

# **Centre for Studies in Science and Mathematics Education**

## **Annual Report**

**2000-2001**



<http://education.leeds.ac.uk/devt/research/cssme.htm>

## *Membership of the CSSME*

Prof. John Leach, Director and Professor of Science Education

Hilary Asoko  
Dr. Sam Bekalo  
Dr. Bob Bruce  
Keith Butler  
Colin Crebbin  
Dr. Jim Donnelly  
Frank Gilmore  
Cathy Goundry  
Andy Hind  
Kevin Holloway  
Prof. Edgar Jenkins  
Peter Johnson  
Stef Lesnianski  
Dr. Jenny Lewis  
Dr. John Monaghan  
Dr. Anthony Orton  
Jean Orton  
Dr. Melissa Rodd  
Tom Roper  
Dr. Jim Ryder  
Dr. Phil Scott  
Richard Sykes  
Dr. John Threlfall  
Geoff Welford

## *Research Students*

Ahmed Al-Rabani  
Kwame Atta-Oben  
Emin Aydin  
Amber Barnitt  
Erhan Bingolbali  
Roger Crawford  
Ali Delice  
Rosa Gunnarsdottir  
Jan Haskins  
Paul Hernandez-Martinez  
Andy Hind  
Kerem Karaadaç  
Mercy Kazima  
Chris Kelly  
Sesutho Kesianye  
Peter Kuminek  
Zlatan Magajna  
Pentecost Nkhoma  
Mehmet Fatih Ozmantar  
Burkhard Priemer

Antti Savinainen  
Colin Simpson  
Ong Eng Tek  
Mbarak Twahir  
Daz Twigger

### *Seminar programme 2000-2001*

Thursday 12 October 2000

Dr. Marilyn Fleer, Dept. of Education, Training and Youth Affairs, Australia.

*Science for the future: The intersection of futures education with science, technology and environment education.*

Thursday 16 November 2000

Dr. Jim Donnelly, CSSME, University of Leeds and Andrew Stibbs, Arts Research Group.

*Ways of knowing and ways of being: the place of science in a humane education.*

Thursday 23 November 2000

Prof. Barry Cooper, School of Education, University of Durham.

*Assessment, class and context.*

Barry talked on issues related to his ESRC project, which examined social class differences in children's responses to KS2 and 3 mathematics tests. Amongst other things he addressed the question, 'Do 'realistic' test items underestimate working class children's capabilities more than those of children from other social class backgrounds?'

If you would like to know more about this research, you could look at:

COOPER, B. and DUNNE, M. (2000). *Assessing children's mathematical knowledge*. Buckingham: Open University Press.

Thursday 30 November 2000

Prof. Richard Duschl, King's College London.

*Dealing with data on the evidence-explanation continuum.*

Thursday 18 January 2001

Michael Reiss.

*What can longitudinal research tell us about science education?*

Thursday 15 February 2001

Tom Roper, CSSME, University of Leeds.

*The relationship between mathematics and science in the school curriculum: has it always been like this?*

### **THE CSSME ANNUAL LECTURE**

Thursday 15 March 2001

Des Dunne, Co-ordinator of the DfEE KS3 Science Strategy.

*Transforming the teaching and learning of science at Key Stage 3 - What lessons can we learn from the pilot Key Stage 3 Science Strategy?*

Thursday 3 May 2001  
Professor Jonathan Osborne, King's College London.

Thursday 7 June 2001  
Dr. Elena Nardi, Dr. Paola Iannone, University of East Anglia.  
*The first-year mathematics undergraduate's problematic transition from informal to formal mathematical writing: foci of caution and action for the teacher of mathematics at undergraduate level.*

A seminar based on a project funded by the Nuffield Foundation at the University of East Anglia.

Project Director: Dr. Elena Nardi

Research Officer: Dr. Paola Iannone

Elena drew upon her small-scale study of the transition from informal (school) to formal (university) mathematical writing and discussed a set of foci of caution and action for the teacher of mathematics at undergraduate level, which have resulted from a scrutiny of 60 first-year UEA undergraduates' written responses to proving tasks in Analysis and Linear Algebra.

