

THE STUDENT VOICE IN SCIENCE EDUCATION: RESEARCH AND ISSUES

Edgar W. Jenkins

Centre for Studies in Science and Mathematics Education, University of Leeds, United Kingdom

Abstract. *The article reviews a range of national and international studies concerned with students' views about science and their school science education. It suggests that such views have gained some prominence in recent years and comments why this is so. It examines the implications of some of the research findings for policy makers, curriculum developers and science teachers. It concludes that, while the outcomes of specific research studies are always interesting, such outcomes may prove to be of most use in helping to develop more general strategies for increasing student motivation, commitment and attainment.*

Key words: *science education, student motivation.*

Science is in the curriculum because it *is* relevant and, it should always be added, relevant to *people*. Relevance is the very reason for its existence, and it should be the very backbone of science teaching. (Newton 1988, p.7)

One of the noteworthy features of recent research in science education is the increased attention given to what might be called the 'student voice'. Such research seeks to identify and articulate what students think about the form, content and purpose of their school science education, their attitudes towards a variety of science-related issues and whether or not they wish to pursue a career in science or technology. This paper explores why research of this kind has gained some prominence in recent years, reviews some of the relevant studies and explores the significance of the findings for policy makers, curriculum developers and teachers.

Why now?

Although research into the student voice in school science education has featured more prominently in the literature in recent years, attention to student opinion is by no means new. Anyone teaching science in a school will have encountered students who ask such questions as 'Why do we have learn this?' and 'What is the point of doing this experiment?' Responses to classroom questions of this kind, however, are essentially local and personal. In contrast, there is a long-established literature concerned with students' views about science and scientists, e.g. Mead and Métraux 1962; Chambers 1983. The work of Chambers, based on a 'Draw-a-Scientist-Test', has proved to be of seminal importance since the test was subsequently revised and deployed by several other researchers (e.g. Mason, Kahle and Gardner, 1991; Symington and Spurling, 1990) and more recent studies have been able to show some shifts in students' images of scientists over time, not least towards a greater degree of gender equity (Matthews, 1996). Data generated by studies of this kind inevitably present problems of interpretation (e.g., Symington and Spurling, 1990) and few of the findings seem to have been turned to significant pedagogical advantage (e.g., Barman, 1996). There is also a literature concerned with students' interests in science (e.g., Tamir and Gardner, 1989) and attitudes (e.g., Schibeci, 1984; Simpson *et al.*, 1994) and there has long been recognition that attitudes and interest have a bearing on the teaching and learning of science as well as being important among the outcomes of science education. Research of this kind has likewise had little general impact on pedagogy or science curriculum reform, not least because the implications of students' attitudes towards, interests in, or images of science for the science curriculum and for the way in which science is taught are by no means straightforward. It is perhaps significant that the word student does not even appear in

the index of the two volume *International Handbook of Science Education*, published in 1998 (Fraser and Tobin, 1998).

The present level of interest in the student voice in science education almost certainly owes much to the unpopularity of the physical sciences as subjects of advanced study in most industrialised countries and the associated enduring gender differentials. Politicians, as well as educational researchers, want to know why these issues arise and want to do something about them. The (untested) assumption is that the more that is known about students' interests, enthusiasms, dislikes, beliefs and attitudes, the more feasible it will be to develop school science curricula that will engage their attention. However, other factors are also in play, especially in those education systems that have espoused a market philosophy. Such a philosophy characterises a science curriculum as something to be 'delivered' and places students and their parents in the position of customers. Customers have rights and one way of exercising those rights is to express views about what should be taught in school science courses. The underlying issue here is where science curriculum expertise should lie. To give students a voice in establishing the content of a science curriculum can be seen as challenging traditional sources of curriculum authority as well as a manifestation of wider social changes that are captured by such terms as post-modernism and constructivism.

At a more formal level, there is the European Convention on Human Rights and the UN Convention on Children's Rights, Article 12 of which asserts a child's right to express an opinion and have that opinion taken into account in any matter or procedure affecting that child. Beyond this, many teachers would acknowledge that advantages may stem from giving students a sense of 'ownership' of what they are required to learn and that students' experience of school science may be very different from that perceived or assumed by those who teach them. It is hardly surprising if, as disaffection with the physical sciences continues to grow in many industrialised countries, the need to understand why this is so becomes increasingly urgent, although it needs to be recognised that such disaffection varies greatly among, and within, different cultures.

