

What is empowerment in mathematics education?

Paul Ernest, University of Exeter, UK

In this paper I explore three different but complementary meanings of empowerment in the teaching and learning of mathematics. 1. Mathematical empowerment concerns gaining the power to use mathematical knowledge and skills in school mathematics. 2. Social empowerment is the ability to use mathematics for social betterment. 3. Epistemological empowerment means confidence and personal power over the use, creation and validation of knowledge. Lastly, I relate these three dimensions of empowerment to the theme of equity.

What is empowerment?

Empowerment is the gaining of power in particular domains of activity by individuals or groups and the processes of giving power to them, or processes that foster and facilitate their taking of power. Thus a discussion of mathematical empowerment concerns the aims of teaching mathematics and the objectives of learning mathematics. It also concerns the role of mathematics in the life of the individual learner and its impact on their school and wider social life, both in the present and in the future. Empowerment through mathematics necessitates a consideration of the development of the identity of learners and their potentiation through the development mathematical and related capacities.

Conceptually, it is useful to distinguish three different domains of empowerment concerning mathematics and its uses, although these are neither wholly discrete nor unrelated in their modes of functioning. These three domains of empowerment may be described as mathematical, social, and epistemological.¹

Mathematical empowerment concerns the gaining of power over the language, skills and practices of using and applying mathematics. This is the gaining of power over a relatively narrow domain e.g. that of school mathematics.

Social empowerment through mathematics concerns the ability to use mathematics to better one's life chances in study and work and to participate more fully in society through critical mathematical citizenship. Thus it involves

¹ A fourth domain of mathematical empowerment can also be defined, namely the professional empowerment of the mathematics teacher. Professional empowerment in this sense concerns the development into an autonomous and reflective teacher of mathematics, with the confidence to both construct and to critically assess teaching, learning and assessment schemes. However, in the present context I will focus only on mathematical empowerment as it affects the learner, especially since this is where issues of equity are most acute.

the gaining of power over a broader social domain, including the worlds of work, life and social affairs.

Epistemological empowerment concerns the individual's growth of confidence not only in using mathematics, but also a personal sense of power over the creation and validation of knowledge. This is a personal form of empowerment: the development of personal identity so as to become a more personally empowered person with growth of confidence and potentially enhanced empowerment in both the mathematical and social senses (and for the mathematics teacher – enhanced professional empowerment).

Mathematical empowerment

From a semiotic perspective, mathematical empowerment consists of the development of power over the signs of mathematics, that is the 'texts' of mathematics within their social context. Here the word 'text' is used in its broadest semiotic sense to mean any simple or elaborate constellation of signs, be they symbols, indices, icons (Peirce 1931-58) or a mixture, together with the social nexus of their use (Ernest 1993, 1998a). The semiotic perspective of mathematical activity is currently less well developed than cognitive perspectives (including constructivism), but some of its features are as follows.

Semiotic capabilities in mathematics include the ability to:

Read mathematical texts and make sense of them as tasks and to apprehend their object, purpose and goals, within a variety of contexts, most notably, in the school context.

Transform mathematical texts presented as tasks into further more manageable representations and to apply a variety of textual and symbolic transformations to these representations and their parts to complete the tasks. This process involves the active processes of imagining, writing or drawing sequences of representations (not necessarily either monotonic or single branched sequences) progressing from the initial text (given task) to a final (in terms of fulfilling task demands) and permissible (i.e., derived by allowed transformations), often simple, textual representation (i.e., the achievement of a potential task 'solution').

Pose mathematical problems and to write mathematical questions and tasks, with some sense of what the task text transformations involved in solution processes entail.

Make sense of, read and follow mathematical texts representing computations, derivations and where appropriate proofs, such as previously written task 'solutions', and to critique such texts from the perspective of 'correctness', i.e., with respect to current norms and rules of their context.

The first two abilities are more traditionally glossed in terms of understanding and solving mathematical problems, both routine and non-routine. The third corresponds to mathematical problem posing or task setting. The fourth ability

comprises evaluation capabilities in reading and judging the correctness of mathematical solutions. Overall, mathematical empowerment comprises the ability to make sense of, write and judge the correctness of mathematical texts concerning mathematical tasks and questions as well as their solutions and answers, including asking the questions themselves. Only when a person has mastered the four capabilities can they be said to be fully empowered mathematically, even if the domain of application of these abilities is limited (e.g., to a significant part of school mathematics).

