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Rethinking the 'problem' of gender and IT schooling: discourses in literature

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Abstract:

A review of the international research literature pertaining to gender and information technology (IT) schooling reveals changing ideas about what constitutes a gender problem. Much of the literature is concerned with gender differences in computer uses and interests and perceived disadvantages accruing to females as a result of these differences. This reflects and contributes to a dominant liberal equity discourse. Growing awareness of the limitations of earlier research, the changing nature of IT schooling, contradictions in students' computer interests and dissatisfaction with simplistic explanations has led, however, to post-structural rethinking and the emergence of a critical discourse. Assumptions of essential differences and deficit ways of thinking are challenged. Persistent gender differences in IT use are explored in their social complexity and the very notion that there is a gender problem is problematised. This presents a different and ultimately more satisfying way of thinking about the problem of gender and IT schooling.

Key words: academic discourse, computer science education, gender, gender issues, information science education, information technology

Introduction

A populist notion of gender and IT schooling has it that there is a problem. Specifically, that there is a problem in the underrepresentation of females in computer education and careers. This translates into concerns about the nature of IT schooling and of girls themselves in their apparent reluctance to engage in computing. However, the problem can be conceptualised in different ways, reflecting and contributing to different discourses pertaining to gender and IT schooling, which are evident in a review of the gender and IT schooling literature.

Discourses are defined in the Foucaultian sense of sets of concepts, beliefs and practices that define and influence thinking on an issue. They are determined historically and characterised in terms of what it is possible to think and say and the sorts of questions that can be asked (McLaren, 2003; Quicke, 1998; Reed, 1999). At any one time there are multiple, overlapping and coexisting discourses. The ideas of discourses and discursive practices have been appropriated in a range of educational research. For example, within a Marxist framework discursive practices are seen to inscribe power relations where the discourses produced by a dominant group constitute "regimes of truth" that define the thinking and practices of educational institutions (McLaren, 2003, p.83). In post-structuralist feminist analyses, discourses provide a way to understand how sex and gender are constituted and the normalisation of gender power relations (Moore, 2004; Weiner, 1994). In the context of gender and IT schooling debates, analysis of discourses provides a view of gender differences in computer use that goes deeper than awareness of those differences to an understanding of various interpretations of difference that may provide explanations for the success or otherwise of policy developments and have implications for future policy responses.

The research literature pertaining to gender and IT schooling of recent decades can be located within two main discourses – a dominant liberal equity discourse and a post-structural critical discourse. The former is concerned primarily with issues of equality of opportunity, assuming that progressive reforms can and will provide remedies for gender inequities; the latter with issues of social justice, problematising the institutions of society and education and highlighting the evolving, complex and

contradictory nature of society and individuals (Marshall, 1997; Moore, 2004). The critical discourse suggests that the 'problem' of gender and IT schooling may not be as simple as it first appears and that it may relate as much to how we think about it as to specific evidence of gender differences.

Gender Equity Discourse

The literature of three decades describes persistent gender differences in access, use and attitudes to computers in a range of national contexts. This has led to the idea that computing is masculine activity and to concerns about female alienation and disadvantage. The discourse tends to be couched in terms of a male norm and female deficit.

Access, use and attitudes

Boys are typically reported to use computers more often than girls at schools and at home, to dominate the technology and commandeer the most up to date computers, to have higher participation rates in specialist computing classes and computer clubs, and to have greater experience of particular activities including programming (Chen, 1986; Crombie & Armstrong, 1999; Crawford, Groundwater-Smith, & Millan, 1990; McKinnon & Nolan, 1990). Some exceptions to the rule of male domination of computing activities are identified. For example, in an early North American study, Becker and Sterling (1987) detect word processing as the only area where girls dominate in computer use. In the British context, Durndell, Glissov and Siann (1995) find exceptions relating to the use of computers at school for playing games and outside of school for word processing. However, these exceptions support the general argument that there are enduring gender differences in students' access to and use of computers.

General levels of access to computers in the developed world have reportedly improved. Nevertheless, recent literature highlights persistent gender inequalities relating to computer access and use (Clegg & Trayhurn, 2000; Colley & Comber, 2003). These are accounted for as functions of socio-economic status and home situations. In particular, it appears that students from lower socio-economic circumstances and cultural minorities continue to be excluded from engagement with

computers and girls tend to be excluded to a greater degree than their male peers (Butler, 2000; Hackbarth, 2002; Volman, van Eck, Heemskerk, & Kuiper, 2005).