Some Studies and Findings

The research that has been undertaken to establish what students think about their school science education is methodologically diverse, relates to different age groups and embraces both national and international studies.

A *Student Review of the Science Curriculum* was undertaken in England at the end of 2001 and the beginning of 2002 (Planet Science *et al.*, 2003). The *Review* was based on data collected via a web-based questionnaire involving 55 questions. These questions were derived from a range of issues that concerned young people as expressed at a series of regional meetings. These meetings varied in size from under a dozen to over 130, with an average of around 30 students. A selection of these students made up a national group that was given responsibility for the final design of the questionnaire and for helping to analyse and report the findings. The on-line survey lasted six weeks and generated 1,493 responses. 73% of the respondents were between 16 and 19 years of age and a further 22% were 14 to 16 years old. Given what is sometimes said about girls and computers, it is interesting that there were many more girls (66%) than boys (34%) among the respondents. Some care is needed, however, in reading the results of the survey, since almost two thirds (64%) of the respondents were from independent, i.e. fee-paying, schools. If the sample were representative, this figure would be about 7% for 11-16 year olds and 20% for 16-18 year olds. The much higher percentage of independent school respondents probably reflects the higher level of computing resources available in some of these schools and the fact that some of the respondents were boarders at their schools. In this connection it is noteworthy that 53% of the respondents were at co-educational schools, 41% at girls' schools and only 6% at boys' schools. It should also be noted that about half (52%) of the 14-16 year olds in the sample were not expecting to go on to study science beyond 16, with the

remaining 48% expecting to continue with their science studies. A somewhat disappointing 42% of the respondents indicated that their science lessons had not made them curious about the world and interested in finding out more. About 69% of the students agreed that controversial issues should be included in their school science courses. Asked what they found boring in school science, topics drawn from physics were mentioned most often, followed by chemistry and then biology.

Physics. I have never, nor will I ever, either see the point or understand physics. It always seemed pointless spending hours of experimental time proving what was already proven, or that black wasn't a colour, or whatever. (*ibid.*, 17)

At some risk of oversimplifying the outcomes of this study, the broad messages seem clear. Many pupils want more discussion in their science lessons, they want school physics and chemistry to be more relevant to everyday life, especially the girls, and they want to engage with ethical and controversial issues in science.

Some of the above findings of this study resonate with the outcomes of a focus-group based survey that sought the views of parents as well of students, together with teachers' responses to the views expressed (Osborne and Collins, 2000; 2001). The focus groups were conducted with the aid of a series of questions prompted by reference to the value of school science, the application of science to everyday life, visions of school science in the future, and the appeal of science in everyday life. In general, students thought science was important but valued their school science education for career aspirations rather than as a subject of intrinsic interest. Chemistry, especially, was seen as 'abstruse and irrelevant'.

It doesn't mean anything to me. I'm never going to use that that. It's never going to come into anything, it's just boring (*ibid.*, 21)

Yeah, bonding, you're never going to think 'How do I bond'? (*ibid.*, 22)

Students found practical work in the laboratory 'interesting' and indicated that they would like to learn about their bodies in biology, the solar system and the universe in physics and 'mixing chemicals' in chemistry. Among the parents, women valued science when it gave them an insight into the causes and prevention of illness, the maintenance of good health, an understanding of diet, nutrition and exercise, and the dangers of smoking. Men, in contrast, tended to say that they used science 'unconsciously' by which they meant that they had used science-based technologies such as cars and computers into which school science had given them little insight. Teachers, perhaps unsurprisingly, saw any improvement in school education as strongly related to class size, curriculum overload/time and examination reform.

