Baylis, 1998)

Challenging the paradigm: We have argued that challenging the paradigm of computer use in schools central to developing a more gender-inclusive view of IT means that attention must be paid to epistemological pluralism and model building, to the embedding of the technology in ongoing work and to collaborative social interactions as well as the interactions with the technology. Yet evidence suggests that these criteria are rarely satisfied.

It is rare to find a constructionist approach to learning which focuses on learning from feedback in today’s classrooms. What does make it into the classroom is more often sophisticated technology used to ‘deliver knowledge’ such as that deployed in Integrated Learning Systems (ILSs). The learning paradigm is one where the student is seen as deficient and in need of ‘remediation’ achieved by the presentation of sequences of tasks devised on the basis of the students’ learning history. Student responses provide data that determine the nature of future work – a model of learning reminiscent of programmed learning in the 60’s and 70’s.

Turning to the second criteria, computer use still tends to be de-coupled from other classroom activities, separated physically in specialised laboratories with specialised teachers, and expertise. Yet the image of computer use is changing. Not in school maybe but outside school. More and more people are using computers as part of their everyday life to obtain information from the web, to buy goods, and to e-mail their friends – and children are in the forefront of this revolution. Papert (1996a, 1996b) has, perhaps controversially, argued that schools will eventually wither away as students take charge of their own learning. But if the stimulus for change comes from the home are females less likely to be excluded from computer use than before? There is every chance that the same patterns of exclusion will continue with females reluctant to engage with computer activities. As the boundary between these two worlds of IT-use at school and home become more blurred it seems appropriate to turn to a consideration the dominant culture of home computer use, namely the computer game.

The prevailing paradigm at home: Games and how to change them: For many children, their early experience of computer-use occurs within the home and often involves playing computer games. Boys have considerably more experience of computer games than girls (Subrahmanyam & Greenfield, 1994; Yates & Littleton, 1999) and they tend to be more enthusiastic game players. Female gamers are few and far between. This is no doubt at least in part accounted for by the male-oriented nature of computer games, which frequently depict violence and portray women as sex objects (Stutz, 1991; Provenzo, 1991; Dietz, 1998). The plea for 'girl friendly' computer gaming software has been made frequently (see Sutton, 1991). Yet it is difficult to characterise what constitutes 'girl friendly' software. We know that the metaphors used in the presentation of a game exert a powerful effect on girl's engagement with and conceptualisation of it

(Littleton, Light, Joiner, Messer & Barnes, 1998), but we also know that the simple substitution of female characters for male characters is not sufficient to ensure girls' engagement (Joiner, Messer, Littleton & Light, 1996). The huge computer game industry has recognised a potential market for girls and this has been at least partly filled by a new wave of hugely successful games – some still sex stereotyped (Barbie in the shopping mall) while others more gender-neutral involving narrative and strategic approaches (Purple Moon). Cassell and Jenkins (1998) present an excellent summary of the evolution of these games.

Computer games are an important part of children's culture. Is there a way that this engagement can be exploited for IT-use in school without disadvantaging girls? Current computer games typically cast children in the role of game-player, playing according to rules programmed by someone else - a situation which, however motivating, sets strong boundaries around what might be learned. Children's fascination with computer games is almost entirely at the level of interface. That is, manipulation of the game objects is fun, expressive and engaging. But for the most part, the interface is all there is: the level below the interface is the preserve of the programmers and designers, not the user. A way to make computer game playing constructionist and to open a window on learning is to place children in the role of producers as well as consumers of games. This is the aim of an ongoing project, the 'Playground' project (Hoyles & Noss, 1999) which is building on the work of Papert (1998), Kafai (1995), Harel (1988), Klawe and Phillips (1995), and Rubin (1995). 'Playground' is developing two platforms on which children can create and play their own games: an animation-based computing formalism called ToonTalk (Kahn 1999), and a new, concurrent object-oriented version of Logo.