Issues of access and use are often linked to ideas that males and females prefer different computing practices and have different attitudes towards computers. In early literature, girls are reported to prefer communications applications and activities focused on presentation and writing, such as word processing, and boys to prefer computer games and mathematical applications (Becker & Sterling, 1987; McKinnon & Nolan, 1990). Subsequent literature reports persistent gender differences in preferences for different applications. In particular, males are observed to dominate gaming and to have more experience of the Internet than girls (Jackson, Ervin, Gardner, & Schmitt, 2001; Schumacher & Morahan-Martin, 2001; Wilson, 2002). It also suggests, though, that patterns of use and gender preferences have changed as males and females have become more frequent computer users and computers have become a ubiquitous feature of everyday life. For example, Colley and Comber (2003) note that information and communication technology is now much more widely used in the school curriculum and that there is evidence of a reduced gender gap regarding students' use of word processing, graphics, programming and mathematics applications. Also, they find no overall gender differences in frequency of use of recently developed technology, such as e-mail, the Internet and CD ROMs. Others similarly find that boys and girls access and use computers regularly for entertainment, particularly the Internet, although they may use the Internet differently (Gardyn, 2003; Papastergiou & Solomonidou, 2005; Volman & van Eck, 2001).

In respect of students' attitudes to computers, females are commonly identified as having less positive attitudes towards computers than males (Jackson et al., 2001; Kramer & Lehman, 1990; Mitra, LaFrance, & McCullough, 2001). Girls are portrayed as less confident, more tentative and anxious computer users and as having lower levels of self-efficacy, particularly in relation to programming and computer science (Chen, 1986; Colley & Comber, 2003; Crawford et al., 1990). They are also observed to be more cautious in their assessments of the value of technological innovations and more sceptical and willing to question the utility of a computer compared with other information sources and modes of processing information (Beynon, 1993; Chambers & Clarke, 1987; Crombie & Armstrong, 1999). Gender

differences in attitudes and preferences are observed to cross cultural boundaries (Durndell & Haag, 2002; Huber & Ward, 1998; Kadijevich, 2000).

Some account for attitudinal differences as matters of learning orientation (including, Crawford et al., 1990). Turkle (1984) theorises that males and females approach computer programming differently. Girls, she suggests, tend to be 'soft' masters, while boys are almost exclusively 'hard' masters. Hard mastery involves the imposition of will over computers through the implementation of a premeditated plan. Soft mastery is more intuitive and interactive. It involves tinkering and is the approach of the artist who works with materials. These two approaches reflect Levi-Strauss' concepts of the scientist and the *bricoleur* (Turkle, 1984; Turkle & Papert, 1990). Some account for differences in girls' and boys' preferences and approaches as matters of learning styles and fundamental cognitive differences (Culley, 1993; Hoyles, 1988; Littleton, 1996; Selby & Ryba, 1993). Females are described as task-oriented users who focus on utilitarian functions of computers and on the end product. In contrast, males are described as power users who are machine-oriented and for whom the computer is a toy to be manipulated for its own sake. Males are reputed to be more individualistic and competitive in their computing orientation and females to be more socially inclined.

There are, then, clearly identified historical gender differences in use and attitudes to computers. However, care needs to be taken when extrapolating to schooling contexts of the new millennium. Research from the 1980s and 1990s tends to focus on a limited range of IT practices and not to distinguish between types of applications in reporting on students' attitudes to computing (Mitra, Lenzmeier, Steffensmeier, Avon, Qu & Hazen, 2000; Volman & van Eck, 2001). This gives a partial and potentially misleading view of students' attitudes. In particular, focusing on a computer science model of computing tends to highlight those things about which females are most negative and fails to identify those aspects of IT that they are reputed to find more enjoyable and about which they are more confident, such as word processing and communication applications. This may misrepresent females' involvement with and attitudes towards computers.

