British Educational Research Journal, Vol. 20, No. 5, 1994

When Do Girls Prefer Football to Fashion? An analysis of female underachievement in relation to 'realistic' mathematic contexts

JO BOALER, *Centre for Educational Studies, King's College London*

ABSTRACT *This article considers the move in mathematics education, away from abstract calculations and toward 'mathematics in context', particularly in relation to female underachievement in the mathematics classroom. It is suggested that 'unreal' contexts, which require students to view school mathematics as useful only in the make-believe world created in the classroom, are particularly damaging for girls. A small-scale piece of research is reviewed which suggests that girls are more likely than boys to underachieve in contexts which present real world variables but do not allow the variables to be taken into account. The implications of this situation in relation to girls' reported underachievement and disinterest in school mathematics are discussed.*

To begin with an answer to my own question—when do girls prefer football to fashion, the answer I believe, is in a mathematics examination. This conjecture many seem to run counter to popular opinion, but I believe that for the girls who are not interested in football, the nature of mathematics as it is currently taught makes this apparently nonsensical position tenable. This does not mean that I believe that football should be used as an example in a mathematics examination; the world of football is still perceived by many girls as almost exclusively male and this alone is good enough reason not to connect football with mathematics. The issue of context and 'reality' in mathematics education is, however, extremely complex and research suggests that it has much to offer to theories of female underachievement; for whilst it seems that male domination of the mathematics classroom will always preclude equality of access to understanding (Stanworth, 1981; Spender, 1982), there seems to be an emerging concern which submits that girls' perceptions of what is real, relevant or ridiculous in mathematics examples significantly contribute to much of the reported underachievement, 'mathsphobia' and disinterest amongst girls. I would like in this article to present some research which indicates that female underachievement may be most likely to occur in contexts which girls *can* relate to and to consider the implications of such a situation, which, if it exists, must challenge the fundamental character of the mathematics curriculum which is currently taught in British secondary schools.

Why Teach in Context?

In the late 1970s increasing awareness of adults' inability to use school-learned mathematics in 'real' situations prompted a shift toward the 'everyday' use of mathematics, reflected in many of the textbooks of the time. This emphasis was initially aimed at low attainers but gradually broadened to encompass all areas of secondary mathematics. Supporters of this approach believed that everyday mathematics would help students learn about *relevant* areas of mathematical content; significantly, they also believed that everyday contexts would provide learners with a bridge between the abstract world of mathematics and their world outside of the classroom (Broomes, 1989). Attempts to make mathematics relevant resulted in publications like the Inner London Education Authority's (ILEA's) *Mathematics in Context: a handbook for teachers* (ILEA, 1983). This offered mathematical exercises which considered budgeting, bills, banking, salaries, income tax, reading electricity meters and so on. More generally the move away from abstract mathematics and towards mathematics in context was increasingly viewed as the solution to problems of transfer, enabling students to reflect upon the demand of real life problems and become prepared for the mathematical requirements they would face in their everyday lives.

The move away from the teaching of mathematics as a series of abstract calculations was also supported for a number of different reasons concerning students' access to mathematical understanding. The abstractness of mathematics was encapsulated in the 'modern mathematics' movement of the 1960s and 1970s which argued for the universality of abstract rules and calculations, a premise built very firmly upon the learning transfer theories of Judd (1939), Thorndike (1971) and others which many now believe to be fallacious. De Lange (1992) writes about Vredenduin, one of the Dutch participants of the Royaumont conference in 1959 who heard Dieudonne's famous address 'New Thinking in School Mathematics'. This address inspired the modern mathematics movement. Years later, Vredenduin, in an interview with Goffree (1985) concluded that his concept of structure in geometry books for secondary education: 'was a beautiful edifice, but I do not think there was one student who shared that opinion' (De Lange, 1992, p. 196). For many students the abstractness of 'modern mathematics' was synonymous with a cold, detached, remote body of knowledge; as Davis & Hersh (1981) once said, a subject which is as 'dry as dust, as exciting as a telephone book, as remote as the laws of infangthief of fifteenth century Scotland'.

Many believe that this 'dry' and abstract image of mathematics may be countered if contexts are used which introduce students to the subjectivity of mathematical decision-making, contexts which, for example, require students to interpret events around them using examples from the local community or personalised examples which the students may bring into the classroom, analyse and discuss. Such an approach may enable mathematics to be viewed, not as an isolated body of knowledge, but as a flexible means with which to interpret reality. The opportunity for flexibility and creativity in the mathematics classroom is also believed by many to enhance motivation, confidence and enjoyment, particularly amongst girls (Walkerdine, 1989).