Social empowerment

There is a continuum of ways in which mathematics can contribute to social empowerment from the straightforwardly utilitarian to the more politically radical 'critical mathematical citizenship'. In the minimal utilitarian way, success at mathematics gives students power through enhanced life chances in study, the world of work, and social affairs. Thus developing applicable capabilities in mathematics often benefits the student directly in these domains. However, quite often it is personal certification in the form of examination and test results that serve as evidence of the student's capabilities which open the doors of social opportunity. Typically such formalised achievement documentation is required by 'gatekeepers' for admittance to advanced study and also to many rewarding occupations.

Qualifications in mathematics are accorded a privileged role and have unique social significance. Their use as a 'critical filter' controlling entry into higher education and higher paid occupations has long been noted, especially by researchers in gender and mathematics (e.g., Sells 1973, 1976, Walkerdine 1997). This role extends far beyond occupations involving scientific and technological skills to many other occupations, including education, the caring professions, financial services and management positions in business. This has important implications for social equity, and in many anglophone western countries there are widespread patterns of girls' and women's lower participation rates in advanced mathematics study, as well as lower examination attainments during schooling. The latter may be diminishing but the overall 'critical filter' effect, in combination with other social factors, still results in many women getting lower paid work, thus sustaining and reproducing gender inequity in society (Ernest 1995). Similarly, differential patterns of mathematical and general educational achievement by social class, long noted by researchers (e.g., Task Group on Assessment and Testing 1988) also has important implications for social equity.

At the other end of the continuum of meanings of social empowerment is critical mathematical citizenship. This involves the development of mathematically-literate or socially-numerate citizens who are able to exercise independent critical judgements with regard to the mathematical underpinnings

of social and political decision-making. The idea of 'being critical' is not the popular meaning of being inclined to judge severely and find fault, or of calling attention to petty errors. Instead it is about engaging in a critique; it means making careful judgements, using all available evidence, reasoning and balanced arguments to evaluate claims and to reach conclusions. It also means not taking explanations and views of tradition or 'authorities' for granted but questioning them to see if they stand up to careful and challenging scrutiny. Above all it means independent thinking, which draws upon the larger contexts and implications of the issue under consideration, as well as detailed knowledge, to make balanced judgements.

There is a tradition of critical mathematics education (e.g., Ernest 1991, Skovsmose 1994) with two main sets of questions underpinning it. First, there is the nature of mathematics itself. Is it the superhuman realm of timeless certainty consisting only of objective and value-free knowledge? Or are there other ways of conceptualising mathematics in more human, cultural and historical ways? Second, is questions about the aims and purposes of teaching and learning mathematics. What are and what should be these aims? Whose aims? For whom? Based on whose values? Does mathematics education favour some groups at the expense of others? If so who gains and who loses? How should mathematics learning empower learners in their lives and in relation to society? Can it provide a critical mathematical literacy strengthening citizenship and furthering justice for all in modern society?

From this perspective students should be able to think mathematically, and be able to use their mathematical knowledge and skills in their lives to empower themselves both personally and as citizens, and through their broadened perspectives, to appreciate the role of mathematics in history, culture, and the contemporary world, as follows.

Critically understand the uses of mathematics in society: to identify, interpret, evaluate and critique the mathematics embedded in social, commercial and political systems and claims, from advertisements to government and interest-group pronouncements.

Be aware of how and the extent to which mathematical thinking permeates everyday and shopfloor life and current affairs.

Have a sense of mathematics as a central element of culture, art and life, present and past, which permeates and underpins science, technology and all aspects of human culture.

Being aware of the historical development of mathematics, the social contexts of the origins of mathematical concepts, symbolism, theories and problems.

Understanding that there are multiple views of the nature of mathematics and controversy over the philosophical foundations of its knowledge.

In short, critical mathematics education should give learners an appreciation and awareness of the nature and value of mathematics and the uses to which it is put, as well as understanding and being able to critique its social uses.

