

UK Science Education Research Conference – Researchers sharing with researchers 2-4 July 2012

National Science Learning Centre, University of York

The 2012 conference has two main aims:

1. To share current science education research in the UK
2. To discuss future plans and opportunities for science education research in the UK.

CONFERENCE TIMETABLE

Monday July 2nd

Morning – research students’ presentations. All very welcome to attend

9:00 -10:00 am Coffee Atrium

10:00 -11:30 am **OA Science teaching and learning strategies** **LT1**

- Cukurova, M., *An investigation of the effects of a novel teaching approach on students’ learning of chemical ideas, and their views of chemistry as a subject at undergraduate level*
- Monge, H., *Heritage Education for improving the learning of scientific concepts*
- Turkenburg-van Diepen, M., *How Science Works in the UK secondary school science curriculum: effects on teachers*

11.30-11.45 coffee break Atrium

11:45am - 1:15pm **OB Conceptual Development** **LT1**

- Thorley, D., *Girls’ Physics Choices – A Case Study of Two Schools*
- Bulpin, K. *Learning identity in relation to 'making' in synthetic biology*
- Riga, F., *Interpreting Three Students’ Developing Ideas about Eclipses: coherent theory or knowledge-in-pieces?*

1:15 -2:15 pm Lunch – Quarks restaurant - Start of main conference

2:30 -3:30 pm **Building on a research legacy - Key note presentations** **LT1**

Professor Phil Scott (1953-2011) was an exceptional science education researcher with research activity which spanned pupils’ conceptual development, classroom teaching strategies and teachers’ professional development. Professor Robin Millar, Dr Jaume Ametller and Dr Jenny Lewis discuss Phil’s research, their links with his research and the future direction of research in these areas.

3:30-4:00 pm Coffee break Atrium

4:00 -5:30 pm **Parallel discussion sessions on developing and future avenues of science education research**

- Conceptual Development Chair: Ralph Levinson LT1
- Teaching and Learning Strategies Chair: Chris Harrison TR1
- Teachers’ Professional Development Chair: Shirley Simon TR4

Dinner 6.30pm Quarks restaurant

Tuesday July 3rd

9:00 -10:30 am Parallel sessions of paper presentations

1A. Primary Science

LT1

- Glauert, E et al., *A study to investigate conceptual and language development in primary school science*
- James, J. et al, *Creative Little Scientists: Creativity in science and mathematics in the early years*
- Allen, M. and Choudhary, A., *Categorisation of ‘animals’ and related taxonomic entities by pre-school children*

1B. Students’ attitude to science and science learning

TR1

- Banner, I. et al, *Student experiences of ‘real life’ science after a national curriculum reform*
- Sharpe, R., *Students’ attitudes to practical work in secondary school science*
- Shirazi, S., *Student experience of school science and its relationship to post-16 science take-up*

10:30 -11:00 am Coffee break

11:00 am-12:30 pm Parallel sessions of paper presentations

2A. Socio-cultural contexts of science education

LT1

- Billingsley, B. et al, *Divorce, common ground and talk of truce: Science and RE teachers’ perceptions of teaching about topics that bridge science and religion*
- Hanley, P., *Can science teachers afford to ignore students’ religious beliefs?*
- Hetherington, L. et al, *Exploring Science Education for Diversity*

2B. Impact evaluation of STEM related projects

TR1

- Kudenko, I and Ratcliffe, M., *Evaluation of European Industry-School Links in STEM Education*
- Feng, W.Y., *Towards profiling the impact of STEM enrichment programmes: work-in-progress*
- Rietdijk, W. et al, *Engaging students with physics: a follow-up evaluation of the national “Action Research for Physics” programme’s impact on post-16 take up of physics*

12:30 -1:30 pm Lunch

Quarks restaurant

1:30 – 14.30pm **Choosing methodologies in science education research - plenary discussion LT1**

Hilary Leever, Wellcome Trust; Angela Hall, Nuffield Foundation

14:30 -15:00 pm Coffee break

Atrium

15:00 – 17.0 pm Parallel sessions of paper presentations

3A Pre-service science teacher education

LT1

- Hillier, J., *How does that work? Developing pedagogical knowledge from subject knowledge in beginning science teachers*
- Millar, R., *Auditing the science subject knowledge of beginning teachers*
- Levinson, R. et al, *Problem-solving with a simple electric circuit: a study of pre-service science teachers in London and Ramallah*
- Kirkman, J., *Decisions about likelihood of veracity of news reports of science: The contribution of advanced knowledge of science*

