A systematic review of the effects of context-based and Science-Technology-Society (STS) approaches in the teaching of secondary science

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Review summary

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Contextual information

This document contains the Summary of an EPPI-Centre review supported by the Teacher Training Agency (TTA) to promote the use of research and evidence to improve teaching and learning. The review was conducted by the Review Group for Science at the Department of Educational Studies, University of York. The EPPI-Centre is part of the Social Science Research Unit, Institute of Education, University of London. The full technical report was published in August 2003 and can be found in the EPPI-Centre's Research Evidence in Education Library at http://eppi.ioe.ac.uk/reel/T

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Possible conflicts of interest

Two members of the Review Team, Judith Bennett and Fred Lubben, have been involved in the development of school science materials which emphasise context-based approaches to the teaching of science. All members of the Review Team have been involved in evaluating context-based courses and have published in this area. In fact, one of the authors of the Review (Bennett) is the author of one of the five studies included in the in-depth review (Ramsden, 1997). Another study included in the in-depth review concerns a thesis undertaken under supervision of a colleague of the Review Team members. In addition, the Review Team members are members of the University of York Science Education Group (UYSEG), which is

currently developing a new secondary level science course, *21st Century Science*, aimed at developing pupils' scientific literacy. However, none of the team members is directly involved in the development of this course.

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Introduction and background

Underpinning the topic which has formed the focus of this review is a situation most teachers will recognise: many of their pupils simply do not seem to find science lessons particularly interesting or see the point of what they are doing. This concern is not new; there are examples of articles dating back to the 1920s in which very similar worries are expressed.

The last twenty years or so has seen a number of changes in science teaching, of which one of the most significant has been the development of a wide range of materials which use contexts and applications as a starting point for developing an understanding of scientific ideas. Such approaches are variously described as 'context-based', 'applications-led' or using 'STS' (Science-Technology-Society) links. Examples of curriculum development drawing on such approaches can be found in materials ranging from small teaching units to whole courses, developed on local, national and international scales, and for all age ranges from primary through to tertiary. A key aim of these approaches is to stimulate young people's interest in science and to help them see how it relates to their everyday lives.

Given the aspirations of these approaches and their widespread use, it is very important to examine their effects in a systematic way. This report therefore presents the work undertaken for a systematic review of **the effects on pupils of teaching approaches which emphasise placing science in context and promote links between science, technology and society (STS).**

The reasons for selecting this area for review are as follows:

- Courses adopting context-based and STS approaches have attracted national and international attention in the last two decades as they are seen to have an important role to play in developing pupils' scientific literacy.
- Approaches which set science in context and help pupils see links between science, technology and society are strongly advocated in the *National Curriculum for Science* in England and Wales, and in the *Qualifications and Curriculum Authority (QCA) Scheme of Work for Key Stage 3.*
- Approaches which set science in context and help pupils see links between science, technology and society have been advocated for a number of years on Initial Teacher Training (ITT) courses.
- It seems highly likely that the current move towards developing school science courses which emphasise scientific literacy will continue, and that this will have significant implications for science ITT courses. The overlap between the aims of context-based and STS courses and scientific literacy courses, together with the approaches they advocate, makes it highly desirable to establish the strength and nature of the evidence base for the claims made for such approaches.

Research into the effects of context-based and STS approaches falls into three main areas. The most significant concerns pupils' affective responses. A number of people working in science education, particularly those involved in the development of the associated curriculum materials, have argued that they are very motivating for pupils, and there is some evidence to indicate that pupils do respond positively in lessons where such approaches are used. A second strand of research has focused on the development of pupils' understanding of scientific ideas as a result of following context-based approaches. The final strand has explored aspects of teachers' responses to, and use of, materials incorporating context-based and STS approaches. Broadly speaking, the research appears to indicate that pupils following context-based and STS courses develop an understanding of scientific ideas which is at least as good as that of pupils following more conventional approaches, and that such approaches do appear to motivate pupils in lessons. One purpose of this review is to establish the strength of the evidence base which supports these claims.

Aims of the review and review question

The review has two principal aims:

- to explore the effects on pupils of teaching approaches which emphasise placing science in context and promote links between science, technology and society (STS)
- to inform the evidence base on which Initial Teacher Training (ITT) courses draw in relation to the above teaching approaches

The research review question is:

- What evidence is there that teaching approaches which emphasise placing science in context and promote links between science, technology and society improve the understanding of science ideas and the attitudes to science of 11 to 18-year-old pupils, and what are the implications of the evidence for initial teacher training courses?

The focus on understanding encompasses science concepts, ideas about the nature of science, and scientific method. The focus on attitude encompasses attitude towards science, attitude towards school science, motivation to learn, interest in science activities, and career intentions.