Thursday 11 October 2001  
Martin Hollins, QCA  
*The science curriculum for the 21st century.*  
Chair: John Leach.

Thursday 8 November 2001  
Dr. John Monaghan and Dr. Melissa Rodd (School of Education), Teacher Associates  
*The graphic calculator project.*  
Chair: Jim Donnelly.

Thursday 6 December 2001 CANCELLED  
Dr. Sam Bekalo and Dr. Geoff Welford (School of Education)  
*Environmental education in developing countries.*  
Chair: John Leach.

### *Thursday Morning Seminars*

The CSSME runs a series of informal seminars each week of term time on Thursday mornings, attended by staff and doctoral students. For more information, contact Dr. Jenny Lewis ([j.m.lewis@education.leeds.ac.uk](mailto:j.m.lewis@education.leeds.ac.uk)).

### *From the Director*

The Centre for Studies in Science and Mathematics Education is an interdisciplinary research Centre of the University of Leeds, established in 1970 to promote research and scholarly understanding in science and mathematics education. It is one of the leading international centres for work in this field and attracts students and researchers, including Visiting Fellows, from all over the world. Its membership includes staff from the School of Education at the University of Leeds, as well as colleagues in science, mathematics, engineering and medical departments, school teachers and other educationists. Current lines of scholarship include history and

policy studies in science education, science teaching and learning (with a particular emphasis on student epistemologies and science learning and language), the public understanding of science, and mathematics education.

The Centre has links with the Learning and Teaching Support Networks for Physical and Biological sciences, the Medical Education Unit at the University of Leeds, the Qualifications and Curriculum Authority, as well as other academic groups with interests in science and mathematics education in the UK and overseas.

During the year 2000-2001, staff in the Centre were involved in a variety of international research activities. At the beginning of 2001, John Leach and Phil Scott visited Lyon, France, as invited speakers at a seminar organised by the Haute Savoie *département*. Their contribution is part of an ongoing research collaboration between Leeds and Lyon, focusing on the design and evaluation of science teaching sequences. John also visited Paris in the Spring, through this link, as an invited expert at a seminar on *Apprentissages et leurs disfonctionnements* (Learning and its difficulties), organised by the French Ministry of Education.

Jim Ryder and Andreas Redfors (Kristianstad University, Sweden) have recently completed a collaborative research study funded by the British Council. This has resulted in the publication in 2001 of the following research article:

REDFORS, A. and RYDER, J. (2001). *University physics students' use of models in explanations of phenomena involving interactions between metals and electromagnetic radiation*. International Journal of Science Education, 23 (12), pp.1283-1301.

Andy Hind, John Leach, Phil Scott and Jim Ryder attended the Annual Meeting of the American Educational Research Association, held in Seattle at Easter. They presented three papers, which focused upon recent funded research addressing teaching and learning about the nature of science, and evidence-based practice in science education. In August, Andy, John, Phil and Jim were joined by Hilary Asoko, Jim Donnelly, Edgar Jenkins and Jenny Lewis at the meeting of the European Science Education Research Association in Thessaloniki, Greece. Hilary represented the CSSME in the Science Teacher Education and Development in Europe (STEDE) network, which met at the conference. Jim Donnelly organised a Symposium entitled *Searching for a humanistic account of science education*. The papers presented at both AERA and ESERA can be downloaded from the CSSME website, under *Publications*.

As an invited expert, Sam Bekalo attended the Annual multi-stakeholder seminar on "Education and Sustainable Development" held at South Bank University London in June 2001. The Annual Seminar is jointly organized by United Nations Environment & Development (UNED) & South Bank University.

John Monaghan presented a paper on mathematics teachers' classroom interactions at the 25th annual conference of the international group for the psychology of mathematics education in Utrecht, The Netherlands in July. John was also one of the organisers of a symposium on Communicating Mathematics through Computer Algebra at the conference.