If this emphasis is intended to empower learners, these need to be *live* aspects of awareness. They need to link to the real interests, enthusiasms and experiences of students. All students bring with them an extensive range of knowledge and experience from everyday life, the world of work and the social and cultural milieu in which they live. These include their knowledge and involvement in local affairs, leisure activities, pastimes, hobbies, clubs, and the media including popular music, video games, television, films, magazines and newspapers. There is an extensive range of issues involved, including local, national and global politics, environmental issues, health, fitness, sport, nutrition, drugs, education, policing, law and order, finance, housing, transport, accidents and safety, and so on. Mathematically empowered students should be to apply their critical mathematical-literacy skills across these domains. It is also indicates the rich range of issues which can be drawn upon as meaningful resources for contextualising the teaching and learning of mathematics. Authentic materials, social statistics, and other resources thus provide a basis for understanding how mathematics is used and applied in the world outside school. In particular, they can be used to teach students to identify, interpret, evaluate and critique the socially embedded mathematics.

In the development of critical mathematical literacy and citizenship the empowered learner will not only be able to pose and solve mathematical questions (mathematical empowerment), but also will be able to understand and begin to answer important questions relating to a broad range of social uses and abuses of mathematics (social empowerment). Many of the issues involved will not seem to be primarily about mathematics, just as following current affairs from reading serious newspapers is not primarily about literacy. Once mathematics becomes a '*thinking tool*' for viewing the world critically, it will be contributing to both the political and social empowerment of the learner, and hopefully to the promotion of social justice and a better life for all.

Do pupils really need to be able to see the world through mathematical eyes to be effective citizens in modern society, when most of these concerns are general and not mathematical? From a critical mathematics education perspective they do, because the mathematisation of modern society and modern life has been growing exponentially. Today, virtually all human activities and institutions are conceptualised, regulated and communicated numerically. For example, sports records are numerical, as are music charts and those for best selling books. Many aspects of modern society are controlled by complex hidden mathematical systems, such as supermarket checkout tills with automated bill production and stock control; tax systems; welfare benefit systems; industrial, agricultural and educational subsidy systems; voting systems; stock

market systems. These automated systems carry out complex tasks of information capture, policy implementation and resource allocation. The point is that complex mathematics is used to regulate many aspects of our lives with very little human scrutiny and intervention once the systems are in place. Only through a critical mathematics education can future citizens learn to analyse, question and challenge these systems that can distort life chances and reduce freedoms.

Much of our experience of life is already mathematised. Unless schooling helps learners to develop the knowledge and understanding to identify these mathematisations of our world, and the confidence to question and critique them, they cannot be in full control of their own lives, nor can they become properly informed and participating citizens. Consequently, they may be manipulated by commercial, political or religious interest groups, or may become cynical and irrational in their attitudes to social, political, medical and scientific issues.

The mathematisation of modern society and is more than a neutral language that serves as a useful tool. It also embodies a set of values about what is socially possible and desirable. Thus economics as used in modern society is not merely a neutral description of the flow of resources. It also represents a perspective that maintains the status quo, dehumanising discussions of military expenditure, social welfare, world debt, etc. It is not easily possible to question the pronouncements of political and commercial authorities in such areas of policy unless one has the skills and confidence to understand and sometimes challenge the applications of mathematics, and the hidden assumptions upon which they rest.

What does critical mathematics education mean in terms of classroom practice? The aims of critical mathematics, require the use of a questioning and decision making learning style in the classroom. Teaching approaches should include discussions, permitted conflict of opinions and views but with justifications offered, the challenging of the teacher as an ultimate source of knowledge (not in their role as classroom authority), the questioning of content and the negotiation of shared goals. Also learners should be given the chance pose their own problems and initiate their own projects and investigations at least some of the time, as did the children of the School of Barbiana (1970). Learning materials should include socially relevant projects, authentic social statistics, should accommodate social and cultural diversity, and use local cultural resources. However the approach must also honestly and openly address the instrumental and life goals of the learners themselves, both in terms of needed skills and passing exams.

However, using mathematics for political and social understanding and empowerment has always been controversial for fear that it can become propaganda and a political misdirection of the young. But, as anyone who has

taught contentious issues in the mathematics classroom or lecture hall in a democratic country knows, such an approach invariably results in dispute and heated argument rather than in passive acceptance. The pupils of today will not accept teacher propaganda without question. The safeguard built into the critical mathematics education approach is that it encourages students to think for themselves and to apply their skills in independent appraisals of contentious issues based on balanced reasoning and arguments constructed by themselves. As long as this independence remains at the heart of critical mathematics education, then it cannot degenerate into polemics and political propaganda.

