Gender and design and technology education

RESEARCH

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Technology in the curriculum

Technology is a relative newcomer to the curriculum of even secondary schools. Its arrival, and its discrimination from technical education, are a recognition of the pervasive influence of technology on modern life and the prosperity of nations. This requires populations who are skilled in living with, managing and contributing to, technological development.

But the form that technology education should take continues to be controversial, not only in the UK, but in other parts of the world also. Inevitably, the final outcome is dependent on the views of dominant pressure groups but also on the skills, identities and self-perceptions within the available teaching force, on the existing accommodation and equipment and related programmes offered in the past.

The antecedents of technology education in England and Wales are threefold: applied science courses (used by pupils considered to be academically able), handicrafts (offered to younger pupils and pursued by the 'less able') and computing, which had entered the curriculum on an *ad hoc* basis as computers became available in schools. McCulloch et al (1985) documented the power struggle between 'science' and 'craft' for the heart of technology education in the 1960s and 1970s. Meanwhile the nature of 'handicrafts' was changing with the growth of 'Design and Technology', in place of woodwork and metalwork, for the more able pupils at what is now Key Stage 4.

A gendered history

All three antecedents of technology have been sex differentiated in the past. They have been the most strongly gendered of all curriculum areas. McCulloch et al (1985) point out how the discourse surrounding technology education in the 1960s and 1970s focused exclusively on boys. Entries at 'O' and 'A' level in Engineering Science, Electronics and Modular Technology in the 1980s were overwhelmingly from boys, until the TVEI programme required that efforts should be made to avoid sex-stereotyping where these subjects were included in the TVEI programme.

Statistics for 1982 showed only 2.7% of CSE and 1.6% of 'O' level Woodwork entrants were girls, for Metalwork the figures were 1.2% and 0.9% and for Technical Drawing 5.1% and 5.3% (Appendix 1). The participation of boys in Domestic Subjects was 8.9% for CSE and 3.4% at 'O' level. A survey of more than 50 schools in two LEAs in the same year showed that, in what is now Key Stage 3, only 25% of schools included continuous strands of CDT and Home Economics for all three years. The most common form of organisation was a compulsory rotational scheme of 'taster' courses in 'creative studies' for the first year of secondary schooling. The courses were of 8 or 9 sessions and included CDT, Home Economics, Art and, sometimes, Music. Optional courses would then be offered in the second and third years. The offering of choice inevitably resulted in sex-differentiation of CDT and Home Economics as gender stereotyping operated on the choices made (Harding, 1989).

The examination entries for 1992 show that some progress had been made in breaking down stereotypes: 21.5% of CDT entries for GCSE were from girls and 13.8% of Domestic Subjects entries were boys, with girls gaining a higher percentage of grades A-C in both. At 'A' level 24.8% of entrants in Technology were from girls, who also had a higher pass rate (Appendix 1). These entries and pass rates are comparable to those in Physics that year, although the volume of entries were considerably less. If we look at what was happening in the sciences over the same decade we see that the pattern of entries is complicated by a change from the dominance of single science entries in 1982 to that of 'double science' in 1992, which has accompanied the replacement of CSE and 'O' levels by the GCSE. The 1992 figures show similar entry and success patterns in Double Science for girls and boys, but it is perhaps disturbing to notice that sex differentiation in entries in A level Biology and Physics was slightly greater in 1992 than in 1982 (Appendix 1).

Merely to make a subject compulsory does not necessarily result in gender-fair curricular experiences, as a number of studies in mathematics have shown (e.g. the HMI 1989 survey, and the Girls and Mathematics Project, Walden and Walkerdine 1985).

Computing, or Information Technology, has but a brief history in schooling in England and Wales, but it has become gender-stereotyped. Before computers were available in schools and homes women formed more than 30% of students in undergraduate Computer Science courses, but over the 1980s their participation dropped to less than 10%. Culley (1986) discusses some of the factors associated with girls' lesser participation in computing in schools; these include teacher expectation, boys' dominant behaviour, girls' limited access to computers at home and the nature of available recreational software.

Does it matter?