Male domain and masculine culture

The existence of gender based preferences and male dominance of particular forms of computing has lead to the idea that computing is a male domain. A masculine culture of computing is seen to have sustained a gendered domain. It has been argued that skill with computers is more socially approved in the culture of adolescent males than females (Chen, 1986), that the image of computing has become predominantly a male image associated with notions of 'boys' toys' (Newton & Beck, 1993) and with male traits or symbols of control, aggression, analytical processes and technological power (Cockburn, 1985; Culley, 1993; Wajcman, 1991). It is contended that cultural symbols of computing, with their strong male associations, are far more likely to alienate girls than boys and that this accounts for the historical absence of females in computing work and education.

Various factors are cited as contributing to the creation and sustenance of a masculine computer culture. For some, it is a matter of socialisation and pervasive gender stereotyping in families, social groups and the media (Dryburgh, 2000; Schulz-Zander, 1990). Others highlight teaching practices and school structures that produce and reproduce a male computer world (Beynon & Mackay, 1993; Crawford et al., 1990; Littleton, 1996; Watson, 1993). Boys are observed to claim superior knowledge, dominate discussion and teacher time, dominate the machinery and make girls feel unwelcome or inadequate (Beynon & Mackay, 1993; Culley, 1986). The attitudes and actions, or inaction, of teachers are seen to discourage females from participating in computing activities and to reinforce masculine computing culture – albeit unwittingly. For example, it has been suggested that pedagogical practices that leave students to learn by themselves are particularly problematic for girls. Boys are more likely to be able to draw on prior experience and girls are penalised for a comparative lack of access and lower use of computers at home, a situation that is compounded by patterns of computer use in the classroom (McKinnon & Nolan, 1990).

The computer industry is also held responsible for promoting a masculine computer culture, especially in the field of computer gaming. Games software, it is argued, is developed mainly for a male market and the stereotyped images and subject matter

tend to be of greater interest to males than females. Also, it is thought that males tend to be more comfortable with the competitive nature of gaming. Girls, it is suggested, are inclined to view computer games as boys' toys and find the computer gaming environment hostile, socially inappropriate, offensive or boring (American Association of University Women [AAUW] Educational Foundation Commission on Technology, Gender and Teacher Education, 2000; Crawford et al., 1990; Culley, 1993).

The idea that a masculine computer culture is anathema to females supposes that the way in which males act around computers is discomforting for females. There are different views, though, on the nature of this discomfort. Learning styles theories relating to cognitive differences suggest that females are put off by a male way of working, which is characterised by rational, logical and systematic approaches to computing (Culley, 1993; Hoyles, 1988). Conversely, Sofia (1998) argues that it is masculine irrationalities – the competitiveness, passions and fantasies exhibited by males for the technology – rather than rationality and logic that tend to alienate females and turn them off computers. This irrationality is legitimated in the culture of computer gaming and technophilic approaches to computer learning. Turkle and Papert (1990) contend that computer technology supports epistemological pluralism, that is, different approaches to computing and programming, but that such pluralism is not supported by the dominant male computer culture.

Thus, there is a strong thread in the research literature that describes computing as a male domain, supported by a masculine computer culture. By implication, different computing practices could be seen to constitute female domains and feminine culture. The literature of the 1980s and 1990s has little to say about female domains, though, focusing as it does on computing practices that have historically been dominated by males.

Female disadvantage and deficit

Gender differences relating to computer use and a lack of female involvement in particular domains of practice have been presented as a gender equity problem. The imperatives of the information age have created a widely held view that computer competency is a condition of citizenship and that to be computer illiterate, or less

knowledgeable and skilled with computers than others, is to be economically and socially disadvantaged (Crombie & Armstrong, 1999; Spender, 1995). A discourse of disadvantage is clearly evident in international literature. Girls are presented as a disadvantaged group because they lack breadth of experience and specific experience in 'hard' computing fields such as programming and systems analysis, being over represented in 'soft' computing areas that include graphic art and office applications (Chambers & Clarke, 1987; Selby & Ryba, 1993). Drawing on the idea that information is power, Selby (1995) implies that lack of involvement in the authoring of software and in activities that explore the potential of computer technologies will disempower and disadvantage women. There is a broadly held view that males' computing experiences make them better prepared for a world of work where computing skills and knowledge are increasingly a job requirement, and concomitantly that females are less well prepared and therefore economically and socially disadvantaged.