Epistemological empowerment

This concerns the individual's growth of confidence not only in using mathematics, but also a personal sense of power over the creation and validation of knowledge. This is a personal form of empowerment: the development of personal identity with a growth of confidence.

Many students and other individuals, including mathematics teachers (Cooper, 1989), are persuaded by the prevailing ideology that the source of knowledge is outside themselves, and that it both created and sanctioned solely by external authorities. They believe that only such authorities are legitimate epistemological agents, and that their own role as individuals is merely to receive knowledge, and to reproduce or transmit it as accurately as possible. Thus despite being knowers most individuals are disempowered as epistemological agents.

In order to explore this dimension of empowerment, it is valuable to turn to models of the development of the individual knower. There are a number of such models (see Ernest 1991 and Baxter Magolda (1992), but that of Belenky *et al* (1986) is the most relevant in the present context because of its direct focus on the developing epistemological powers of the individual. This models the stages of empowerment of the knower, in which students develop as epistemological agents from a position of complete passivity (passive receivers of knowledge) dominated by authority to one of epistemological autonomy and empowerment, as they progress through the stages. Becker (1996) interviewed a number (31) of students of mathematics of both sexes, and interpreted their personal views of mathematics and knowledge using this model. While she found a good match for their views of knowing, few were at the final 'constructed knowing' stage, and overall they did not fit neatly into gender categories, with both male 'connected knowers' and female 'separate knowers'.

The model offers a hierarchy of stages of epistemological empowerment, from the passive, silent reception of knowledge from authority, through to the active construction of knowledge coupled with awareness of this power. Thus the strength of this theory is that it accounts for the range of relative positions, including power relationships, that hold between knowledge users and

knowledge creators or authorities. One, the subject, is the receiver and user of knowledge (explicitly treated in the theory). The 'other', implicit in the account, is the external source of knowledge and authority.

The range of relationships begins with the complete domination of the subject by the 'other' in authority, in the stages of Silence and Received Knowledge. In these cases the transmission metaphor in its most authoritarian form reigns supreme, with the subject being the passive recipient of the absolute knowledge from the 'other'. This case describes the position of many learners of mathematics, who accept that they must simply receive knowledge unquestioningly from the teacher, and who believe that there are no other touchstones for its validity. In the first stage the learner or subject has no agency or power and simply receives passively. In the second stage, the learner has the power to 'parrot' the received knowledge, that is, to utter the same pronouncements simply and solely on the authority of the teacher.

In the stage of Subjective Knowledge, the transmission metaphor still dominates, but the subject may passively resist the knowledge and authority of the 'other', preferring to listen to her own intuition or 'gut feeling'. This describes how many learners in mathematics prefer their own informal methods which they intuitively feel to be safer to new ones provided by the teacher which the learner does not yet feel she 'owns' (Hart, 1981).

At the stage of Procedural Knowledge, the subject is no longer overpowered by the 'other' as an unquestioned epistemological authority. The subject is able to seek and justify objective knowledge by means of either the Separate or the Connected Knowing approaches.

Separate Knowing is a new, rational mode in which the subject realises that there are objective logical criteria and rules for justifying and criticising knowledge, and uses them. Authority supplies these criteria as unquestioned assumptions and rules out as irrelevant matters that do not fall within their sphere. However, within the field of application of the rational criteria, all knowledge claims can be scrutinised for correctness, and criticised, and new knowledge claims can be put forward. In the learning of mathematics this form of knowing can encompass mastery of notation, symbolism and syntax. Also an emphasis on following procedures, logical reasoning, proof and correctness.

Connected Knowing is an elaboration of the intuitive knowing of the previous stage, and arises from an immersion in the domain of experience. This mode of knowing involves a rapprochement between the knower and known; an intimacy with the inner relationships of the area of knowledge which give them meaning and plausibility. In the learning of mathematics, this can involve the understanding of conceptual links, and the use of reasoning processes and general strategies to conjecture mathematical relationships. To a partial extent this matches Skemp's (1976) idea of 'relational understanding'.

At the stage of Constructed Knowing, the subject is an autonomous epistemological agent, and does not make concessions to the 'other' in authority. The subject has the confidence to integrate both connected and separate knowing, and to question the foundations and assumptions implicit in any inquiry, as well as to pose new questions. In the learning of mathematics, the constructed knower questions new items of knowledge, and relates them to the body of mathematical knowledge and to human purposes and culture. She also able to pose new mathematical problems, and explores approaches to them, and shares the outcome with peers and teachers.