In discussing this question Head (1980) makes three points: one is an equal opportunity argument – women's earnings are considerably less than men's, which is partly due to their lack of technical qualifications; another relates to skills shortage – although girls and women have the ability to work within science and technology, few qualify to do so; and the third relates to the nature of technology education – this has been presented too often as intensively narrow and divorced from human concerns. Within this framework girls have been defined as deficient. Head claims that the failure to attract girls is a failure of technology education, not a failure of girls.

If we look more closely at this last point we can ask: whose world views are more usually represented in the practice of technology and in its presentation for learning? The answer, of course, is that of men and boys. The recent review of women in science, engineering and technology (HMSO 1994) shows that very few women are in positions to influence decision-making, and presentation methods have evolved in the context of mainly men teaching mainly boys.

Because society currently maps different roles onto men and women and expects different behaviours from them, males and females tend to develop different value systems and world views. Concerns of males include achievement, leadership, control and independence; those of females include care, nurturance, relatedness and personal responsibility. If women do not work within technology the values associated with them will not be strongly represented in technological development, which puts people and the planet at risk.

Although girls experience disadvantage more often in technology education than do boys, the gendered nature of expectations can also put boys at a disadvantage. The APU Technology Report (SEAC 1991) cites one boys' school in which the pupils refused to develop an interactive toy for a baby. In what follows, the ways in which boys and girls may differ in their responses to curricular presentations will be explored.

Facilitating girls' participation and success in technology education

The Assessment of Performance Unit (APU) was set up within the DES (Department of Education and Science) in the late 1970s, to establish standards of performance in the major subjects of the curriculum at ages 11, 13 and 15. The APU Design and Technology, a late comer to the scheme, operated only in the second half of the 1980s, with a brief to monitor the capability in design and technology of 15 year old pupils. It defined design and technology as *"a purposeful, task-related, activity that results in 'improvement' in the made world"* (while recognising that the concept of improvement was problematic, depending on a set of shared values). The 'activity' was divided into sections for the purpose of assessment, short tests being devised to assess capability within these. Some clear gender differences in performance emerged (SEAC 1991).

Using reflective skills. It was found that tasks requiring reflection (e.g. the identification of a need, or the evaluation of a product) enabled girls to participate with confidence and to demonstrate good capability, whereas 'active' tasks favoured boys.

Recognising context. In general, girls out-performed in a 'people' context and boys in an 'industry' context; no clear gender difference was found in an 'environment' context. Context also differentiated between boys and girls in APU science surveys. Murphy (1990) reported:

> "Typically girls tend to value the circumstances that activities are presented in and consider they give meaning to the task. They do not abstract issues from their context. Boys as a group conversely do consider issues in isolation and judge content and context to be irrelevant".

The significance of context for girls' achievement in physics is also demonstrated by an initiative adopted in 1992 within the Victorian Certificate of Education in Australia. This certificate serves to generate points for university entrance and is assessed in Year 12. Previously few girls had studied physics in Year 12 and those who did achieved less well than boys overall. The new course requires physics to be learned 'in context'. For example, the laws of motion can be studied historically '*From Aristotle, Newton and Beyond*', or '*On Your Own Two Feet*' or '*Wheels*'. Four assessments are staggered through Year 12: the first is a practical investigation, internally assessed; the second an external test of concepts and principles; the third a research project into an area where physics has social relevance, which has to be presented as a science poster; and the fourth is again an externally assessed written test. The proportion of both boys and girls obtaining a pass in physics has increased dramatically, with girls showing the greater gains in 'A' grades (Hildebrand 1995).

Valuing the social context. In particular the social context supports girls' performance and their readiness to be involved. In the early 1970s Ormerod reported that the perception that science has social implications correlated with girls' choice of science but not with boys'. An analysis of girls' and boys' entries over a three year period to a National Design Prize Competition showed that while they worked on similar devices the problem they had identified differed: boys were working to improve the device (a technical problem) whereas for the majority of girls the problem was perceived to be one of human need which could be met by use of the device (the social context) (Grant and Harding 1987).