Historically, mathematics has often been presented as a subject of 'absolute truths' with the existence of one correct answer to each problem. Many now believe that this image is damaging for girls, who often find innovation and challenge a lot easier in a subject like English than mathematics (Burton 1986a, 1986b; Open University/ILEA, 1986). The threat of the teacher in the mathematics classroom is often basic and profound. A demonstration of creativity in English is relatively personal, more open-ended and the significance of 'knowledge' or of getting the 'right' answer is very different from that of mathematics. Buxton (1981) interviewed a group of adults about their anxiety in relation to mathematics and found that they often referred to the difference between mathematics and other subjects. With reference to English, one of his participants suggested, 'if you get a low mark you can think they don't understand. You can question their judgement because it is so uniquely their judgement'. When asked if one can question the judgement of a mathematics teacher the adult answered 'no, he is totally right and you are totally wrong'. Buxton refers to the 'nakedness' that such a position invokes, the clarity of a right or wrong approach enhancing the sharpness of emotional response, 'a piece of writing may be good, bad or indifferent, but this fact is not always as abundantly clear to oneself as the result of an attempt upon a mathematical problem' (Buxton, 1981, p. 59). Contexts which encourage negotiation and interpretation may counter the threat of the mathematics lesson, a threat which is linked, not to the nature of mathematics itself but to the nature of the environment generated within many mathematics classrooms. Fasheh (1991), in proposing that context makes mathematics more meaningful, cites an occasion when he asked Palestinian students to count school absentee rates and give *reasons* for the fact that the biggest number of absentees occurred on Saturdays. He concluded that this exercise resulted in enhanced understanding because students used mathematics to discover facts about the community and to interpret them, exposing the variety of possible interpretations of a mathematical fact.

A historical perspective in mathematics may also raise awareness that mathematical rules have not been created by God and passed, inflexible, to generations of school students; they are statements that have been invented by people and which have evolved and changed after many years of discussion and debate. Lakatos (1976) contrasted the Platonist presentation of mathematics as a body of knowledge with the recognition that mathematics does not develop through the use of a number of indubitable, established theorems but through continuous improvement based upon guesses, speculation and criticism. A historical perspective may also play an emancipatory role, demonstrating to students that the male, Eurocentric image of mathematics which is usually portrayed by textbooks, and some teachers, is at least partially incorrect. Joseph (1991) demonstrates the significance of the contributions of non-European countries to current mathematical thinking and his tour of the hidden and invisible historical contribution of the non-European demonstrates that our 'comforting rationale for European dominance has become increasingly untenable' over recent years. Mathematics has a rich cultural history and by drawing upon African, Indian, Chinese, Arabic and other examples, teachers may counter students' distorted views of the history of mathematics. Discussion of the role that women have played in the history of mathematics may also further this cause—few students (or teachers) are aware of the many eminent women mathematicians such as Emmy Noether or Sophia Kovaleskaya whose contributions have been ignored in most historical documents.

The reasons offered for learning in context generally fall into three broad categories. Firstly, contexts are often used in order to provide students with a familiar metaphor, following on from the theories of Donaldson (1984) who suggested that concrete, familiar experiences make learning more accessible for students. Contexts are also used in order to motivate and interest students, providing students with examples which enrich and enliven the curriculum. Contexts are now also used in the belief that they will enhance the transfer of mathematical learning through a demonstration of the links between school mathematics examples and real world problems. As a result of these and similar assertions most current mathematics schemes use examples presented 'in context'. Yet research findings continue to show that students are unable to transfer mathematics and still perform differently when faced with 'abstract' and 'in context' calculations aimed to offer the same mathematical demand (see for example, Kerslake, 1986; Lave, 1988; Taylor, 1989; Foxman *et al.* 1991). This suggests that students do not perceive the links between the mathematics learned in school and problems in the 'real world' just because their school mathematics examples were presented in context. It also suggests that assumptions regarding enhanced understanding and transfer as a result of learning in context may be oversimplistic. Consideration of students' responses to the contexts often used in mathematics examples becomes particularly interesting in furthering this debate.

The Problems of Context

Probably one of the most significant problems provided by many of the contexts used in mathematics textbooks occurs when students are required to engage partly as though a context in a task were real whilst simultaneously ignoring factors pertinent to the 'real life version' of the task. For example, take the following mathematics problem taken from a Dorset mathematics teacher pack:

> The cold tap on full will fill a bath in 5 minutes. The hot tap takes 20 minutes. When the taps are off, a full bath takes 8 minutes to empty. If both taps are turned on full but you forget to put the plug in, how long will it be before the bath overflows?

This sort of problem is common in mathematics classrooms. It is a nonsensical problem which has an obvious common-sense answer—the bath will never overflow if the plug has not been put in. This is not however the 'right' answer, nor is this the right mode of thinking; for we are now entering a fantasy world described by Wiliam (1992) and others as 'mathsland'.