3B Measuring and explaining attainments in post-16 science education

TR1

- Homer, M. et al, *Investigating influences on post-16 progression in science in England using quantitative national data*
- Braund, M., *Teaching approach and attainment in A-level Biology*
- Bennett, J., *Schools that make a difference to post-16 uptake of physics and chemistry*
- Richardson, K., *Deconstructing the socioeconomic gap in science attainment*

Dinner 6.30pm

Wednesday July 4th

9:00 -11.0 am Parallel sessions of paper presentations

4A Changing science teaching: the school context

LT1

- Abrahams, I. et al, *The effectiveness of the 'Getting Practical' Continuing Professional Development (CPD) programme*
- Oversby, J., *Mind the Gap*
- Ryder, J. et al, *Multiple policies in the workplace: Teachers' responses to science curriculum reform*

4B In-service science teacher training

TR1

- Bowker, A., *Teachers of Physics CPD project: setting the context of physics specific CPD in England*
- Harrison, C., *Moving from Professional Development to Sustained Practice*
- Simon, S. et al, *Developing web-based CPD for groupwork and argumentation in science*
- Maro, W et al . *Designing and implementing innovative curriculum materials and associated professional development to enhance biology teachers' pedagogical knowledge and skills in Tanzanian secondary school*

11.00-11.30 am coffee

Atrium

11.30am – 12.15pm Parallel sessions of round table discussions

5A Connecting Science Education with Health Literacy

LT1

Discussion leaders: Grace, M. and Byrne, J.

5B Education for Social Justice and Professional Development

TR1

Discussion leaders Tas, M. and Garrett, C.

12.15 -12:45 pm **Plenary Session** - Conference summary; future directions **LT1**

Lunch 12.45-1.30pm Quarks restaurant

Key:

Refreshments	
Breakfast, Lunch & Dinner	To be served in Quarks Restaurant
Breaks – Tea & Coffee	To be served in the Atrium

Conference Rooms	
LT1	Lecture Theatre 1 (Ground Floor)
TR1	Teaching Room 1 (First Floor)
TR4	Teaching Room 4 (First Floor)

Parallel session arrangements

Abstracts for all sessions are given below. Powerpoint facilities are available in all rooms, from laptops or USB sticks . If you have your presentation on USB stick, please check that there is no virus on it.

The final presenter of the paper set is asked to chair the session, in order to keep to time. Each presenter will have 30 minutes and should allow for at least 10 minutes discussion time within this.

There is no requirement to have a written paper available, though should presenters wish to circulate a paper, this will clearly be encouraged. Papers can be put on the research page of the Science Learning Centres portal for those who wish for public dissemination.

Unless presenters indicate otherwise, we intend to make all electronic presentations available to delegates at the end of the conference.

ABSTRACTS

Session 0A PhD Students' presentations

An investigation of the effects of a novel teaching approach on students' learning of chemical ideas, and their views of chemistry as a subject at undergraduate level

Mutlu Cukurova, University of York

Background

The aim of this paper is to provide a preliminary insight into the use of a novel method of teaching degree level chemistry that has the aim of increasing student interest in this subject during the course of their university education and beyond.

Purpose

The main focus of the study is to analyse the effects of a novel teaching approach amongst first year chemistry undergraduates at a university in the North East of England. The approach used replaces traditional lectures with an individual learning package developed by academic members of the Chemistry department that includes an interactive booklet, an online discussion board and a range of other unique activities designed to create a heightened level of student autonomy. The focus of this novel approach is to move, what is perceived as the current focus on 'learning fact' toward one that generates eagerness to learning. It re-orientates the goal of chemistry education within the department towards one that aims to both support and improve students' independent learning skills whilst at the same time developing the conceptual understanding of undergraduate level chemistry.

Sample

The sample involves 178 undergraduate students – the entire first year cohort.

Design and methods

In order to evaluate conceptual understanding a diagnostic test was developed to be administered to the entire sample prior to and after the intervention. In order to assess changes in student's interest towards chemistry data will be collected using a mixture of open ended questionnaires and focus group discussions involving a convenience sub-sample of 24 students.

Heritage Education for improving the learning of scientific concepts.