If we apply this model to school children, most of them will best be described as being in the early stages. They may have acquired some of the knowledge and means of doing mathematics at school but because of the 'disconnected' way in which mathematics is usually taught it will probably just be a small compartment in their lives and a way of thinking that they bring out in the mathematics classroom. If they succeed in mathematics hopefully they develop the ability to apply some of the features of the intermediate stages, but this may still leave mathematics as something technical and little to do with their lives and experiences. Very few will be able to relate to mathematics through connecting different areas of their own knowledge. This is primarily about intuition and an 'inside knowledge' of mathematical concepts. (Feeling you can get inside mathematical ideas, and feeling that they have some life inside your imagination too.) The ultimate goal, according to this model, is to achieve the stage of being a '*constructing knower*', where you can combine intuition and the procedures and skills of mathematics to make sense of the world and confidently apply mathematical thinking to it.

What this model suggests is that to achieve the epistemological empowerment it is not enough for learners to gain mastery over some mathematical knowledge and skills. There needs to be a personal engagement with mathematics so that it becomes an integral part of the learner's personal identity. This means that the learners need to:

- be confident in their mathematical knowledge and skills; in their ability to apply these capabilities both in routine and non-routine mathematics tasks, and in applied social contexts; and in their ability to understand mathematical ideas and concepts including new ones;

- have senses of mathematical self-efficacy, i.e., a confident self image of themselves as successful in mathematics; and of personal ownership of mathematics including a sense that they can be creative in mathematics.

These are very ambitious goals for school mathematics. Such goals can very likely only be achieved over the long term. Probably the most important factor will be the quality of student-teacher relationships in the mathematics classroom. In case studies where learners have suddenly surged ahead and been mathematically empowered the catalyst has usually been personal

encouragement by the teacher and the establishment of a personal relationship with the teacher after some success in a special student project (e.g., Womack 1983).²

A number of factors seem to be important:

Student success at mathematical tasks over prolonged period of time

Student 'ownership' of this success, i.e., the sense that it results from their own powers and application

Increasing cognitive demands in set tasks so that challenge and hence levels of attainment increase, i.e., the success is real, not contrived

A rich variety of mathematical tasks and projects so that some of the time students have to use their initiative and creative powers

An emphasis on problem solving processes and less importance given to correct answers, so students become confident to take risks in their mathematical work and to share their ideas with the class

A shift in power relations so that the teacher listens to pupils in depth and allows them to make and express judgements and values their contributions

A shift away from individual competitive work towards more group sharing of mathematical ideas.

Based on both a theoretical analysis and on professional experience, these appear to be the most important factors. However, even if these recommendations were based on research evidence there would be no guarantees that implemented over an extended period of time they would succeed in empowering all learners as epistemological agents. Human beings are complex and self-constructing entities and their reactions are simply not mechanistically predictable. In some cases not all factors will be necessary. Indeed, as indicated above, sometimes a single incident can initiate a shift towards engagement, confidence and epistemological empowerment. In other cases, despite the best efforts of teachers to structure classroom mathematics in these listed ways students may not gain the required confidence or sense of autonomy. After all, experiences in mathematics classes contribute only a small part to learner identity construction. Other factors such as emotional insecurity or strong peer identification may overwhelm such positive experiences. Nevertheless over an extended period these factors should have a dramatic impact on the confidence and mathematical powers of most students.

Of course the social context of teaching and the constraints and opportunities it provides will limit the opportunity of many teachers to teach mathematics in these ways. Indeed teachers themselves need to be professionally

² Anecdotal evidence exists of the opposite effect too. Students have developed mathephobia following incidents in which the learner failed to succeed at some mathematical task or series of tasks, felt criticised and diminished by the teacher for this failure, and was publicly humiliated or was fearful that this might occur.

empowered as near-autonomous agents to have the confidence to work in such ways.

Conclusion: Empowerment and Equity

The aim of empowering learners as epistemological agents is a radical and summative one, as it brings together and integrates all three of the different types of empowerment discussed above. Only when all of these powers are developed will they feel they are entitled to be confident in applying mathematical reasoning, judging the correctness of such applications themselves, and critically appreciating (including rejecting, in some cases) the applications and uses of mathematics by others, across all types of contexts, in school and society. Thus epistemological empowerment is the culmination of the other types of empowerment discussed here.