Allied with the discourse of disadvantage is a discourse of deficiency, where blame for the perceived inequity is located with females themselves. The fault is seen to lie with females' lack of interest in computing and their passivity in the face of male domination. Girls are construed as deficient in their lack of self-esteem, assertiveness and application, which denies them the same outcomes as boys. For example, Chen (1986) suggests that "a chief source of gender differences in attitudes is the greater willingness of males to participate in computer experiences" (p.278) By implication, it is the attitude of females, their unwillingness to participate, that is a problem. However, females are not necessarily blamed directly for the problem. They may be portrayed as victims of socialisation processes that establish different gender stereotypes for boys and girls. Whatever the attribution of cause, the solution tends to be framed in strategies to change girls' attitudes to computers and computing.

A variety of school-based strategies have been promoted to address the perceived problem of female disadvantage in computing. These tend to focus on changing the way in which computer education is organised and presented. Suggestions include reducing competition for resources by locating computers in regular classrooms, integrating IT in a range of subjects and changing classroom pedagogy. Pedagogies that have been touted as particularly appropriate for females include constructionist

and group collaborative approaches, investigations, shared problem-solving, discussions about social issues and peer evaluations (Selby, 1995; Selby & Ryba, 1993; Spender, 1995). Some have advocated for adoption of a computers-as-tool construction of computing that emphasises applications of interest to girls, such as information processing (Clarke, 1990; Ryba & Selby, 1995). The intention is to soften the image of computer education and make it more interesting, palatable and pertinent for a wider range of students, especially girls.

Paradoxically, though, there is potential to reinforce rather than reduce gendered computer cultures in reformist calls for curriculum change. Bryson and de Castell (1995) identify a tension in the positioning of girls as disadvantaged and disenfranchised computer users and the implementation of policies to reduce gender discrimination in computing. They suggest that the instructional practices that are intended to promote gender equity actually embody exclusionary values and are likely to entrench discriminatory practices. An example of this is the movement of computer education into curriculum contexts that are favoured by girls, such as English composition and information handling. The intention is to reduce the self-limiting stereotypes adhered to by females, but the effect may be to reinforce stereotypes that associate females with particular types of computing practices.

Critical Discourse

The limitations of the research literature of the 1980s and 1990s, the changing nature of IT schooling and contradictions evident in students' computing practices has led some to re-think the gender equity issue. This has coincided with a post-structural shift in thinking characterised by concern with difference and complexity in understanding gender and power relations. The result is a critical discourse pertaining to gender and IT schooling. It moves beyond an unproblematised acceptance of the 'truth' of gender differences and faith in simple interventions to solve problems associated with gender and IT schooling.

Defying stereotypes and challenging essentialism

An emerging literature questions notions that females as a group are less experienced and less confident computer users than males, that they dislike traditionally masculine

computing practices and are reluctant to embrace new technologies. For example, Bjorkman, Christoff, Palm and Vallin (1997) note that some women adjust comfortably to male dominated IT culture, that traditionally gendered (male) domains of practice may be breaking down and that the traditional stereotype of computer phobic females may not apply in some situations – based on Swedish research relating to the experiences of participants in tertiary level computer programming courses. Others describe willingness by girls to embrace new technologies, albeit particular technologies that include the Internet and e-mail (AAUW, 2000; Christie, 1997).

New constructions are placed on girls' choices. Siann (1997), for instance, argues that computers have become so ubiquitous that young people, male and female, use them in almost all occupations. She observes that gender differences in computer use at school are diminishing. Based on the work of Durndell et al. (1995), Siann argues that females make constructive decisions not to pursue tertiary education and careers in computer science, rejecting such life paths as matters of positive self-interest rather than lack of confidence or self-efficacy. Durndell et al. (1995) ascribe differences in participation to the idea of "pragmatic advantage" (p. 226). They suggest that once females become convinced of the usefulness of computers they are happy to use them. Similarly, the AAUW commission portrays girls' rejection of computing as a matter of conscious choice resulting from disenchantment (Green, 2000). The implication is that girls like computers. It is particular practices that individuals react against.