> Over the last eight years, I have visited a lot of mathematics classrooms, and it seemed to me that in most of them, it was as if there were a kind of check-in desk just outside the classroom door labelled 'common sense', and as the pupils filed into the classroom, they left their common sense at the check-in desk saying 'Well we won't be needing *this* in here.' (Wiliam, 1992, p. 3)

This response is not really surprising when so many mathematics problems require students to suspend reality and ignore their common sense in order to get a correct answer. As Adda (1989) suggests, we may offer students tasks involving the price of sweets but students must remember that 'it would be dangerous to answer them by referring to the price of sweets bought this morning' (Adda, 1989, p. 150). These pseudo-real contexts, far from enabling students to see links between the mathematics learned in school and problems encountered in the real world, encourage students to see school mathematics as a strange and mysterious language which is of no use to them in the real world. In the classroom, however, students become used to answering mathematics problems which they know are meant to be 'real', but are not. One of the results of this is that students become trained and skilful at engaging in the make-believe of school mathematics questions at exactly the 'right' level—they believe what they are told within the confines of each task and do not question its distance from reality. Cooper (1993) shows examples of questions taken from the 1993 key stage 3 mathematics test pilot which, he asserts, require 'some reference to the real ... but not too much'. Cooper suggests that these questions require the child to 'know, and be willing to accept, the rules associated with this strange 'real' world ... One of these rules may be: do not ask any questions; accept the meaningfulness of tasks from authority on trust'. It is possible that the implications of the situation caused by such questions are worse than this, for many students do not 'accept the meaningfulness of the tasks'; what they accept is their own confusion and helplessness, derived from tasks which they *know* to be meaningless, at least in any 'real world' sense. The result of this situation seems to be a strange sort of context-conditioning whereby students are prompted to read each task or situation and attempt to recall the 'correct' method or procedure based upon the context or some other irrelevant feature of the task. Students know that approaching a task holistically and exploring the real world and mathematical variables would, in a mathematics question, result in failure. They therefore have no choice but to attempt to recall a method which last proved successful in a question of similar ilk. The subsequent confusion or lack of understanding of the need for similar methods and processes in different questions and situations is what I believe is reflected in much of the research demonstrating lack of mathematical transfer. Taylor (1989) for example, conducted a research study to compare students' responses to two questions on fractions and found that one of the four case-study students varied his methods in response to the simple replacement of the *word* 'cake' with 'loaf'.

In the 'real world' students are left confused because mathematics examples have encouraged them to think in the opposite way from that which is necessary when tackling a 'real' problem. Lave (1988) explored the relationship between the use of a shopping context in mathematics lessons and the use of mathematics in shopping situations. She argued that 'neither of the two experiences had symmetrical organising effects on one another' as students constructed their mathematical ideas in relation to the different mathematical environments. Lave asserts that, even after learning in context, students are more likely to base mathematical decisions involving choice of method or procedure upon the situation or context of a problem than the mathematics involved. This 'situation specificity' effectively means that students do not perceive the connections between mathematical situations presented in different contexts. I believe that this situation has arisen, not despite, but in some cases *because* of the contexts used in mathematics classrooms. 'Mathsland', the fantasy world created by many mathematics questions, is likely to be most harmful to those students who are socially aware and concerned about the relevance of subjects to their future lives—often these students are girls.

Piaget (1968) furthered a view that each individual constructs new knowledge on the basis of actions which are of interest. This led to a notion that individuals construct mathematical concepts if they are provided with concrete, familiar experiences. The constructivist interpretations proposed by Piaget and furthered by Vygotsky (1978) suggest that individuals develop in interaction with an object world. In this analysis the relationship between the learner and her educational setting is highly significant. The interaction which forms learning is essentially personal and the complexity of this interaction suggests that notions of mere familiarity are insufficient. Theories which assert the use of contexts in offering general familiarity and understanding ignore the range and complexity of individual experience and interpretation acknowledged by constructivist theories. Walkerdine (1988) rejects a model of humans possessing skills in contexts and suggests that the 'social is not a fixed and singular totality but a contradictory series of discursive practices. Thus a position such as that adopted by theories of "social cognition" or by Donaldson (1978), for example, which graft the social as "context" on to the edifice of development left intact, fail to engage fully with the implication of the point'. Contexts cannot offer a unique meaning to all students and if transfer is to be enhanced as a result of learning in context then the mathematical situations involved must necessitate a recognition that different students are likely to interpret the same mathematical situation in many different ways.