During 2001, John Leach and Edgar Jenkins were involved in developing links with science education researchers in the Nordic countries. At the end of the Session, John started a 2-year contract as Visiting Professor at the University of Gothenburg, Sweden. He will be spending 1 week per month in Gothenburg, during term time, for the next two academic sessions. His work involves the supervision and teaching of doctoral students in science education, and developing research projects of mutual interest to colleagues in Leeds and Gothenburg. John is also involved on the Steering Group of the newly-formed Centre for Research in Science Education at the University of Copenhagen, Denmark. Edgar Jenkins is one of five international science educators associated with the *Relevance in Science Education* project based at the University of Oslo. The project has involved both seminars and publications.

Edgar Jenkins gave a Keynote Lecture to mark the centenary of the Association for Science Education in January 2001. The lecture was subsequently published in the *School Science Review*.

During the period, staff in the CSSME have been joined by 6 Marie Curie Research Fellows, all of whom are studying for doctorates in science education in universities outside of the UK. They are funded by the European Commission to spend between 3 and 12 months in Leeds as part of their doctoral studies, through the Marie Curie Training Site scheme. Staff in the Centre have really appreciated the contribution made by the Fellows, which includes 4 research papers in collaboration with CSSME staff. Antti, Burkhard, Marion, Berit, Roland and Jaume: thanks for your contribution!

During mid September to mid November 2001, 3 academic link visitors - Ato Yacob Zulla, Ato Markos Mekuria and Ato Girm Tilahum - from Awassa College of Teachers Education [ACTE] in Ethiopia, visited The School of Education to work with 3 CSSME academic staff, Sam Bekalo, Hilary Asoko and Geoff Welford.

*Overseas Link Visit I.* Sam Bekalo visited Somaliland and South (New) Sudan between August and October 2001 to conduct Phase I international collaborative research and development project led by The School with Africa Educational and UNICEF (OLS). As part of the fresh international initiatives, the research-development project, which is commissioned by DFID, explores more flexible and effective educational approaches that promote the provision of quality universal basic education in the 2 most peculiar and disadvantaged target countries. Since 1991, following the civil conflict and collapse of the Somali state, Somaliland has existed as a de facto independent making positive progress towards restoring peace and stability and revitalising education. Similarly, following "stop-gap" measures for emergency education in the aftermath of the civil war that has spanned more than 4 decades in the Sudan, there is now a growing concerted effort amongst the international community to restore and expand standard education to the South (New) Sudan.

*Overseas Link Visit II.* During January 2002, 3 CSSME academic staff, Sam Bekalo, Hilary Asoko and Geoff Welford will pay alternating return academic link visits to Awassa College of Teachers Education (ACTE) in Ethiopia to conduct joint field research.

### *Indicative publications*

BEKALO, S.A. and WELFORD, A.G. (2000). *Practical activity in Ethiopian secondary physical sciences: implications for policy and practice of the match between the intended and implemented curriculum*. Research Papers in Education, 15, (2), pp.185-212.

CHAMBERS, G.N. and ROPER, T. (2000). *Why students withdraw from initial teacher training*. Journal of Education for Teaching, Vol.26, no.1, pp.25-43.

DONNELLY, J.F. and JENKINS, E.W. (2001). *Science education: policy professionalism and change*. Paul Chapman/ SAGE.

JENKINS, E.W. (2000). *The impact of the national curriculum on secondary school science teaching in England and Wales*. International Journal of Science Education, 22, pp.325-336.

LEACH, J., MILLAR, R., RYDER, J. and SÉRÉ, M-G. (2000). *Epistemological understanding in science learning: the consistency of representations across contexts*. Learning and Instruction, 10, (6), pp.497-527.

LEWIS, J. and WOOD-ROBINSON, C. (2000). *Genes, chromosomes, cell division and inheritance - do students see a relationship?* International Journal of Science Education, 22, (2), pp.177-195.