Hortensia Morón, University of Leeds

Background

Learning of scientific concepts can be more difficult without a social-cultural context for students, especially in secondary (when more complex and abstract science concepts are taught). Heritage can provide this socio-cultural context if this is treated in appropriate form. So this study is part of a larger Spanish project related with heritage education on the most popular teaching resources.

Purpose

The target is to define what attributes heritage education has for improving the teaching and learning of scientific concepts.

Sources of evidence

The construction of knowledge starts with the interaction between individuals in a socio-cultural medium (Güney and Seker, 2012). Sadler (2009) suggests that the learning is not a process that transpires independent of context and it cannot be considered as isolated events in the minds of individuals. Particularly from experimental science, the study of scientific ideas in their original context of discovery will help to develop students' conceptual understanding (Monk & Osborne, 1997). In the same way, heritage and its teaching provides a historical cultural context for contents (Pluckrose, 1993).

Main argument

Heritage education is a pedagogic process which seeks social participation to preserve the heritage elements. This lets us work in four educational dimensions (to know, to understand, to assess and to act) through heritage. In this way, heritage is a resource to learning which connects to society with their socio-cultural medium. So, some of the main attributes of heritage education are: work with heritage elements close to the student, temporal-space scale, multicultural perspective, sociocritic knowledge, motivation, preservation and conservation, active role of student, emphatic, etc. All these attributes provide a cultural-social context, through identity, for knowledge. Heritage doesn't have meaning if society is not involved in the construction of their heritage and gives it an identity value. Therefore, heritage provides two important attributes for the education a *context* and *identity*.

Conclusion

If scientific concepts are treated through heritage education, it will provide a socio-cultural context for scientific contents which connects with student (provide identity) i.e. personal meaning. In short, heritage education makes possible the connection between knowledge and person/culture/society hence fostering deeper learning and a more humanistic science.

References

Güney B. and Seker, H. (2012). The use of History of Science as a cultural tool to promote students' empathy with the culture of science. *Educational Science. Theory & Practice* 12 (1). 533-539. Educational Consultancy and Research Centre.

Monk, M. and Osborne, J. (1997). Placing the History and Philosophy of Science on the Curriculum: a model for the development of Pedagogy. *Science Education*, 81, 405-424.

Pluckrose, H. (1993). *Enseñanza y aprendizaje de la Historia*. M.E.C.-Morata, Madrid.

Sadler, T. (2009). Situated learning in science education: socio-scientific issues as contexts for practice. *Studies in Science Education*. Vol. 45, No. 1, Peg. 1-42.

***How Science Works* in the UK secondary school science curriculum: effects on teachers**

Maria G.W. Turkenburg-van Diepen, University of York

Background

In 2004 in the UK, a new secondary science curriculum element was introduced under the heading *How Science Works*. Teachers were asked to start teaching it in KS4 in 2006, and in KS3 and KS5 in 2008.

Purpose

In the present study, answers are sought to the following main research questions:

1. How does *How Science Works* influence science teachers' classroom practice?
2. Do teachers see the more explicit emphasis on *How Science Works* as a positive development?
3. Does the presence of *How Science Works* in the science curricula 11-18 influence science teachers' thinking about secondary school science and how it should be taught?

Sample

The sample consists of 25 teachers from five different types of schools in the North-East of England.

A good mix was achieved of male/female, biology/chemistry/physics and range of teaching experience.

Design and methods

The most effective way to learn about a person's thoughts and actions, is to ask them in an interview. It is imperative to have a certain amount of structure to the interviews, to satisfy an interest in the understanding of patterns and perhaps consensus.

As 'actions speak louder than words', observing teachers in action in the classroom is a logical part of a study into teachers' classroom practice. Observations were performed before the interview.

Results

The majority of teachers with experience from before 2006 claim they always included aspects of HSW even before the curriculum change, and that HSW in the curriculum is nothing new. Despite this, many of them acknowledge that it has brought certain changes to their teaching and thinking. The change is generally seen as positive.

Conclusions

Although the criteria for *How Science Works* are not completely new additions to the curriculum, the increased emphasis on them has had some effects on teachers' practice and thinking.

Session 0B PhD students' presentations

Girls' Physics Choices – A Case Study of Two Schools

Deborah Thorley, Sheffield Hallam University

Background

This research is primarily focused on why some girls choose to study physics post 16 and others do not. The number of students studying A-level physics is recognised as being too small to meet the future demand for physicists. The proportion students taking A-level physics who are female has remained at about 20% for a number of years.