Another criticism relating in particular to the 'everyday' mathematics contexts which have formed the basis of many lessons aimed at low attainers in the past, concerns the extent to which children actually relate to contexts which are extracted straight from the adult world. Students may engage in tasks which consider banking, income tax and general finance but these contexts are usually a lot more 'real' to the adults who teach them and probably only to students as a problem located within the mathematics classroom. They take on the status of a school mathematics exercise and there is little research to suggest that students are able to relate what they learn in the classroom to 'similar' mathematical situations outside the classroom. Lave (1988) showed that a classroom exercise on shopping had no significance of substance and served only to disguise mathematical relations; in the supermarket the mathematics which was used was arranged to suit the context of *buying* food—the situation was more important than the object or the context. Contexts are often used in order to provide meaningful situations which students can learn and generalise from when often the intended meaning is misinterpreted, overlooked or ignored by students. The learning which results from such situations is completely tied to the specificity of the situation and forgotten when students go through the classroom door.

Many of the contexts used in mathematics classrooms reflect the simplicity of assumptions which are made in relation to the influence of context, assumptions, for example, that a universal meaning can be imparted to all students or that make-believe situations can be created in the mathematics classroom without offering damaging messages to students; assumptions also that contexts which have clear and obvious meaning for adults offer something more than a representation of a school classroom exercise to students. This is not to preclude the possibility that the sensitive use of appropriate contexts may enhance 'real world' transfer. Further, the complexity of the context debate does not allow the insufficiency of learning in context to be explained solely by the particular contexts chosen. I believe that contexts can encourage a type of mathematical understanding that is more readily transferable to the 'real world' but not through the replication of situations to be faced in 'real life'. The real world offers an infinite number of variations upon any one mathematical problem and it would be impossible to train students on all of the problems that they are likely to face. What *is* possible is the encouragement of an appreciation and understanding of the similarities between what is learned and future problems. This appreciation can come from an examination and reflection of the underlying structures and processes which connect experiences. Contexts can, in some instances, encourage this understanding by giving students situations which require them to think rather than to remember, to discuss and negotiate the mathematics involved and to consider holistically what it is useful to do in different situations. Good or model contexts can encourage this type of thinking (Treffers, 1987); unreal, textbook contexts in short atomistic questions are likely to suppress and devalue it.

There is also a notion about the nature of mathematics which is being offered by much of the research into learning in context. When Fasheh discussed the success of his exercise involving school absentees he cited the opportunity to interpret facts and to demonstrate the many interpretations and explanations of mathematics. This analysis says more about the nature of the mathematical activity than the particular context used. The realisation that there can be more than one answer; that mathematics can involve discussion, negotiation and interpretation seems to be critical to the success of the example. Many of the reasons given for the use of contexts in learning are dependent upon a view of mathematics which is 'process' based. It is suggested that contexts may encourage students to 'discover', 'explore', 'negotiate', 'discuss', 'understand' and 'use' mathematics but these aspects of mathematics are not intrinsically related to the use of contexts but to the acknowledgement of mathematical processes. I believe that contexts can motivate students, engage their interests and encourage confidence, but they will only enhance learning transfer if they are also able to offer a realistic and holistic view of mathematics which makes sense to students both in the classroom and in the 'real world'.

Research Aims

In 1991 I conducted a small-scale research study which aimed to contrast the effectiveness of a process-based learning environment with a content-based learning environment. The research was concerned with the extent to which students could transfer their mathematical knowledge and understanding across different task contexts. The assumption behind this investigation was that if students could transfer knowledge across different task contexts they would be *more likely* to transfer this knowledge from the classroom to the 'real world'.

Method

Fifty students from each of two schools were given six questions. Three of the questions assessed the same mathematical content (equivalence of fractions) through different contexts. One of the questions was an abstract calculation, one involved the number of penalties scored out of the number of penalties taken in a football season and the third involved the number of plants grown out of seeds planted. The other three questions all involved putting numbers into groups so that each group would have the same total. One of these questions was abstract, one involved cutting pieces of wood and the third involved a 'fashion workshop'. The questions were intended to be representative of those used in mathematics classrooms and so stereotypical contexts such as football were retained. Students were told that they were taking part in an important trial and that they should try to do as much of each question as they could. I gave the questions to the students and stayed with them while they worked through them. Students were given an hour to do each set of three questions; this was more than sufficient for all concerned. It appeared from my observations that students took the task seriously, they reported enjoying the questions and all seemed to be attempting to attain correct answers.