What are the implications for equity through mathematics? Implicit in my analysis is the assumption that enabling learners to become mathematically empowered will enhance their capabilities and confidence in all forms of using and applying mathematics, and hence their levels of attainment in mathematics by whatever means they are measured. On this assumption, the first step towards equity is to provide equal opportunities for all learners to become empowered mathematically. This means implementing long-term programmes through which learners develop the mathematical capabilities, the skills of using and applying mathematics, and confidence and a sense of personal ownership of mathematics. Much is already known about achieving these goals, although these proposals suggest an increased emphasis on social and epistemological empowerment in mathematics.

A legitimate criticism is that my discussion of empowerment is primarily individualistic, for I have mainly looked at the powers that can be developed by individuals, with little attention to their membership within societal groups and with no attention to the relationships between sectors. But there are well known structural and systemic differences which favour some groups and inhibit the progress of others. Although this is irrefutable, an empowerment perspective can nevertheless address some of the problems of inequity. For example, one of the enduring patterns of mathematical difference in terms of gender in Anglophone Western countries is the lower mean measures of confidence and self-efficacy (especially in terms of Attribution Theory) of girls and women (see, e.g., Ernest 1998b). This can be read in terms of differential levels of epistemological empowerment by girls and women, since this encompasses confidence and self-perceptions of efficacy and autonomy.

References

Baxter Magolda, M. B. (1992) *Knowing and Reasoning in College: Gender Related Patterns in Student's Intellectual Development*, San Francisco: Jossey Bass.

- Becker, J. R. (1996) Research on gender and mathematics: One feminist perspective, *Focus on Learning Problems in Mathematics* 18 (1, 2 & 3) 19-25.
- Belenky, M. F., Clinchy, B. M., Goldberger, N. R. and Tarule, J. M. (1986) *Women's Ways of Knowing*, New York: Basic Books.
- Cooper, T. (1989) Negative Power, Hegemony and the Primary Mathematics Classroom: A Summary, in Keitel, C. et al., Eds., *Mathematics Education and Society* (1989), Paris: UNESCO, 150-154.
- Ernest, P. (1991) *The Philosophy of Mathematics Education*, London: Falmer Press.
- Ernest, P. (1993) Mathematical Activity and Rhetoric: Towards a Social Constructivist Account, in Hirabayashi, I. et al., Eds, *Proceedings of PME-17 Conference*, Tsukuba, Japan: University of Tsukuba, 2, 238-245.
- Ernest, P. (1995) 'Values, Gender and Images of Mathematics: A Philosophical Perspective' *International Journal for Mathematical Education in Science and Technology*, 26 (3) 449-462.
- Ernest, P. (1998a) *Social Constructivism as a Philosophy of Mathematics*, Albany, New York: State University of New York Press.
- Ernest, P. (1998b) 'Introduction: Changing Views of 'the Gender Problem' in Mathematics', in Walkerdine (1998), 1-14.
- Hart, K. Ed. (1981) *Children's Understanding of Mathematics: 11-16*, London: John Murray.
- Peirce, C. S. (1931-58) *Collected Papers* (8 volumes), Cambridge, Massachusetts: Harvard University Press.
- School of Barbiana (1970) *Letter to a Teacher*, Harmondsworth: Penguin Books.
- Sells, L. (1973) 'High school mathematics as the critical filter in the job market', *Proceedings of the Conference on Minority Graduate Education*, Berkeley: University of California, 37-49.
- Sells, L. (1976) 'The mathematics filter and the education of women and minorities', paper presented at the Annual Meeting of American Association for the Advancement of Science, Boston, February 1976.
- Skemp, R. R. (1976) 'Relational Understanding and Instrumental Understanding', *Mathematics Teaching*, 77, 20-26.
- Skovsmose, O. (1994) *Towards a Philosophy of Critical Mathematics Education*. Dordrecht: Kluwer.
- Task Group On Assessment and Testing (1988) *A Report*, London: Department of Education and Science.
- Walkerdine, V. (1998) *Counting Girls Out*, New Edition, London: Falmer Press.
- Womack, D. (1983) 'Seeing the Light', *Times Educational Supplement*, 8 April 1983.