The Tasmanian Education Department placed their computer education in a social, rather than a science or mathematics, context by providing training initially for social science and humanities teachers. In addition, the rich resource of the detailed database for convicts sent to Van Diemen's Land (Tasmania) in the nineteenth century captured the girls' interest and they were as enthusiastic in their use of computers and software, to question the database, as were the boys.

Recognising complexity. The reluctance girls show in abstracting aspects of a problem from its context means that they often recognise a greater complexity in a given situation. This is referred to several times in APU reports. For example:

> "(Girls) were often cautious in their entry into a situation, wanting to know how, why and who it was for. While studying and designing the minutiae they were constantly seeking to keep the implications of the whole in view, and for some this complexity became intolerable to the point where they capitulated" (SEAC 1991 p120).

Perhaps this is why it was also found that a tight structure to the activity supported girls' performance. On the other hand a loose task, one in which they could decide meanings and priorities, also favoured girls. For example, the loose task that asked pupils to suggest areas where new or improved products or systems could be designed for the garden was structured in seven steps by the following instructions: *Brainstorm different situations (5 mins); Put down all your design ideas (25 mins); List all the things the product will do (5 mins); Plan all stages (25 mins); List what you need to know to carry out your plan (15 mins); Write a design brief (10 mins).*

The openness of the original task allowed pupils to develop ownership of the problem by reflecting on the gardener's need, but the tight structure provided a framework within which complexity was controlled without being denied.

On the other hand a tight task, but loose structure supported boys. An example was the requirement to develop a device to enable a drilling operation to be executed

quickly and repetitively. Although the task involved a child's toy (a hobby horse), it was set in an industrial context and its closed, technical nature inhibited girls' performance, but not that of boys. Additionally, the exercise included more than an hour of unstructured 'free modelling' time, in two blocks. Girls' lesser familiarity with technical tools also contributed to their low performance in this task. The task administrator reported that girls tended to confine themselves to the safety of paper and pencil development (SEAC 1991 p125).

These findings highlight a further complexity that teachers need to recognise: the way a number of factors interact to influence pupils' performance to produce gender differentiated outcomes.

Differing teaching and learning styles. Following the Nuffield Science Projects of the 1960s and 1970s a study of teaching styles and related pupil attitudes to, and achievement in, science was carried out. Three teaching styles were identified: the Informer (I), the Problem Solver (II) and the Inquirer (III). Style I was the least successful, even in knowledge gains. Style II (a style wherein the teacher dominates) was used more by men than by women teachers; in it pupils were publicly challenged to hypothesise solutions to problems from data given verbally or from experimental work. This style was most successful in generating knowledge. Style III was more pupil-controlled, in which pupils investigated problems, often formulated by themselves, in small groups. It was used more by women than by men teachers, it produced highest levels of achievement in problem solving tasks, its knowledge gains were close to those of Style II and it was the only style in which the pupils' attitudes to science showed positive gains over a year. It was particularly successful with low achieving girls (Galton, 1981). Girls were reported to dislike Style II and to prefer Styles I or III. As these are very different, this outcome was puzzling, but Galton suggests both Styles I and III do not require girls to 'go public' in a context where boys may make disparaging comments. They also provide less interaction with the teacher. Some studies in other parts of the world have also shown that girls prefer to work in a group, independent of the teacher, in science and technology, but others suggest girls show a marked teacher dependence. A possible explanation is that in a more teacher-controlled classroom, if the teacher's style, or the conceptual framework used, is alien in any way the pupils will switch-off or resort to rote learning or dependency. This may occur more for girls in a subject area which has evolved in a male-dominated context and is more usually taught by men.

An investigation in Denmark which required 'top junior' classes to solve problems in small groups, using a computer, found that boys preferred to work individually, negotiating time on the computer, whereas girls preferred to work collaboratively, exploring verbally a number of ideas relating to the problem. The APU Technology survey also found this gender difference in collaborative working.

Barriers to participation and achievement
Some barriers may be deduced from the evidence given above. Problems may be created for girls by disregarding the special (and valuable) skills they employ in the learning process. Other specific examples of barriers are given below.