The two schools used in the research were chosen because they had a comparable intake in terms of gender and socio-economic factors but were different in their approach to the teaching of mathematics. I learned about the mathematics in the schools through lesson observations, interviews and analysis of materials. The lesson observations were unstructured but focused upon the relative influence of mathematical processes in classroom learning situations. I observed the mathematics lessons of the students involved in the research over the period of 1 week and I analysed a range of their classroom materials. I also interviewed both heads of department about the department's approach to mathematical processes as part of a general interview about their approach to the teaching and learning of mathematics. The main difference in the teaching of mathematics was the way in which the two schools approached the teaching of mathematical processes. In Lingforth School the head of mathematics disbanded the previously used scheme, SMP 11–16, and introduced a new teaching approach which requires students to work on open-ended activities at all times. All students, who work in mixed ability classes, are given the same open-ended activities, they are then encouraged to investigate and discover the mathematics, following any route or forming any resolution which they deem to be appropriate. The open-endedness of the activities allows topics to be introduced to all students and to be developed at a number of different levels. The students are encouraged to enquire, discover and challenge, responding to their own desire to investigate and be involved, rather than a series of questions. When activities are put into contexts the contexts are 'real', not described: measuring the length of a tree in an activity requiring trigonometry for example, rather than being given a picture of a tree in a book. The intention in Lingforth School is to encourage a mathematical environment which is 'real' for students because it involves students' own ideas, values and intuitive methods.

In Carroway comprehensive the school uses SMP 11–16 and when investigations are given to students, they are given to them to do for homework. SMP booklets concentrate upon mathematical content, presenting students with an explanation or example of a method followed by a number of short, directed questions, usually set in context. The practice of giving open-ended investigations separated from the usual classwork of closed, well-defined content questions is common in British mathematics classrooms. Carroway maintains a more pronounced divide between process and content mathematics by concentrating upon content in school, processes at home. Investigations probably provide the greatest opportunity for discussion and negotiation in Carroway's scheme of work; but this opportunity is lost as students only ever work on investigations at home, probably alone. However the mathematics department in Carroway would not be described as particularly 'traditional'; indeed, they would probably be described as progressive in comparison with some mathematics departments; the teachers were open to suggestions, valued investigative work and believed that mathematical communication is important. Carroway provided the ideal contrast to Lingforth as the schools were very similar but Carroway's mathematics department separated process and content, gave closed, atomised questions and did not encourage communication and negotiation whereas Lingforth used open-ended activities in a discussion-oriented environment, at all times.

Four out of the six questions used in the research involved a context. In three of these questions the context was used in order to describe a situation, for example, 'Brandon scored 4 out of 6 penalties'. These questions did not really require students to engage in the context in any significant way, nor were the students required to develop ideas or involve any of their own knowledge or experience. One of the questions, 'fashion workshop', was slightly different in this respect and is shown in Fig. 1.

The research questions were chosen in order to provide situations and contexts which were quite different but which required the same mathematical content to be applied. The question in Fig. 1 was interesting because it presented students with a description of a real world scenario which they could approach in one of two ways. The way that the question should be approached in order to attain the 'right' answer is effectively to

FASHION WORKSHOP

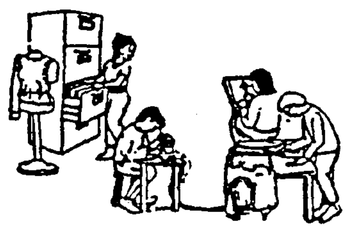
There are four people in the fashion workshop, Jane, Darren, Susan and Ramesh.

They have got two days to do all of the following jobs (8 hours work each day).

They can start a job one day and finish it off the next but they cannot share a job.

Work out who can do which jobs.

Show all of your working out and write down all of the decisions you make.



SKIRTS	
Cutting	5 hrs
Tacking	5 hrs
Machining	7 hrs

SHIRTS	
Cutting bodies	3 hrs
Cutting collars and sleeves	4 hrs
Tacking bodies	3 hrs
Tacking collars and sleeves	3 hrs
Machining	7 hrs

OTHER JOBS	
Deliveries to London	10 hrs
Deliveries to Birmingham	9 hrs
Answering letters and filing	8 hrs

FIG. 1. Fashion workshop.

ignore the context and deal with the numbers in the task: i.e. forget the nature of the jobs and try to find combinations of numbers which add up to 16. If this task were being approached in a *real* situation a different approach would need to be taken. For example, it would not be sensible to start the day with deliveries if the items you were delivering were those that you first had to cut out and sew. If a student were to take these, or similar, real world factors into account they would get the question 'wrong'. The original Graded Assessment in Mathematics (GAIM) (1988) activity from which the question was adapted does encourage students to consider and control the real world variables offered in the question. The question was adapted for research purposes in order to

Abstract \ Fashion	1	2	3	4
4				2
3			7	
2	1	3	1	
1	10	2	1	1

FIG. 2. Lingforth School—girls.

Abstract \ Fashion	1	2	3	4
4				1
3			6	
2		4		
1	10	3	2	1

FIG. 3. Lingforth School—boys.