A critical perspective invites challenges to assumptions that attitudes towards particular computing practices and attitudes towards computers necessarily equate, that negativity towards particular computing practices necessarily results in avoidance of computers, and that all girls and all boys interact with computers in similar ways and are naturally more or less confident with computers (Clegg, 2001; AAUW, 2000). Girls may be observed to be more critical and polarized in their attitudes towards computers and to prefer using the Internet to programming, but this is not interpreted to mean that they necessarily dislike or reject the technology. Also, notions of female inadequacy are questioned. It has been suggested that a maxim that was coined to epitomise females' attitudes to computers, "We can, I can't" (Sanders quoted in Durndell et al., 1995, p.220), be revised to "I can, but I don't want to" (Durndell et al., 1995, p.221; Siann, 1997, p.120). This revision is intended to reflect the pragmatic

views and rational decisions made by girls and women to avoid forms of computing that they find are of little use or interest, or that they associate with an image of computer nerds that they do not wish to identify with. It could further be argued that females are acting to change the culture of computing, rather than changing themselves to fit the dominant culture (Green, 2000). Rather than positioning females as helpless victims of themselves or society, they are presented as active agents and decision makers (AAUW, 2000; Abbiss, 2005).

Assumptions that there are essential differences in the way males and females think and interact with computers are also contested. Theories of gender-based learning styles, it is argued, can themselves be seen as collaborative products of particular social and cultural settings and as simplistic and superficial categorisations (Bryson & de Castell, 1995). Also challenged is the reification of the notion that male thinking and ways of doing computing, particularly programming, are analogous. For example, Mahoney (2001) draws on the work of Håpnes and Sørenson (1995) pertaining to Norwegian computer hackers to challenge apparent certainties about the masculine nature of computing. It is reported that the practices and attitudes of hackers straddle gender lines, which is contrary to expectation. Hackers are described as competitive but communal and mutually supportive, 'hard' masters who are open to strategies of 'soft' mastery, fascinated by the machine but wanting to create useful programs.

In her seminal work, Turkle (1984) does not claim that all males are 'hard' masters and she presents examples of boys who approach programming in a 'soft' manner. However, subsequent literature suggests that there has been a tendency for commentators to essentialise on the basis of Turkle's and others' observations of male and female differences in approaches to computing. This gives concern to theorists who challenge the essentialist gender discourse (Bryson & de Castell, 1995, 1998; Clegg & Trayhurn, 2000; Trauth, 2002; Wajcman, 1991). Clegg (2001) argues, for example, that formal and creative methods of computing do not constitute intrinsically male or female approaches, but that the "simple dichotomy of hard/soft, male/female is an ideologically constructed fixing of ideal masculinity and femininity" (p.317). Whilst some males and females may approach computing tasks differently, the application of such differences as a universal principle is contested.

The essentialising of gender and the creation of male and female categories automatically establishes binaries. It places male and female in opposition with each other through dichotomies such as hard-soft, abstract-concrete, objective-subjective, logical-intuitive, aggressive-passive (Mahoney, 2001). This leaves little room for contemplation of the subtleties associated with the social construction of multiple masculinities and femininities that are described in the gender literature (Connell, 2002; Kimmel, 2000; Mac an Ghaill & Haywood, 1998) and in the work of developmental psychologists who describe multiple representations of gendered adolescent selves and highlight the importance of context in the development of personal concepts of self (Curry, Trew, Turner, & Hunter, 1994; Harter, 1999; Markus & Nurius, 1986). A critical perspective invites consideration of these subtleties and complexities.

Gender identity and power relations

There is a growing body of literature that focuses on identity formation in relation to IT schooling. The ways in which people interact around and with computers are seen to contribute to the establishment of male and female identities and to reflect gender images. This literature investigates the complex ways in which masculinity and femininity are ascribed in relation to computing practices and highlights the plurality of masculine and feminine constructions. It also explores ideas about authority and expertise in relation to computers and power-knowledge relations.

It has been shown that masculinity and femininity are attributed in part through assumptions about technological competence and skill (Jenson, de Castell, & Bryson, 2003; Schofield, 1995; Wajcman, 1991). Technology, of which computing is a manifestation, is identified as a field where males can and do assert their masculinity, especially at the 'hard' end of product design (Clegg, Mayfield, & Trayhurn, 1999). In taking this perspective on gender and identity formation, a supposed 'natural' affinity of men and machines is questioned and is seen as a historically constructed phenomenon. Female alienation from computer technology becomes a product of the historical and cultural construction of male identity and computing as masculine practice (Gill & Grint, 1995; Wajcman, 1994).