To illustrate our approach we will briefly describe now how two girls and then two boys changed a simple game so it fitted more closely what they wanted to play. We describe this case study to show how it is possible for students themselves to shape the prevailing computer culture while following a constructionist agenda.

We wrote a very simple 'Pong' game in ToonTalk. This original Pong game was a two-player game, where one player controls the top paddle using the keys SHIFT and CTRL to move the paddle left and right, and the other uses the mouse to move the bottom paddle left and right (see Figure 1). The ball bounces around and the players must each try to hit it with their paddle. The score (bottom right hand corner) increases by 10 points whenever the top paddle hits the ball.

Insert Figure 1 here: The 'Pong' game.

We gave the Pong game to one pair of 7 year-old boys and one pair of girls of the same age. The children were asked to play the game and to change it if they wanted to make it more enjoyable for them and their friends. To change the game the children had to have a certain level of familiarity with programming in ToonTalk and all the children had been working with ToonTalk in an after-school computer club for about three months. They were therefore relatively familiar with the metaphor and the simple tools available. First we describe the work of two girls.

The girls' case study: From 'Pong' to 'Underwater': At first the two girls Harriet and Roberta simply treated Pong like a 'sport': as they put it, 'it's like tennis'. As they played, they soon worked out that the score was changed by the top paddle. They thought the game was rather boring, so we wondered if the girls wanted to change the game, which took us to the first phase of game evolution.

I:	How can you change the game?

H:	Could have two scores, one for bottom one for top.

H:	Make it more colourful… it's a bit dark.

H:	You could have… like the paddle as a fish.

R:	I've got an idea: Bammer hits the thing down and hits the ball.

Out of these ideas they first implemented the change in colour - to light blue. This is trivial in ToonTalk, achieved by hitting the space bar. They had decided to make the paddles look like Bammer - a special animated mouse in the ToonTalk world, so we asked:

I:	How will you get Bammer to behave like the paddle?

H&R:	I know — you stick the paddle on the back.

The two girls were referring to a general method for exchanging behaviours in ToonTalk. On the back of any picture are its behaviours, as illustrated in Figure 2. The girls knew that if you flip over a new picture, flip over the paddle, and put the paddle on the back of the picture, then the picture will inherit the paddle's behaviours.

Insert Figure 2 here: The paddle and its behaviours.

Next they changed the ball to look like a bird.

I:	That's horrid! [i.e. the bird is being hit by a hammer!]

H & R:No, no it's flying up and down, up and down — it's OK.

This was achieved exactly in the same way as the change of appearance of the paddle. They also changed the colour of the background at the bottom to be yellow (see Figure 3).

Insert Figure 3 here: Changing the appearance to Bammers and Birds (Bammer is the animated mouse with a large hammer).

The changes in colour stimulated more ideas, and it seemed to support the girls' inclination to build an underwater narrative. They were full of ideas as to what the screen could signify and were willing to suspend conventions of reality, and indulge in make-believe play.

H: I know… that's like the sea and he's [Bammer] running down into it! Cos that's like there's a hill and there's sand going down.

R: There's a problem! He's walking on… the water!

H: It doesn't matter.

The new game is no less boring in terms of playability than the first version. Yet the girls found it far more compelling because they had made it. They also became less concerned about scoring. We only encouraged them to implement the (simple) picture changes at this point. This indicates the importance of the interactions with a more capable other (such as a teacher) who is able to judge what is possible as well as desirable in computer interactions at a particular time and for a particular group of children. It was clear that Harriet and Roberta needed extra playground elements for their underwater world such as pictures of fish and sounds. We developed these and stored them in libraries for them to access later.

In the next session, we gave Harriet and Roberta some new pictures of fish and they picked out the shark picture for the paddles. Roberta wanted to have lots of fish bouncing up and down, (an idea she had picked up from the boys who had made multiple balls for their game).

H: But if the fish reach the top or bottom then they make another fish?

R: And also they take away from your score.