Student's interests in science also feature in a wide-ranging study undertaken in the UK in 2004 as part of the Nestlé Social Research programme (Haste 2004). The sampling procedure and methodology of this study are more complex than most surveys of student opinion and the age range of the students involved (11-21) is also much wider. Some 33% of the sample of 1,958 young people expressed an interest 'in varying degrees' in a job relating to science, 21% agreed to some extent with the statement that 'science is largely irrelevant' to their everyday lives, with a further 31% expressing no opinion. As with other studies, the Nestlé study revealed marked gender differences, although these changed somewhat with age, and the overall conclusion is that

Girls are not so much less interested in science than boys; almost exactly the same proportion of girls as boys – about a third – would be interested in jobs relating to science. But girls focus on different things (*ibid.*, 3)

A very different study of some relevance to what students want to learn at school comes from research into the use made of newspapers in secondary schools in Northern Ireland. Data were drawn from 35 non-selective and 15 selective schools (20% of the total) by means of semi-structured interviews with heads of departments in schools or their nominees. Students responded positively to the use of newspapers to discuss issues relating to contemporary science whereas science teachers used such resources only on an occasional basis (Jarman and McClune, 2000; 2003). The findings of this study need to be set alongside research that suggests that most people get their information about science from newspapers and from television, although in the case of teenagers, school science remains a particularly important source of scientific knowledge (Gunter *et al.*, 1998; see also Lock, 1996).

Students' views about school science in England are also evident in the outcomes of a study into the future of schooling (Burke and Grosvenor 2003). Invited to describe the school that they would like, students from over 1,500 schools responded with essays, photographs, pictures, stories, plays, plans, poems and film. Although the consequent data archive has not been systematically trawled for students' views on science, some examples are available.

The notion of writing prize-winning essays on tropical rainforests without taking some action would be seen as strange (boy, aged 17)

I think our school should look at plants and wildlife and nature (girl, primary school)

Note should also be taken of a major research project in the UK, entitled "Consulting Pupils about Teaching and Learning". The project supports a number of more specific studies, one of which is concerned with 'Ways of consulting pupils about teaching and learning'. Science does not figure prominently in the overall programme, although there are occasional glimpses, and full details are available on the project web site (<http://www.consultingpupils.co.uk>).

One of the prominent features of research and policy in science education in the past decade or so has been the emergence of large-scale international comparisons of the outcomes of school science teaching and learning. The best known examples are the Third International Mathematics and Science Study (TIMSS) and the OECD Programme for International Student Assessment (PISA). The results of these international comparisons have been widely used by policy makers, despite the methodological and other difficulties associated with international comparative research and the criticism to which such work is vulnerable (Shorrocks-Taylor and Jenkins, 2000). The focus of these two studies is different. TIMSS has focused attention on the curriculum as a broad explanatory factor underlying student achievement (Martin and Mullis, 2000) whereas the emphasis in PISA is on the extent to which education systems in the participating countries prepare students to become life long learners and to play constructive roles as citizens in society (Schleicher, 2000). The volume of data generated by these projects is immense but each presents interesting questions about students' views of school science. In the case of TIMSS, for example, students' generally very positive views about their school science education were not reflected in the level of their performance in the TIMSS tests (Schmidt *et al.*, 1999).

The international *Science and Scientists* (SAS) project, based in Norway, published its results in May 2000 (Sjøberg, 2000). The project investigated the 'interests, experiences and perceptions of children in many countries that might be of relevance for the learning of science' (*ibid*, p. 4). Some 30 researchers from 21 countries and over 9,000 children aged 13 were involved in the questionnaire study constructed around seven broad themes: The scientist as person, Out of school experiences, Things to learn about, Importance for a future job, Science in action, Scientists at work and 'Me as a scientist'. Some elements of the questionnaire drew upon and developed earlier work, e.g., the 'Draw-A-Scientist' test (Chambers, 1983; Matthews, 1996) and an inventory of Out of School Experiences (Lie and Sjøberg, 1984; Whyte, 1986). The Project was an important precursor to the *Relevance of Science Education* (ROSE) study currently underway. Details of this latter project, including the questionnaire, a review of

methodological issues and information about the countries involved, are available on the project web-site (<http://www.ils.uio.no/forskning/rose>). Unlike TIMSS and PISA, the ROSE study is not a test of learning outcomes. Preliminary results reveal a number of significant differences in the patterns of responses from the 15-year-old students, e.g., between boys and girls, between students in developed and developing countries, and in attitudes towards a number of environmental issues. At the country level of analysis, policy makers are likely to be particularly interested in students' opinions about their school science education. Among the developed countries, science is generally regarded as important and useful, school science as moderately interesting but not much liked relative to other school subjects, and few students would like to become scientists. Here, as with other findings from the ROSE study, gender differences are significant. Such differences are particularly marked when students indicate what they would most wish to learn by using a four point Likert scale to respond to a list of 108 statements. For girls, the priorities lie with topics related to the self and, more particularly, to health, mind and well-being. In contrast, the boys' responses prioritise strong interests in destructive technologies and events.