Purpose

Research aim:

to make an original contribution to the literature about why girls choose or do not choose to study physics for A-level through a focus on physics identity and physics self efficacy.

Research objectives:

1. to explore what physics identity means for girls in school years 9 to 11
2. to explore what physics self efficacy means for girls in school years 9 to 11

Sample

Girls from two non selective, comprehensive schools which, based on 2009 data, had an above average percentage of girls taking A-level physics, are the primary data set. Girls were selected following a questionnaire given to all students in year 9 and 10 who were predicted to have the necessary attainment to progress to AS physics. Girls were grouped according to future subject choices. In all 11 small groups were selected for interview, 5 from one school (three year 9 groups and two year 10 groups) and 6 (three groups in each year) from the other. In total 43 girls were involved in the group interviews.

Design and Methods

I am using a case study approach to investigate these issues. The main components of the case studies are small group interviews, a small number of individual interviews, a questionnaire and lesson observations as well as supporting evidence from the schools. Data from all of the data gathering tools will be analysed to produce evidence for the case studies.

Results

I will be reporting some preliminary findings from the questionnaire and the first two interviews.

Learning identity in relation to 'making' in synthetic biology

Kate Bulpin, University of Sheffield

Background

This is a study of students' experiences of participating in a nascent field of biotechnology and their emerging sense of disciplinary identity.

Purpose

This paper aims to explore how the discourse defining 'synthetic biology' is taking shape and how this relates to the experience of students participating in the field through the international genetically engineered machine (iGEM) competition.

Sample

This study follows a team of six undergraduate students and seven members of staff at a UK university participating in iGEM in 2010.

Design and methods

This is an ethnographic study of the team's activities involving participant-observation, semi-structured interviews with the students and their advisors. The study also includes documentary analysis in addition to data collected at related synthetic biology events.

Results

One of the underpinning aims of synthetic biology is about 'making biology easier to engineer', tied to the idea of making biological engineering accessible to the 'novice' through the provision of *readymade* resources. The field is also committed to transforming biological engineering into an *industry*. The iGEM competition is embedded within 'industrial' values that focus on product and efficiency over educational processes. However, within the university, the students are heavily involved in seeking and making their own resources. The students' participation in 'resource-making' is felt in tension with the structure of the competition, but is seen by their advisors as a vital part of their training.

Conclusions

The industrial visions of synthetic biology that include the automation and commercialisation of many aspects of 'making' are in conflict with this university laboratory's epistemic culture of 'craftwork' and 'self-sufficiency' that are seen as important skills and values for the student scientist. This study points to the challenges that are faced by universities and students in response to these emerging industrially-oriented disciplines.

Interpreting Three Students' Developing Ideas about *Eclipses*: *coherent theory or knowledge-in-pieces?*

Fran Riga, University of Cambridge

Background

The question of whether students' ideas evolve 'naturally' from earlier ideas or whether radical changes need to take place for ideas to progress, is an issue that has dominated the research literature on conceptual development for many years. Some of the confusion concerning how students change their minds might be due to a unclear understanding of what exactly constitutes conceptual change, and more precisely, a *concept*.

Purpose

This empirical study takes an in-depth look at 3 students' ideas in one topic in astronomy education (*Eclipses*) and discusses how their ideas progress over a length of time.

Sample

The three students, aged 14 at the start of the study, formed part of a multiple case study research project, and were selected on the basis of their responses on a survey which examined students' ideas on a number of topics in astronomy. The survey was administered to 342 Year 9 students in 3 three comprehensive schools in Cambridgeshire.

Design and methods

An interpretive design was used, which drew on aspects of grounded theory. The data used in the study consisted of the students' responses on the survey and on a series of audio-recorded, semi-structured interviews – 2 interviews over one year for two of the students, and 5 interviews over four years for the third case study student. Each interview was approximately 50 minutes long, though only part of this time was devoted to the discussion of *Eclipses*.

Results

Evidence from all 3 students indicated that almost all the cognitive resources required for understanding why *Eclipses* occurred were present at the start of the study. Moreover, these initial ideas – whether accurate or inaccurate – are *carried forward*, and even if adapted later, appear to remain within their memory, either running parallel to, or representing the starting points of future, more accurate evolutions of their ideas on *Eclipses*.