This latter suggestion requires a different sort of transformation incorporating a penalty scheme in addition to the scoring one. In fact they simply changed the paddles to sharks, now an easy manoeuvre as they had already changed the paddle to be Bammer. The girls were changing the appearance of the game and programming at what we termed ‘the picture level’. They simply put the paddle on the back of the shark picture. They also changed the ball to a fish by putting the ‘ball with all its behaviors’ on the back of a fish, and then copying it many times with another tool which copies objects and all their inherited behaviors. Their game now looked like Figure 4.

Insert Figure 4 here: Changing the appearance to sharks and fish.

Once Harriet and Roberta played with the shark and the fish, they immediately wanted to make more changes - changes in the rules of the game as well as its appearance.

R: The sharks are the paddles. And if one of those hit the sharks -

H: - any of them -

R: it goes like this [R chomps]

H: No it doesn't.

I: That's what you want?

H: This is what we want.

R: We really want to make more of the balls and when it comes they go [chomp] and if you press a button it spurts out again.

So the girls wanted a new sound that would be played whenever the shark hit the fish. This was rather harder to manage: they needed to get further into the system. Next, the girls tried to build a game that was more realistic by changing another rule: every time a fish hit a shark, instead of bouncing off, it would be eaten. This idea made the pair think of new ways to win - which shark eats the most fish!

In this chapter it is not possible to illustrate all of the phases of their game evolution. We simply summarise: first they made the shark eat the fish, then they made many fish and changed the scoring system so the game had two scores, one for each shark. After help with this final phase, their game looked like Figure 5.

Insert Figure 5 here : Shark game with two separate scores.

The boys' case study: Simulating football and cricket: We also gave Pong to two boys, Rashid and David, who despite having a personality conflict played together fairly successfully. But they came up with few ideas as to what to change. They added cars and rockets, but did not come up with a new game. Rather, they simply accumulated different pictures, noises and behaviours. David wanted to make a cricket game, so Rashid explained how he would like it:

R: there's a man and he has a bat if the number …you can move the man with the hand if you go near a number you have to hit it with the bat…

Both boys could only talk about the cricket game as if it was a real cricket game. They did not appear to appreciate what could or could not be implemented, or how the game could be improved by being on the computer. We helped them design a cricket pitch, gave them a picture of a cricketer and stumps, and a working ball (see Figure 6).

Insert Figure 6 here: David and Rashid's first cricket game.

When they asked how to play the game Rashid wanted simply to simulate the real game of cricket:

R: I want a bowler ... I want it like cricket.

R: put that wicket at the front and a ball comes along and that man hits it and if it hits the wicket he's out and if it goes over the wicket he's not out. … He hits it and if he hits the wicket he's out.

At this point Rashid turned to make a football game and again the boys only referred to actions in a real football game; the characters, the team names and so on were all real.

They did not talk about a computer version of a football game nor did they at any time suggest that anything in their game could or should be different from reality. They even gave their football teams names, Arsenal and Watford.

What is surprising is that we expected boys to have played many computer games and therefore be more ready to suspend reality. But while talking about building games and during design, they were not willing to move away from reality and play with the rules. They changed the game in ways they liked – but into an activity that was clearly part of their culture.

Celia _ insert line or two bringing the two parts of the case study together??

Conclusions

In this chapter we have traced the development of female's participation in IT in school. We have argued that girls' disengagement from computer work may be compounded by the computer-based activities with which they are required to engage. Technologies inevitably arise in the context of existing social relations and for this reason are likely to result in the reproduction, even the magnification, of these forms of relationship. We are aware of the danger of creating digital under-classes and must guard against this in terms of gender. The same technologies can open up possibilities for the transformation of social relations if we seek out and create the conditions for achieving such a transformation. As computer use has changed dramatically, we have pointed to the danger of schools still imposing a style of IT use which not only disadvantages girls but is fundamentally at odds with computer use and interactions at home. Clearly for IT to be useful for all children in schools, it must encourage diversity in interaction and models of learning, to expand rather than constrain horizons. The way IT is defined in school in terms of curriculum, assessment, activities and images of success will fundamentally shape students' views of the meaning of education.