Research in schools suggests that computing classes provide a context for the ascription of gender. This literature problematises gender and suggests that students negotiate multiple masculine and feminine identities in their classroom interactions. Elkjaer (1992) describes computer science classes as a sphere where males struggle to assert their masculinity and to prove themselves publicly. Some attempts by boys to maintain their masculine identity are observed to be more performance than they are a reflection of genuinely knowledgeable positions. Thus, rather than present boys as unproblematic and naturally dominant when it comes to computers, Elkjaer presents a picture of boys' computing practices and associated behaviour as a means of negotiating gender identity. In another example illustrating the complexity of the connection between school computer use and gender identity formation, Singh (1993; 1995) observes that not all girls passively accept a marginalised position when interacting with computers in primary classrooms and that not all boys fit comfortably in the roles of experts. In fact, some boys may experience emotional distress as they attempt to negotiate positions within male expert groups and some girls are far from powerless victims in their social interactions around computers and display aggressive, rational femininity in their actions and reactions.

Gender identity is expressed through gendered preferences for different computing practices and the acquisition of different computer knowledge and skills. This positions males and females in different relations of power and authority with computers and with each other. The critical literature suggests that males' knowledge and skills tend to be attributed greater value than females' knowledge and experience (Clegg & Trayhurn, 2000; Culley, 1993). Clegg and Trayhurn (2000) observe that computer gaming, which tends to be dominated by males, is associated with 'real' computing, while word processing, which tends to be dominated by females, is associated with a previous and dated technology, typing – yet both are end-use applications. They argue that what counts as experience with technology is socially constructed in a gender discourse. The privileging of male computer activity and knowledge may lead to girls' achievements being under-valued and boys' abilities being over-rated. Males and females appear to be set in unequal power relationships. Males assume greater authority than females through their interest in particular computing practices. This is not to say, though, that all males have this authority,

because not all males engage in the same type of computing activities, nor that all females lack such authority.

Within a critical discourse, gender differences in computer use are explained in terms of gender-technology and power-knowledge relations, which describe the ways that males and females relate to each other around computers (Clegg, 2001; Jenson & Rose, 2003; Stepulevage, 2001). Commentators describe these relationships in different ways – male controller-female functionary (Beynon, 1993), male insider-female outsider (Vale, 2002), male host-female guest (Elkjaer, 1992), male norm-female other (Singh, 1993; 1995). Although such descriptions could be criticised for creating binaries, they highlight the socially constructed nature of gender-technology relations, which tend to exalt males' actions and marginalize females' contributions but which are complex and dynamic. Singh (1993), for example, finds that boys tend to control power-knowledge relations in classroom computer settings and claim computer expertise with the collusion of their teachers, who acknowledge and defer to boys' claims to expert knowledge. However, she argues that the positioning of girls within a discourse of other and of boys as experts and risk takers does not infer a conscious conspiracy to oppress girls. Rather, boys enter "positions within existing classroom practices and appropriated power relations to reproduce a patriarchal order" (p.51) and students negotiate and shift positions within the discourses and practices of the classroom. In the critical literature, then, girls and boys are presented as active players in the social construction and reconstruction of classroom gender relations.

No ground swell of concern at the lack of males in traditional female roles is detected in literature that is commensurate with concern about the lack of females in traditional male computing occupations. Why not? Why is it that males are not seen as deficient for resisting work in the office practice tradition? Why is their thinking not proclaimed as faulty? Viewed through a critical lens, this is attributable to social processes that associate computer technology with masculine symbols of control, authority and expertise and establish particular computing practices as 'real' computing. The inclination to blame females for their lack of involvement in the IT industry and in 'hard' computing courses is itself a reflection of the social structuring of gender and IT.

Reframing the problem

A review of the literature pertaining to gender and IT schooling reveals persistent differences in girls' and boys' computing preferences and participation. However, it also illuminates exceptions, variations and changes in students' attitudes and computing practices. Gender-technology relations are shown to be complex. What does this mean, then, for a reading of the 'problem' of female underrepresentation in IT education and careers?