LEWIS, J., LEACH, J. and WOOD-ROBINSON, C. (2000). *Chromosomes: the missing link - young people's understanding of mitosis, meiosis and fertilisation*. Journal of Biological Education, 34, pp.189-199.

MILLAR, R., LEACH, J. AND OSBORNE, J. (Eds.) (2000). *Improving science education: the contribution of research*. Open University Press. This book was written as a *Festschrift* for Rosalind Driver, and contains contributions from Hilary Asoko, Edgar Jenkins and Phil Scott.

MONAGHAN, J. (2000). *Some issues surrounding the use of algebraic calculators in traditional examinations*. International Journal of Mathematical Education in Science, 31, pp.381-392.

ORTON, A. and ROPER, T. (2000). *Science and mathematics: a relationship in need of counselling?* Studies in Science Education, Vol.35, pp.123-154.

RODD, M.M. (2000). *Connections*. Mathematics Education Review, no.12, pp.62-73.

RODD, M.M. (2000). *On mathematical warrants: Proof does not always warrant, and a warrant may be other than proof*. Mathematical Thinking and Learning, Vol.2, no.3, pp.21-244.

RYDER, J. and LEACH, J. (2000). *Interpreting experimental data: the views of upper secondary school and university science students*. International Journal of Science Education, 22, (10), pp.1069-1084.

RYDER, J. (2001). *Identifying science understanding for functional scientific literacy*. Studies in Science Education, 36, pp.1-44.

## *Projects*



### **Evidence-based practice in science education**

John Leach, Phil Scott, Andy Hind and Jenny Lewis are involved in working in a Research Network funded by the Economic and Social Research Council's Teaching and Learning Research Programme (£438k). The work is being conducted in collaboration with colleagues at the Universities of York (Robin Millar; Network Co-ordinator) and Southampton (Mary Ratcliffe) and King's College London (Jonathan Osborne). The Network is undertaking four inter-related projects. Two focus on the learning of science content. Project 1 looks at how diagnostic assessment can be used by teachers to provide reliable evidence about their pupils' understandings. Project 2 will work with teacher groups to devise and evaluate short teaching packages, based on existing research evidence, to teach some key ideas in science more effectively. Project 3 will develop and evaluate materials to improve pupils' learning 'about science', such as their understanding of the scientific approach to enquiry, and of ideas like risk that often feature in media reports about science. This is widely seen as crucial for better public understanding of science. Finally, Project 4 will draw on the experience of the first three to explore with teachers and other practitioners the factors which facilitate or inhibit the use of research evidence in their work. CSSME staff are involved in Projects 2 and 4.

<http://www.york.ac.uk/depts/educ/projs/EPSE>

### **The supply of science and mathematics teachers**

This project, involving Jim Donnelly, Edgar Jenkins and Tom Roper, is funded by the Standing Conference on Studies in Education. It has three main elements:

- the organization of a workshop on aspects of the issue. This took place in December 2001 at the Royal Society, and a report of the conference will be issued shortly.
- a review of the issues, literature and statistics associated with the supply of science and mathematics teachers.
- an empirical study of the attitudes of undergraduates. This study, involving 1200 undergraduates at a total of 5 universities, is nearing completion.



### **Teaching about the nature of scientific knowledge and investigation on A/AS level science courses**

This project is funded by The Nuffield Foundation, and involves Jim Ryder, John Leach and Andy Hind. Current A/AS level science syllabuses identify developing students' understandings about the nature of science as a course aim. However, for many areas of the nature of science there are no teaching resources currently available to support teaching at A/AS level. Furthermore, very little is known about teacher knowledge and expertise required for effective teaching about the nature of science. This project has developed teaching resources and strategies to promote students' understandings about aspects of the nature of science in A/AS level science courses. These resources have been evaluated in the classroom by a team of local science teachers. Further details are available at the project website: <http://www.nuffieldfoundation.org/aboutscience/index.shtml>

### **Flexible approaches to education in Africa: Improving access to education**

Started in January 2001, this 19 month DfID-funded (£96k) project involves a collaboration between Geoff Welford, Sam Bekalo and Dr. Michael Brophy of Africa Education Trust, London. It aims to identify flexible, informal schooling strategies to improve access to basic education for children in Sudan and Somaliland, where large numbers of people do not participate in formal schooling, and to understand how to develop local capacity to raise demand for education and to increase school retention rates.