One of the components of the ROSE questionnaire invites students to respond to a set of 18 statements about environmental issues such as air and water pollution, the overuse of resources and global climate change. Work of this kind complements a substantial volume of methodologically diverse literature concerned specifically with environmental education (see Hart and Nolan, 1999 for a review). The research that relates to student thinking about the environment covers attitudes, beliefs, values and perceptions and much of this work is quantitative and strongly positivist in nature. Researchers working within this tradition have typically focused their attention on students' answers to questions about the environment or students' environmental behaviour. More recent work has been more exploratory and less normative in nature, probing students' ideas, values and beliefs about a range of environmental issues. The research has shown that students can hold simultaneously multiple structures of belief about global environmental issues and that their understanding of, and attitudes towards, environmental problems are influenced by several agencies and factors. These include the mass media, cultural norms, gender, parental views and the length of formal education. A subset of the environmental education literature relates to children's understanding of environmentally important concepts such as 'nature', the ozone layer, radon and endangered species. The evidence from studies of this kind suggests that childhood experience is important in determining life-long attitudes, values and patterns of behaviour towards the environment. Attitudes towards environmental issues are also reported in a variety of surveys such as the *Science and Engineering Indicators* in the USA (National Science Board, 2004) and the twice-yearly Eurobarometer reports based on face to face interviews with approximately 1,000 people in each of the Member States of the European Union (e.g., EU, 2001) For the social construction of an environmental problem, see Burgess, 2004.

Some issues

As noted above, the literature reporting students' views and experience of their school science education draws upon a variety of research techniques. The methods used for data collection range from on-line and paper questionnaires and focus groups to diaries, personal logs and various types of interviews and free response techniques. Each of these approaches to data collection presents problems of interpretation, reliability validity and credibility. Since these issues are well rehearsed in the literature (e.g., Shadish *et al.*, 2002; Oppenheim, 1992; Cohen *et al.*, 2000), they are not repeated here but their importance should not be underestimated.

Two issues, however, deserves some comment in the present context. First, in a questionnaire-based study such as ROSE, what weight is it appropriate to attach to students' views about, for example, what they want to learn in their school science courses? It can be argued that the students are not in a position to make an informed choice. Their experience of

science is very partial and few are likely to possess the wider perspective that would allow individual scientific concepts to be linked together to form a more coherent and informative whole. It is also sometimes the case that questionnaires ask students for their views about *science* rather than physics, chemistry or biology. As Osborne and Collins (2000) have shown, there are significant differences in students' interest in, and attitudes towards, the different scientific disciplines. Secondly, it is important to acknowledge that an indication by a student that he or she wishes to learn about a given scientific topic cannot be equated with a willingness to make the intellectual and other commitment necessary to achieve the required level of understanding.

Given the methodological diversity among the various studies of student opinion about their school science education, it is perhaps somewhat surprising that many of the findings are consistent across a number of different education systems and cultures. For example, physics seems an unpopular subject with girls in most countries and a number of other gender differences in students' responses are prevalent. It is also the case that many students would like to see more attention given in their school science education to contemporary and controversial issues in science that relate to their everyday experiences. 'Many' however, is not all and most surveys reveal a significant but important minority of students who either have no strong opinion upon, or take a contrary view about, a number of issues such as the alleged difficulty of school science or the inclusion of socio-scientific issues within the school science curriculum. For example, in the Student Review of the Science Curriculum in England, referred to above, 29 per cent of the students (n = 1,471) "didn't mind" whether or not controversial issues were included in school science and 55 per cent said that their experience of primary schools had had no effect on their attitudes towards science (Planet Science *et al.*, 2003).

The major differences in student responses, however, are between the industrialised and the developing world, especially in their attitudes towards aspects of science and technology (Sjøberg *et al.*, 2004). Why this should be so requires investigation, although any explanation is likely to be both complex and subtle. In the case of the ROSE questionnaire, Schreiner and Sjøberg (2004) have suggested that it may be fruitful to account for the differences in responses between the developed and developing worlds in sociological terms, drawing upon such notions associated with post-modernism and youth culture. They are, however, careful to emphasise that no one set of theories is likely to be able explain the results presented by the ROSE survey (Schreiner and Sjøberg, 2004).