Within a liberal equity discourse, gender differences in computer uses and attitudes constitute a problem because of inequities that are seen to accrue as a result of these differences. In particular, girls are represented as disadvantaged because of their lack of involvement in IT, or, more precisely, their lack of involvement in 'hard' computing. This is seen to create gender inequalities as females are denied economic opportunities and influence in the IT world. The problem tends to be located with the existence of a male computer culture, which is thought to be anathema to females, and with females and their purportedly negative attitudes towards computers and computing. The solution is seen to lie in changing females' attitudes, which it is proposed can be achieved through curriculum changes and interventions to get females interested and involved in further IT education and IT careers.

In contrast, the critical discourse locates the 'problem' more broadly with the social construction of IT as a masculine domain, with socially constructed notions of what 'counts' as computing and with power-knowledge relations. Rather than viewing historically gender-stereotyped domains of IT practice and persistent inequities as *fait accompli* and submitting to technological and biological determinism, they are presented as social phenomena associated with the historical production and reproduction of power and masculine forms of IT. Cukier, Shortt and Devine (2002), for instance, contend that a very narrow definition of IT dominates in industry and academe, based on computer science and electrical engineering models that are dominated by males. This is despite evidence of the multi-dimensional nature of IT in workplaces and overlap between telecommunication functions and knowledge about computer hardware and software that requires a range of 'hard' (technical) and 'soft'

(communication) skills. In their opinion, the effect of identifying IT with these particular models is to marginalize females and their contributions in the IT world.

Within the critical discourse, solutions to the 'problem' of gender differences in computer interests are seen to lie in broadening the scope of what constitutes computing and reconfiguring IT institutions and practices, including the form and structure of IT schooling. Reassessment is sought of what constitutes computing knowledge in order to recognise and legitimate what have traditionally been female computing practices and interests. Cukier et al. (2002) advocate for epistemological change to broaden the scope of IT education and include multi-disciplinary perspectives and consideration of the social impacts of IT developments as part of the curriculum. This is similar to the idea of critical literacy in science, where students are educated about science rather than trained to be scientists (Gilbert, 2001; Letts, 2001). The AAUW Educational Foundation Commission on Technology, Gender and Teacher Education (2000) invites a broader critique of computing culture and promotion of a computing culture that "embraces multiple interests and backgrounds and that reflects the ubiquity of technology in all aspects of life" (p.x). Resolution of the gender problem is thought to lie with the re-conception of computer literacy and computer fluency and movement away from the use of skills with communication and productivity software as measures of technological literacy. Solutions to the 'problem' of underrepresentation of females in IT are thought to lie in broadening the scope of what counts as computer knowledge and in reorganising computer related schooling in an effort to break down distinctions between traditional male and female computing practices.

This focus on and concern with the social construction of IT does not deny unique experiences, multiple gender constructions or individual agency. Rather, the emerging critical discourse highlights a tension between agency and structure that is worked out by individuals in particular contexts. Essentialist thinking that assumes all males and all females to have similar attitudes and experiences in relation to computers is challenged, as is the idea that the 'problem' of female lack of interest and engagement in 'hard' computing lies with females themselves. These ideas are seen to be superficial and simplistic. Gender is presented as a complex and powerful social

construct as opposed to a simple category of analysis. The 'problem' of female underrepresentation in IT becomes problematic.

So, is there a problem of female underrepresentation and disinterest in respect of IT schooling at all? It is clear from literature that there are gender differences in computer uses and interests. However, the idea that there is a gender problem, specifically a problem with females, is underpinned by the idea that what (some) males do with computers counts more than what (most) females do. It could be argued that there would be no problem if the tendency to privilege male practice were undermined. This is unlikely, though, given the potency of the symbolic association of masculinity with technology and the pervasiveness of the discourse of computing expertise as a technological site. It is enshrined in social, economic and educational structures and rewarded through the status and authority that accrues to those in the IT industry. There is a problem or dilemma, but it is complex and relates to the social construction of IT as gendered practice, rather than being a problem with males or females *per se*. Whilst there is no easy fix for gender inequities relating to IT schooling, the critical discourse provides a deeper, more satisfying understanding of the complexities observed and dilemmas posed and points to a need to reconceptualise the problem of gender and IT schooling as a precursor to policy development.

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