Girls' attitudes? If girls' attitudes to science and to technology are interpreted as negative, this will be conveyed to them in a number of ways by comment and by attempts to change their attitudes without changing the ways science and technology are presented. Most surveys of attitudes to technology conclude that girls' attitudes are less positive (more negative) than boys'. The Equal Opportunities Commission stated in a leaflet entitled 'Equal Opportunities in TVEI' *"... unless special measures are taken, the negative attitudes towards technology which girls already reveal, will undermine the objectives of TVEI'*. As Head (1989) suggests, those special measures should be addressed to technology education. But Grant and Harding (1987) propose that girls' attitudes to technology, with their reservations about some applications and their perception of the complexity of real problems (not often allowed for in questionnaire surveys) should be regarded as the **more** positive approach. If we make this conceptual change we are more likely to work with girls through **their** views of the world.

Teachers' behaviour. The GIST project found that most science and technology teachers regarded girls' low participation in science and technology as unproblematic, and not a serious professional issue (Whyte 1986 p257). This assumption still holds in many parts of the country. Many teachers have different expectations of girls than of boys. The author finds that teachers participating in in-service training on equity issues will consistently counsel Denise differently from Denis, using the same pupil profile. The GIST Project found the same outcome for the exercise (Whyte 1986). Spear showed that teachers given copies of pupils' work in science graded it higher and predicted a brighter future for a pupil if it carried a boy's name, than if **the same piece of work** bore a girl's name (Spear 1984). It is a sobering exercise to reflect on how such expectations are daily conveyed to boys and girls through comment and attitude. The GIST project also observed men teachers using what may be called mildly flirtatious behaviour to jolly girls along and create rapport, thereby reinforcing gender differences in the classroom (Whyte 1986 p28).

A number of classroom interaction studies have shown that teachers generally spend more time interacting with boys than with girls. The GATE project found that this was not always the case. The following pattern was observed in workshops: if a boy approached a teacher with a problem, the teacher would most likely give the boy verbal advice, but if a girl asked for help, the teacher would be more likely to go with the girl to her piece of work and carry out the required procedure for her, thereby compounding her sense of helplessness.

Boys' behaviour. Many of the classroom interactions observed in laboratories and workshops in the GIST project seemed to have the effect of 'edging girls out' (Whyte 1986 p25). In class discussion boys tended to call out their contributions while girls kept to the rule of raising their hand to answer. Boys would mock a wrong answer from a girl or groan at a right answer. Boys used equipment to generate aggressive play, using ray boxes as ray guns, spring balances as catapults and magnets for tug-of-war. Where resources were in short supply it was mainly the boys who elbowed their way to acquire them.

The negative effect of boys' behaviour on girls' participation has also been identified in Young Engineer clubs (Blackman and Brown 1993). One girl reported:

> "We have done really well as a school in winning prizes in technology. I am the only girl in our team that won the awards. So a lot of attention has been focused on me since we won the awards. But the thing is I actually left the team. I had to go. It was so weird being surrounded by all these men and boys. At first it didn't seem to matter, but then it was upsetting me. They would do all the work. Do all the good, most difficult jobs. They had first choice of what to do. They said (the boys) 'do this and that' but it was nothing because I know about cars from my dad, he has really given me support and it was only through him that I went back to join the team. Otherwise the boys had forced me to leave, making it seem that I wanted to, but I didn't, it was their behaviour which made me go". (p47).

Good teacher management and control should eliminate most of this negative behaviour, but to avoid a repressive atmosphere teachers and pupils need to become more gender sensitive in order to establish more equitable experiences for girls in formerly male-dominated areas of the curriculum. A more difficult situation arises when retired male engineers, unused to working with young women in a technical framework, are recruited to help with work in schools.

The nature of the technology curriculum. The most recent version of Technology in the National Curriculum (1995) allows more presentation flexibility for the teacher and curriculum developer, but the focus is on design and make with an emphasis on construction. Although evaluating products (and their applications) is a requirement of the 1995 Orders, the emphasis is on technical performance rather than on aesthetic, social or environmental aspects which may constrain the operation of girls' reflective skills. All materials, including food and textiles, are to be regarded as construction materials, with a heavy

emphasis on the industrial context. It is obvious to all that Food is included with reservations. Its position as an option only in Key Stage 3 may reduce its importance in the eyes of pupils and ensure that an opportunity for sex differentiation occurs.