If students' interest in science depend upon the science, upon gender and upon broader cultural factors, what should be the response of policy makers, curriculum developers and others with a professional interest in school science education? Is it, for example, possible to construct a science curriculum derived from students' expressed interests and thereby build a community of learners from which scientific ideas emerge for discussion and learning? The answer would seem to be a highly qualified yes (Gallas, 1995), although it seems unlikely that such an approach could form the basis for constructing a reasonably broad curriculum that could serve as a basis for 'science for all'. In addition, any attempt to construct a school science curriculum differentiated by student interest would be in tension with a commitment to gender equity and the provision of a broad and balanced science education for all. Given the widespread failure of existing courses to attract larger numbers of students to study science, especially physical science, beyond compulsory schooling, it may be time to re-examine how best to provide school science courses that best meet the needs of both boys and girls. It may also be appropriate to explore the use of different pedagogical strategies when teaching boys and girls.

Some of the outcomes traditionally associated with school science education should perhaps also be revisited. For example, many students in the ROSE survey in England did not judge that their school science education had made them more critical and sceptical or opened their eyes to new and exciting jobs, especially in the case of girls. If the students' opinions can be taken as reliable, valid and credible, there is clearly a task here not just for science teachers and the science profession more generally but also for those with specific responsibility for offering students career advice.

Studies like the ROSE project also strongly suggest that the aims and content of school science courses in developing countries should be significantly different from those found in schools in the industrialised world. Many of the former face long-standing problems associated with nutrition, sanitation, health care, disease, housing, employment and population growth and the daunting realities of life in many parts of the developing world demand a science education that can help alleviate the most basic of needs. However, developing local science curricula and encouraging global curriculum diversity is not without its problems (Knamiller, 1984). It may be regarded, not least by parents and students in the developing countries themselves, as undermining what might be called the universalism of science, together with its associated high status. It also presents a challenge, namely how to provide a science education that is relevant to the needs of students in ways that do not trap them in a milieu from which ideally science education should help them escape. While this challenge may be especially acute in the developing world, it is not without parallel in the developed world and it is by no means a new problem (Layton, 1973). In addition, abandoning the historical association of science with the Enlightenment goals of secularism and democracy in favour of so-called 'indigenous science' presents real dangers, not least to science itself. It opens the door to various forms of nationalism and fascism disguised as 'reactionary modernism' (Nanda, 2003) and to highly politicised forms of science education (Barton and Osborne, 2001).

It will be clear from the preceding paragraphs that responding to students' expressed opinions about science and their school science education is by no means a straightforward task. The specific outcomes of individual research surveys of student opinion are always interesting and sometimes suggest a direction for curriculum or pedagogical reform. In the longer term, however, such outcomes may be of most use in encouraging research into the development of more general strategies to increase student motivation, commitment and attainment.

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Резюме

МНЕНИЕ УЧАЩИХСЯ О ЕСТЕСТВЕННОНАУЧНОМ ОБРАЗОВАНИИ: ИССЛЕДОВАНИЕ И ПРОБЛЕМЫ

Едгар Дженкинс

Статья рассматривает диапазон национальных и международных исследований, в которых анализируются взгляды учащихся о науке в целом и о естествознании в их школьном образовании. Общая тенденция очевидная – интерес к естествознанию падает. Вопрос - почему это - так. Результаты этих исследований важны для политиков образования, для всех, кто занимается разработкой образовательных программ и содержания образования и, конечно, для учителей естественнонаучных дисциплин.

В заключении можно сказать, что результаты определенных исследований всегда интересны, такие результаты имеют большой спектр применения, например, в помощи развить более общие стратегии для того, чтобы увеличить мотивацию учащихся, обязательство и достижение в сфере естествознания.

Ключевые слова: естественнонаучное образование, мотивация учащихся.

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Edgar W. Jenkins

Emeritus Research Professor, Centre for Studies in Science and Mathematics Education, University of Leeds, Leeds, LS2 9JT, United Kingdom.

E-mail: e.w.jenkins@education.leeds.ac.uk

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