Abstract \ Fashion	1	2	3	4
4				
3	1	1		
2	3		4	2
1	4		6	4

FIG. 4. Carroway Comprehensive—girls.

Abstract \ Fashion	1	2	3	4
4				1
3	1	1	1	1
2	2	1	2	1
1	9	1	2	1

FIG. 5. Carroway Comprehensive—boys.

present the same degree of open-endedness as the other two questions and in order to elicit appropriate research evidence.

Results

All of the students' responses to the questions were read and coded (Strauss, 1987) and each response was then allocated one of the emergent '*post hoc*' criteria. In the number questions, code 1 was given if students put all of the numbers into the minimum number of groups possible; code 2 was given if all numbers were put into groups, not using the most efficient groupings but showing a good understanding of the task. Code 3 was given for putting some numbers into groups but failing to demonstrate a clear understanding of the task. Code 4 was given for attempting the task without forming any groupings.

I then compared students' responses to pairs of questions assessing the same mathematical content in order to observe any links between the way that students learned mathematics and their ability to 'transfer' mathematics across different contexts (see Boaler, 1993). Figures 2–5 show students' responses to the abstract and the fashion question, showing the results for girls and boys and the two different schools separately.

Lingforth School

Figs 2 and 3 show that girls and boys at Lingforth generally attained the same grade on the abstract and fashion questions, shown by the fact that 22 out of 28 girls and 21 out of 27 boys were on the leading diagonal of each figure. The two figures also show that a number of girls and boys attain a lower grade on the fashion question than on the abstract question. Figure 2 shows that one girl got a lower grade on the abstract question and five girls got a lower grade on the fashion question. The second figure shows that six boys got a lower grade on the fashion question.

Carroway Comprehensive

Fig. 4 shows that in Carroway School five girls attained a lower grade on the abstract question and 16 girls attained a lower grade on the fashion question. Fig. 5 shows that the boys' attainment was more randomly distributed; four boys attained a lower grade on the abstract question and eight on the fashion question.

Discussion

The results broken down by gender and school involve a relatively small number of students but reveal some interesting patterns of performance. In Lingforth School the performance of girls and boys analysed across all questions was equivalent. The similarity in response and attainment between girls and boys in Lingforth would concur with other research findings in suggesting that a more open, less threatening environment which values communication and negotiation encourages girls' interests and combats underachievement (Burton, 1986b). In Carroway School the only differential attainment between girls and boys, in all six research questions, occurred in response to the fashion question. Sixteen girls attained a lower grade on the fashion question than on a similar question in an abstract context, presumably because of the context. There was no record of 'underachievement' on the questions involving football or wood cutting. The responses of the 16 girls who attained lower grades on the fashion question suggest that underachievement was caused or influenced by a greater involvement in the question. This involvement took a variety of different forms. Some students discussed the nature of the jobs and gave their opinion on the importance of different jobs. Some students took account of the order that the jobs would have to be encountered in; others adapted the times, for example deciding that Ramesh needed time to make deliveries to London *and* travel back again. The student in Fig. 6 has been influenced by the illustration which has suggested to the student that different people have different job suitabilities; other students used the sex of students to decide on job suitability.

The results from Lingforth School could be taken to suggest that when students learn mathematics in a process-based environment, girls *and boys* will attempt to integrate real world variables with the mathematics of a task, as they have been encouraged to do—an approach which must provide a good basis for tackling real world problems. In Lingforth School five girls and six boys attained a lower grade on the fashion question than on the equivalent question set in an abstract context. Thus approximately one-fifth of girls and boys 'underachieved' on the task, mainly because they took account of real world variables presented in the question. In Carroway School approximately two-thirds of girls underachieved on the fashion context compared with only one-third of the boys. The mathematics scheme used in Carroway School could be said to discourage students from taking account of real world variables in school problems. It seems that boys were more successful in employing this strategy and were more able to focus only upon the numbers in the task. Two-thirds of girls used their common sense as well as their mathematical knowledge and were penalised for doing so. This strategy must appear to be sensible to the girls and it is extremely worrying that such a strategy, eminently more sensible when encountering 'real world' problems, leads to failure in the mathematics classroom. What messages are being presented by this situation?—*school mathematics is not very useful in the real world*?; *school mathematics is illogical and difficult*?; *school mathematics is mysterious and confusing*?; *boys are better at school mathematics than girls*? It certainly appears that contexts which encourage girls to engage in them as

FASHION WORKSHOP

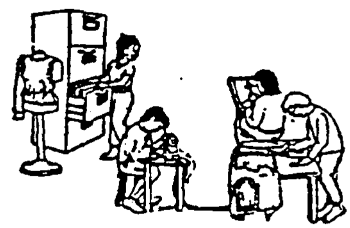
There are four people in the fashion workshop, Jane, Darren, Susan and Ramesh.