### **Graphic calculator use in Leeds High Schools**

This project, involving John Monaghan and Melissa Rodd, examined graphic calculator (GC) use in Leeds High Schools. Quantitative and qualitative census data on GC use and non-use were obtained. The research team consisted of University and local teachers. We found that the key factors which contributed to use were: expertise within mathematics departments; regard for GC as learning aides from mathematics staff and as ICT from senior staff; a 'critical mass' of older/higher attaining students. Key factors which inhibited use of GC were: lack of time to learn how to use the calculator and how to teach with it; concern over recent examination restrictions; perceptions of computers being a resource priority.



### **Students' experiences of undergraduate mathematics**

This is a 3 year project, funded by the ESRC, with King's College London. The project aims to track undergraduate mathematics students' attitudes to their courses as they progress. We hope to:

- understand more about the ways in which mathematics undergraduates' attitudes to the subject change over the period of study;
- understand what experiences and knowledge contribute to building positive attitudes to both students' own competence and to mathematics as an academic discipline;
- explore the ways in which undergraduate students feel they are helped and/or hindered in their learning of mathematics;
- identify ways in which students can be encouraged to complete a mathematics degree rather than transferring, failing or withdrawing;
- explore the reasons why students elect to study mathematics at university and also why they select or reject a teaching career.

Within the context of university mathematics, the study will be informed by, and will contribute to, theories relating to affect (beliefs, attitudes and emotions) and to induction into academic communities of practice. The aim is to take a holistic view of student experience. While cognitive change is not the subject of the study, perceived progress in advanced mathematical thinking is clearly a key factor, and hence the work will be informed by studies in that area.

### **DfID/British Council Higher education link with Awassa College of Teacher Education, Ethiopia**

Started in September 2000, this link is now half way through its planned 3-year period. Three members of the CSSME are involved: Hilary Asoko, Sam Bekalo and Geoff Welford. Two strands of collaborative work are proceeding. The first is based on evaluating changes in teachers' classroom practice catalysed by Ethiopian Government reforms intended to increase child-centred transactions in their primary schools and supported by a prototype Biology Teachers Handbook written by one of our collaborators from the College. The second aligns with the DfID 'Flexible Approaches' Project and is studying how a small number of Awassa Primary schools are attracting and retaining pupils within a context where 60% of Primary school age girls are attending formal school and within the context of fresh international initiative for developing countries of providing quality basic education-for-all by 2015.

### **Formal science education and lifelong learning**

A Research Fellowship funded by the School of Education and the University of Leeds (Jim Ryder). To engage in science related issues in the public domain individuals are likely to need some appreciation of the key concepts of science, that is knowledge-of-science (e.g. the germ theory of disease, the particulate nature of matter, the genetic theory of inheritance). However, individuals also need an appreciation of how science works: how scientists decide which questions to investigate, why scientists do experiments, how scientists assess the quality of data, the role of theoretical models in science and the limitations of scientific knowledge. The work of this Fellowship is considering the following questions:

- What kinds of understandings about science enable individuals to interact effectively with science issues in a wide range of settings outside of formal science education?
- What might a science curriculum designed for continuity in the development of students' knowledge-about-science look like?

- What features of teaching activities promote the development of students' knowledge-about-science?
- What are teachers' and students' responses to teaching tasks whose aims include the development of students' knowledge-about-science?
- What knowledge and expertise do teachers need in order to plan, implement and evaluate teaching tasks which aim to develop students' knowledge-about-science?