At the same time, children are creating their own definitions of computer-use, largely in the context of computer games, which all too often can suffer from gender-stereotyping. We have suggested one way to avoid this. It capitalises on the potential of computer games for learning by allowing children to some extent to design, build and modify their own computer games. It is possible that in this process the image of the computer game will change for the benefit of all children. We presented two case studies that serve to illustrate this potential of allowing children to build their own games – to define the culture in which they can play, to define what they mean by IT. But challenging the paradigm with respect to the culture of home computing does not mean that girls have to be 'converted' into enthusiastic computer-game players. Girls can of course be empowered to use home computers for activities other than gaming.

In thinking about the computer culture, we must also challenge some of our own assumptions and expectations concerning children's relationship with computers. All too often it is assumed that high levels of enthusiasm for computers are unquestionably a good thing. This is the implicit assumption underpinning the design of many of the computer attitude scales referred to earlier in the chapter. Yet from in-depth interviewing of girls and boys about their use of computers, it is clear that when asked about their use of computers, children often talk about the penalties associated with being too enthusiastic a user - you risk being characterised as a 'boff' a 'geek' or a 'jonah' (loner) (Littleton, Artis & Oostewegel, in prep). As researchers, we often study girls' and boys' engagement with computer technology without recognising the way in which our own interpretations of the children's behaviour could be open to alternative readings. A striking paper by Elkjaer (1992) represents a good case in point. These authors present a detailed analysis of boys' dominance and extensive use of computer technology and offer a full interpretation of this as behaviour borne of insecurity rather than confidence. In doing this the author illustrates that through our tendency to characterise boy's relationship with computer-technology as positive and unproblematic, we may be failing to acknowledge and address the problematic facets of the male relationship with computer-technology. Challenging the paradigm will thus involve being continually open to alternative readings of research findings and constantly questioning the basis of our own analyses and interpretations.

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Table 1: Expenditure on computers for teaching and learning in England

	Primary		Secondary	
	1998	1999	1998	1999
Expenditure £million on computers for teaching/learning	49	105	119	136
Average spend £ per pupil on teaching/learning	11	27	38	45

Table 2: Percentage of schools and teachers with Internet access in England

	Primary		Secondary	
Schools with access to the internet	17	62	1998	93
Schools with ISDN or higher connectivity		58	83	70
Teachers using the Internet		51		87
Pupils using the Internet		29		63
Teachers with personal email addresses	2	15	9	32
Pupils with personal email addresses		4	3	12

(*Survey of information and communications technology in schools* 1999 HSMO)

Figures

Figure 1

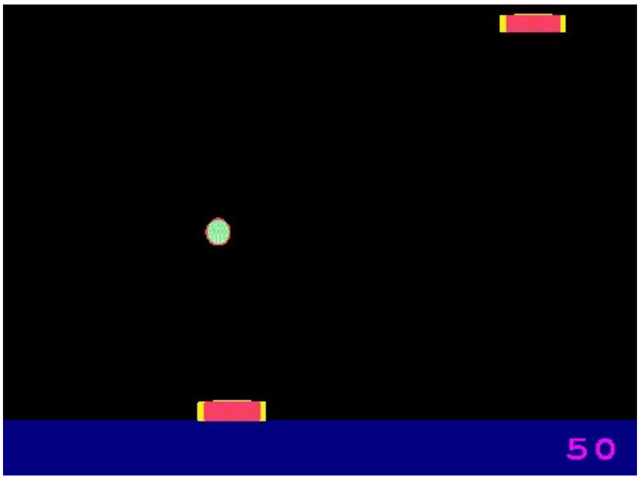
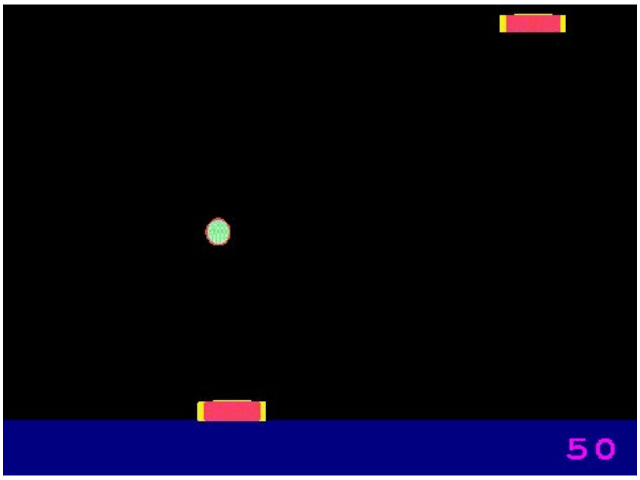