The mapping of the area revealed a wide range of relevant studies. A more limited focus was therefore adopted for the in-depth review, with the review question being refined to focus on the effects on pupils following whole context-based courses.

The question for the in-depth review is therefore:

- What evidence is there from controlled evaluation studies that context-based courses improve understanding of science ideas and the attitudes to science of 11 to 18-year-old pupils, and what are the implications of the evidence for initial teacher training courses?

Review methods

The review methods are those developed by the EPPI-Centre for systematic reviews of educational research literature. The review involves a systematic process which takes place in three main phases.

The phase first involves developing criteria by which studies are included or excluded, searching (though electronic databases and by hand) for studies which appear to meet these criteria, and then screening the studies to see if they meet the inclusion criteria. The second phase involves coding each of the included studies against a pre-agreed list of characteristics. This process is called keywording. Once studies have been keyworded, they are used to generate a systematic map of the area. This groups studies according to their chief characteristics.

The third phase involves selecting an area of the map for in-depth review. Once this area has been identified, the contents of each paper are summarised and evaluated according to pre-agreed categories. This process is called data-extraction. The extracted data are then pulled together to form a key section in the report.

Results

The number of studies identified through the searching and screening processes demonstrated that there are high levels of interest in the review topic, and application of inclusion and exclusion criteria identified 66 studies for inclusion in the systematic map.

The systematic map allowed a number of characteristics of the work to be identified. In particular, the map has shown the following:

- The majority of the work has taken place in the USA, the UK, the Netherlands and Canada.
- Pupils in the 11 to16 age range are seen as the target for the majority of the interventions using context-based or STS approaches.
- There are comparable levels of interest in the effects of such approaches on both understanding of ideas and attitudes to science or science lessons.
- A diversity of measures are used to assess effects on understanding and attitudes.
- 26 studies have drawn on designs which make use of control groups in order to strengthen any claims they make.

Five studies were included in the in-depth review, which focused on controlled evaluation studies of context-based courses which reported on both understanding and attitudes. The in-depth review demonstrated that research in the area is generally of a good quality and, as such, confidence can be placed in its findings.

The in-depth review has shown the following:

- There is some evidence to support the claim that context-based approaches motivate pupils in their science lessons.
- There is evidence to support the claim that such approaches also foster more positive attitudes to science more generally.
- There is good evidence to support the claim that context-based approaches do not adversely affect pupils' understanding of scientific ideas.

Conclusions

The first conclusion drawn from the review is that the process has been very worthwhile in pulling together in a systematic way the research evidence on a very important area in science education, particularly in the context of current developments in the school science curriculum.

Secondly, the in-depth review has indicated that research in the area is of a quality which allows reasonable confidence to be placed in the findings, suggesting that additional areas of the systematic map would benefit from in-depth review. These areas include interventions which focused on whole STS courses; and attitudes alone or understanding alone; and effects on disadvantaged pupils, pupils in specific ability ranges and pupils of different gender.

Thirdly, the systematic map has also identified areas where further research would be useful and informative, such as research into the effects of the more novel of teaching activities associated with context-based and STS approaches. Small group discussion work would be a case in point here.

Finally, the process of undertaking the review has helped the Review Team members clarify their thoughts in two key areas. The first of these concerns the ways in which research is reported, and what makes for clear, concise and accessible reporting of research studies. The second area concerns the nature of educational research and what characteristics it needs to have in order to be judged of good quality.

Recommendations

The Review Team is cautious about making recommendations for policy and practice on the basis of an in-depth review of only five studies, even though these have been identified through a rigorous series of procedures. However, the consistency of the evidence which emerged from the in-depth review does suggest that its findings should be made available in a suitable form to key groups, such as students on initial teacher training courses and their university- and school-based tutors. Other key groups for whom the findings are of relevance and importance are those who formulate policy for initial teacher training courses and who develop materials which students encounter on their courses. These include the Department for Education and Science (DfES), who are responsible for introducing the Key Stage 3 Strategy, and the Qualifications and Curriculum Authority (QCA), who have produced an extensive and detailed Scheme of Work for Key Stage 3.

The Review Team has noted in its report that there is increasing anecdotal evidence that many science lessons now begin with pupils copying down into their books the intended learning outcomes of the lesson from the board or an overhead projector transparency. Whilst it is certainly important that both initial teacher training students and pupils are clear about what they hope pupils will learn in their lessons, this is a necessary but not sufficient condition for high quality science teaching. It is clear from the review that context-based approaches provide an effective way to interest and motivate pupils in their science lessons.

One other recommendation the Review Team would like to make concerns dissemination of the findings of the review. The team supports the efforts made to summarise and disseminate the findings in formats appropriate for a variety of intended audiences, such as ITT practitioners and policy-makers.

APPENDIX 1
Studies included in review map and synthesis

The five studies included in the in-depth review are highlighted in bold.

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