They have got two days to do all of the following jobs (8 hours work each day).

They can start a job one day and finish it off the *next* but they *cannot share* a job.

Work out who can do which jobs.

Show all of your working out and write down all of the decisions you make.



Darren – because 5 + 3 = 8 – – –
8 hours in a day and on the picture he is cutting so we have given him his work.

SKIRTS		
Cutting	5 hrs	Darren
Tacking	5 hrs	Susan – after she's done her deliveries the next day she can do some work in their workshop.
Machining	7 hrs	Ramesh because he has the time.

SHIRTS		
Cutting bodies	3 hrs	Darren
Cutting collars and sleeves	4 hrs	
Tacking bodies	3 hrs	
Tacking collars and sleeves	3 hrs	
Machining	7 hrs	Ramesh because he has got a good idea of machinery!

OTHER JOBS		
Deliveries to London	10 hrs	Jane (because she seems to know what she's desinging)
Deliveries to Birmingham	9 hrs	
Answering letters and filing	8 hrs	Susan (because she has got the knowledge of where the documents are kept!)

FIG. 6. Tracey's response.

though they were 'real' seem to result in more underachievement than contexts which are peripheral, even when the peripheral context is football or woodwork. Previous research by the Assessment of Performance Unit has shown that the context of an assessment task may disadvantage girls, as girls often value the circumstances that a task is presented in and have difficulty abstracting issues from their context (Murphy, 1990). It is possible that of the six questions offered to students only the fashion question had this effect, precisely because girls were more able to engage in this context. The attainment of all students, boys and girls, was not significantly different on any other pair of questions. Neither the girls nor the boys apparently underachieved on the wood or football contexts compared with the abstract versions of the same questions. Murphy (1990) and others have suggested that boys are less likely to be affected by context and the similarity in boys' performance on questions involving football or fashion seems to concur with this assertion. Perhaps the girls were unaffected by questions involving football or wood cutting because they were less interested in these contexts and were able to distance themselves from them to a greater extent.

This should not be taken to mean that contexts which involve real world variables or contexts which interest girls should not be used in assessment. Rather, it suggests that contexts which involve real world variables should only be used in mathematics examples and questions if they require students to *consider* the real world variables introduced in the question. If mathematics questions continue to introduce real world variables and expect students to ignore them they will surely perpetuate students' inability—or perhaps *disinclination*—to use 'school' mathematics in 'real' situations. Mathematics questions should not train students to ignore real world variables but instead enable them to consider and examine the underlying structures and processes which connect classroom questions with real situations. They should require students to determine the direction of the activity (Burton, 1989c), to think, rather than to remember and to view situations holistically, considering all of the mathematical and real world variables presented and what they mean for each other. Mathematical training to ignore real world considerations, which I believe is what is effectively offered by mathematics questions, such as those used in the SMP 11–16 scheme, must be part of the reason for students' apparent inability to transfer mathematics to the real world, as well as the source of much of girls' underachievement and disinterest in mathematics.

At the time of writing this, one year group at Lingforth School had completed 5 years of the process-based mathematics approach; this year group produced the best General Certificate of Secondary Education (GCSE) results for girls that the school had ever had. Is this because the students had experienced a mathematics which was about discussion, negotiation and challenge; a mathematics which was process-based, which considered real world variables and which was presented as a subject which was more than right or wrong answers to atomistic questions? Had this mathematics actually taken away the reported threat and 'mathsphobia' amongst girls? The scheme of work used in Lingforth School was produced partly in response to an Association of Teachers of Mathematics (ATM) initiative. The school was piloting a new process-based syllabus leading to an examination which encouraged process-based learning. Pronunciations from ministers prompted the Schools Examinations and Assessment Council (SEAC) to curtail the pilot of this syllabus. In doing so I believe that ministers have ended hopes of an examination syllabus which could have revolutionised mathematics teaching. I also believe that they have taken away the chance to improve the prospects of many girls trapped within 'mathsland'—a nightmare world of conflicting ideologies.

Acknowledgements

My thanks to Dylan Wiliam for his comments on earlier drafts of this paper.

Correspondence: Jo Boaler, Centre for Educational Studies, King's College, University of London, Cornwall House Annex, Waterloo Road, London SE1 8TX, United Kingdom.

REFERENCES

ADDA, J. (1989) The mathematics classroom as a micro society, in: C. KEITEL, A. BISHOP & P. GERDES (Eds) *Mathematics Education and Society* (Paris, United Nations Educational Scientific).

BOALER, J. (1993) Encouraging the transfer of 'school' mathematics to the 'real world' through the integration of process and content, context and culture, *Educational Studies in Mathematics*, 25, 341–373.