Figure 2



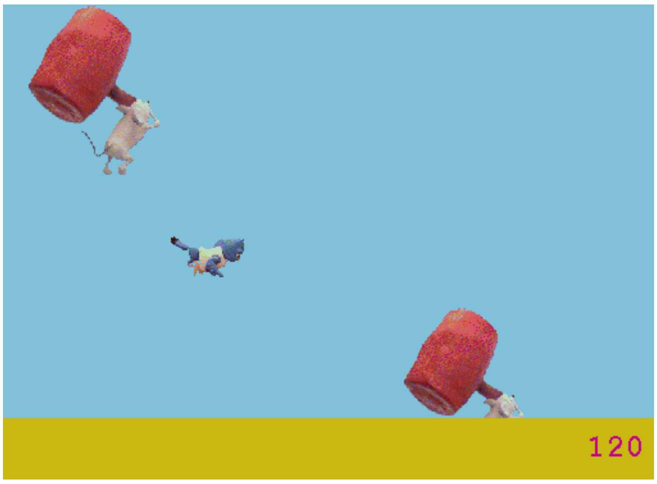


Fig 3 (above)

Figure 4

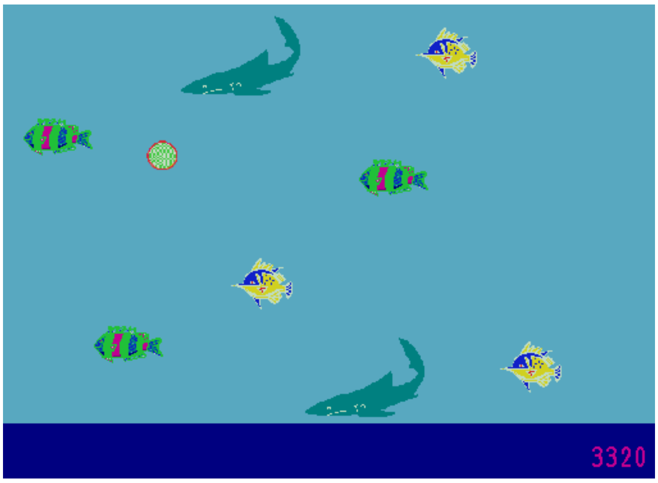


Figure 5

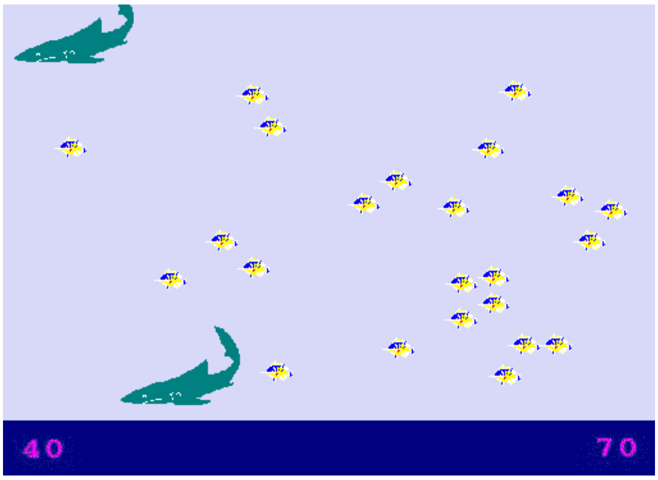


Figure 6