These perspectives not only devalue technology based and developed in the home, but, by association, devalue the traditional skills of women and create a more comfortable milieu for boys than for girls. Unless teachers are aware of these subtle gender interactions and take steps to counter them, girls may be at a disadvantage.

Society's expectations. The expectations of society continue to be strongly sex-stereotyped with little recognition that its gendered nature constrains the potential development of both males and females. Boys may reject activities with a female or feminine association and girls feel less than comfortable when a masculine bias, often unrecognised by teachers, is present. Where choice of participation is offered, stereotyping operates to reinforce the gendered nature of society.

Within this context those working in technology education assume a certain responsibility, for technology and technical activities are some of the most affected by stereotyping. Their assumptions, attitudes, actions and the materials they produce may either contribute to this reinforcement or challenge it.

Conclusion

Although technology education and its antecedents have been strongly sex differentiated and gender-stereotyped, the current place of technology in the National Curriculum provides both an imperative and an opportunity, albeit limited by the chosen framework, to change this status quo. Research has provided insight into the obstacles to participation, mainly for girls, and to ways in which their participation may be supported. This requires the recognition of different ways of working and generating knowledge and the valuing of the special skills girls may have developed.

The frameworks adopted within curricular materials and the suggestions made for presentation for pupils may facilitate gender-inclusive experiences. However, much will depend on the mediation of classroom teachers, in their projection of assumptions and their management of classrooms including the behaviour of boys. This points to the need for substantial in-service programmes in gender-awareness for teachers of design and technology.

References

Blackman, S and Brown, A (1993) *Evaluation of Young Engineers: a case study linked to Technology and the National Curriculum*, Department of Educational Studies, University of Surrey, Guildford GU2 5XH

Culley, L (1986) *Gender Differences in Computing in Secondary School Loughborough University of Technology*, Leicester, UK.

Galton, M (1981) 'Differential treatment of boy and girl pupils during science lessons', in Kelly, A. (ed) *The Missing Half Manchester*, University Press, England pp180-191

Grant, M and Harding, J (1987) 'Changing the Polarity', *International Journal of Science Education* Vol 9, No 3, pp 335-342.

Harding, J (1989) 'Making Technology Education a Reality for Girls', in Head, J (ed) *Girls and Technology*, Centre of Educational Studies, Kings College, London.

Head, J (1989) *Gender and Education in Girls and Technology*, Centre for Educational Studies, Kings College, London,

Hildebrand, G (1995) 'Assessment Interacts with Gender: The Case of Girls and Physics in Victoria, Australia' Paper presented at the UNESCO/Institute of Education Colloquium 'Is there a Pedagogy for Girls?' London, January 1995.

HMI (1989) 'Girls Learning Mathematics', *Education Observed* 14, Department of Education and Science, London. Publications Despatch Centre, Stanmore, HA7 1AZ

HMSO (1994) *The Rising Tide, Women in Science, Engineering and Technology*, HMSO Publications Centre, PO Box 276, London SW8 5DT

McCulloch, G, Jenkins, E and Layton, D (1985) *Technological Revolution? The Politics of School Science and Technology in England and Wales Since 1945*, Falmer Press, Taylor and Francis Inc. Philadelphia, PA 19106-1906

Murphy, P (1990) 'Gender differences: Implications for assessment and curriculum planning'. Paper presented at the BERA Symposium on Social Justice and National Curriculum, Roehampton, London. August 1990.

SEAC (1991) The Assessment of Performance in Design and Technology, Newcombe House, 45 Notting Hill Gate, London W11 3JB

Spear, M (1984) 'Sex bias in teachers' ratings of work & pupils' characteristics' *European Journal of Science Education* 6, 369-377.

Walden, R and Walkerdine, V (1985) 'Girls and Mathematics, from Primary to Secondary Schooling', *Bedford Way Papers* 24, Institute of Education, University of London.