BROOMES, D. (1989) The mathematical demands of a rural economy, in: C. KEITEL, P. DAMEROW, A. BISHOP & P. GERDES (Eds) *Mathematics Education and Society* (Paris, United Nations Educational Scientific).

BURTON, L. (Ed.) (1986a) *Girls Into Maths Can Go* (London, Holt, Rinehart & Winston).

BURTON, L. (1986b) *Femmes et Mathematiques: y-a-il une intersection?* a presentation to the conference *Femmes et mathematiques*, Quebec, Canada 1986.

BURTON, L. (1989c) Mathematics as a cultural experience: whose experience? in: C. KEITEL, P. DAMEROW, A. BISHOP & P. GERDES (Eds) *Mathematics Education and Society* (Paris, United Nations Educational Scientific).

BUXTON, L. (1981) *Do You Panic about Maths? Coping with maths anxiety* (Oxford, Heinemann).

COOPER, B. (1993) Testing National Curriculum mathematics: some critical comments on the treatment of 'real' contexts for mathematics, *The Curriculum Journal*, 3(3), pp. 231–243.

DAVIS, P.J. & HERSH, R. (1981) *The Mathematical Experience* (Boston, MA, Birkhauser).

DE LANGE, J. (1992) Assessing mathematical skills, understanding and thinking, in: R. LESH & S. LAMON (Eds) *Assessment of Authentic Performance in School Mathematics* (Washington DC, AAAS Press).

DONALDSON, M. (1978) *Childrens Minds* (London, Fontana).

DONALDSON, M. (1984) *Children's Minds* (Glasgow, Collins).

FASHEH, M. (1991) Mathematics in a social context: math within education as praxis versus math within education as hegemony, in: M. HARRIS (Ed.) *School, Mathematics and Work* (Lewes, Falmer Press).

FOXMAN, D., RUDDOCK, G., MCCALLUM, I. & SCHAGEN, I. (1991) *APU Mathematics Monitoring (Phase 2)* (Windsor, National Foundation for Educational Research).

GRADED ASSESSMENT IN MATHEMATICS (1988) *GAIM Development Pack* (London, Macmillan).

INNER LONDON EDUCATION AUTHORITY (1983) *Mathematics in Context. A handbook for teachers* (London, ILEA).

JOSEPH, G.G. (1991) *The Crest of the Peacock* (London, Penguin).

JUDD, C. (1939) *Educational Psychology* (Boston, The Riverside Press).

KERSLAKE, D. (1986) *Fractions: children's strategies and errors* (Windsor, NFER-Nelson).

LAKATOS, I. (1976) *Proofs and Refutations* (Cambridge, Cambridge University Press).

LAVE, J. (1988) *Cognition in Practice* (Cambridge, Cambridge University Press).

MURPHY, P. (1990) *Assessment and gender* paper presented at *British Educational Research Association Annual Conference*, Roehampton.

OPEN UNIVERSITY/INNER LONDON EDUCATION AUTHORITY *Girls Into Mathematics* (Cambridge, Cambridge University Press).

PIAGET, J. (1968) *The Construction of Reality in the Child* (London, Routledge & Kegan Paul).

SPENDER, D. (1982) *Invisible Women: the schooling scandal* (London, Women's Press).

STANWORTH, M. (1981) *Gender and Schooling: a study of sexual division in the classroom* (London, Hutchinson).

STRAUSS, A. (1987) *Qualitative Analysis for Social Scientists* (York, Cambridge University Press).

TAYLOR, L. (1989) 'Let them eat cake'. Desire, cognition and culture in mathematics learning, in: C. KEITEL, P. DAMEROW, A. BISHOP & P. GERDES (Eds) *Mathematics Education and Society* (Paris, United Nations Educational Scientific).

THORNDIKE, R.L. (1971) *Educational Measurement* (Washington DC, American Council on Education).

TREFFERS, A. (1987) Three dimensions, a model of goal and theory description, in: *Mathematics Instruction—the Wiskobas Project* (Dordrecht, Kluwer Academic Publishers).

VYGOTSKY, L.S. (1978) Mind in society, in: M. COLE, V. JOHN-STEINER, S. SCRIBNER & E. SOUBERMAN (Eds) *The Development of Higher Psychological Processes* (Cambridge, MA, Harvard University Press).

WALKERDINE, V. (1988) *The Mastery of Reason* (London, Routledge).

WALKERDINE, V. (1989) The Girls In Mathematics Units, *Counting Girls Out* (London, Virago).

WILIAM, D. (1992) What makes an investigation difficult? paper presented at the *Secondary Mathematics Independent Learning Experience (SMILE) conference* held at Nottingham University, March.