Whyte, J (1986) *Girls into Science and Technology*, Routledge & Kegan Paul, London, Boston and Henley.

Appendix 1: Selected examinations entries and results for boys and girls at 16+ in England 1982 and 1992

	1982 CSE[1] Examination					1982 GCE 'O' level[2] Examination				
	Entries			% Grade 1		Entries			% Grade A-C	
	boys	girls	% girls	boys	girls	boys	girls	% girls	boys	girls
English Language	327685	326939	49.9	11.2	18.3	234262	277690	54.2	51.7	57.5
Mathematics	228312	247032	52.0	16.5	14.2	173341	151323	46.6	60.4	51.9
General Science	44134	33192	42.9	5.9	6.4	3153	3163	50.1	51.9	44.3
Physics	123134	31021	20.1	14.0	14.8	134622	49286	26.8	60.4	61.4
Chemistry	63032	46236	42.3	16.4	15.5	87074	58651	40.2	63.0	60.1
Biology	61838	146032	70.2	14.6	12.8	83601	151061	64.4	59.3	51.1
Technical Drawing	92641	4932	5.1	15.8	13.4	57694	3227	5.3	43.9	37.9
Woodwork	61084	1718	2.7	12.1	11.2	14477	239	1.6	57.7	51.5
Metalwork	57680	685	1.2	12.4	12.0	12397	118	0.9	61.7	46.6
Design & Technology	-	-	-	-	-	13670	594	4.2	60.1	57.2
Domestic Subjects	12218	124561	91.1	4.3	13.3	1655	47658	96.6	35.5	60.6

Notes

1. CSE Certificate of Secondary Education; designed for less academic students.

2. GCE General Certificate of Education, used for more academic pupils; offered at 'O' & 'A' level

3. GCSE General Certificate of Secondary Education which replaced CSE and GCE 'O' level in 1988. All these examinations were/are usually taken at 16+ after five years of secondary schooling.

4. CSE Grade , GCE 'O' level Grades A-C and GCES A-C are accepted towards matriculation for entrance to university education. In popular culture these are 'passes'.

	1992 GCSE[3] Examination				
	Entries			% Grade A-C	
	boys	girls	% girls	boys	girls
English Language	245149	243598	48.9	45.9	61.8
Mathematics	231511	228880	49.7	44.9	43.0
Science (Single)	46246	51139	52.5	16.5	22.2
Science (Double)	147244	144192	49.5	44.7	44.1
Physics	35845	16146	31.1	69.2	73.7
Chemistry	30105	21358	41.5	71.6	68.6
Biology	25687	30367	54.2	70.2	61.4
Craft, Design & Technology	133352	36458	21.5	35.8	46.6

Source: Examination Boards Survey, supplied by the DES in 1983, and the DFE in 1993.

Selected 'A' level entries and results for males and females in England

	1982					1992				
	Entries[1]			% Passes		Entries[2]			% Passes	
	Males	Females	% F	Males	Females	Males	Females	% F	Males	Females
English Literature[3]	19003	44386	70.0	58.5	73.1	20062	44859	69.1	85.9	87.6
Mathematics[4]	70090	26626	27.5	66.5	68.5	31525	16972	35.0	77.2	78.8
Biology	17855	25596	60.0	68.0	67.8	12506	20419	62.0	80.6	79.3
Chemistry	30615	16420	34.9	73.7	73.1	17926	12634	41.3	82.3	82.2
Physics	44469	11259	25.3	68.9	70.1	23530	6680	22.1	80.4	82.0
Technology						6152	1528	24.8	77.7	82.1

Notes

1. Source: Examinations Boards Survey, supplied by the Department of Education and Science in 1983. No age range is given, but candidates are referred to as 'boys' and 'girls'.

2. Source: Department for Education Statistical Bulletin, No. 15/93 Candidates aged 18 years or under.

3. 1992 figures show an aggregation of Language and Literature available as separate subjects.

4. Aggregation of six mathematical subjects; 'Pure and Applied' contributed 66% of candidates in 1982.