Session 1A Primary Science

Creative Little Scientists: Creativity in science and mathematics in the early years

Principal authors: Jane Johnston, Bishop Grosseteste University College, Esmé Glauert, Institute of Education, University of London

Co-authors: Anna Craft, Teresa Cremin, James Clack, Open University, Ashley Compton, Alison Riley, Bishop Grosseteste University College, Andrew Manches, Institute of Education, University of London.

Background

This paper presents research conducted as part of the thirty-month EU/FP7-funded project *Creative Little Scientists*, led by Ellinogermaniki Agogi in Greece, and involving partners in Belgium, England, Finland, France, Germany, Greece, Malta, Portugal and Romania. The project reflects the high focus on science, mathematics and creativity in European education policy and the growing recognition of the importance of science and mathematics teaching in the early years, both for a child's development and for science and mathematics learning.

Purpose

Creative Little Scientists seeks to provide a clear picture of existing and possible practices in science and mathematics education in the early years, and their implications for the development of children's creativity and the emergence of appropriate learning outcomes, including children's attitudes to science and mathematics. Based on this, the project will propose policy guidelines, as well as curricula and exemplary materials for teacher training.

Sources of evidence

The paper will present the conceptual framework for the project developed from an extensive review of policy-related and research-related literature covering fields including science and mathematics education in the early years, creativity in education, creativity as a lifelong skill, teaching and teacher training approaches, as well as cognitive psychology and comparative education.

Main argument

The conceptual framework examines relationships and synergies between science and mathematics education and creativity, including key drivers for an interest in science, mathematics and creativity in the early years, opportunities for creativity in inquiry-based approaches to science and mathematics and factors that influence their adoption in practice. It sets out key areas of focus and methodological issues that inform current phases of empirical research that integrate comparative research, in-depth fieldwork and curriculum design.

Contribution to the field

The paper provides a timely examination of recent developments in early years science and mathematics education and the potential for inquiry-based and creative approaches to enhance learning.

A study to investigate conceptual and language development in primary school science

Jon James
Graduate School of Education, University of Bristol

Background

Many pupils, not just those with specific literacy difficulties, find mastering the complex language of science difficult. Furthermore the language can marginalise pupils due to its dissimilarity from their own social language, generating inferiority and disengagement. There is evidence that this effect might be exacerbated for children from socially disadvantaged backgrounds (Lemke, 1990).

A study set up by Brown and Ryoo (2008), investigating the teaching of concepts in a vernacular manner, before using scientific language, showed some evidence of benefit. This research aimed to explore the approach in the primary science classroom, which has the advantage of being a setting that has a more explicit focus on literacy, but is an under-investigated one in terms of research.

Purpose

Can an approach that initially separates language and conceptual aspects of science teaching influence the learning of primary school age children?

Sample

Three primary schools, serving socially disadvantaged communities, were chosen for the study. In each school two teachers were selected as participants, having a range of teaching experience and currently, between them, teaching several different Key Stage 2 year groups.

Design and methods

The study employed ethnographic approaches in which initial interviews were held to explore teachers' perspectives. Classroom observations then took place to gauge the baseline of scientific discourse. Collaborative planning meetings were held where forthcoming science topics were deconstructed, in terms of their language and conceptual facets. Teaching approaches were then designed for use in the classroom over a period of several months. Final examination included audio-recorded interviews with the teachers, classroom observation and inspection of pupil logs.

Results

Initial findings show that participant teachers have valued the approach that separates language and conceptual components, with evidence of enhancement of their own understanding of and enthusiasm for science. Discourse in the classroom, both oral and written, has increased its focus on scientific processes and explanation.

Conclusions

Final results and conclusions will be available at the conference.

References

Brown, B., & Ryoo, K. (2008) Teaching Science as a Language: A "Content-First" Approach to Science Teaching. *Journal of Research in Science Education*. Vol. 45, No. 5, p. 529–553

Lemke, J. (1990) *Talking science: language, learning and values*. NJ: Ablex

Categorisation of ‘animals’ and related taxonomic entities by pre-school children

Principal author Michael Allen, Co-author Ayshea Choudhary. Brunel University

Background

It is well established that children can hold misconceptions about which organisms they categorise as being ‘an animal’ (e.g. Bell, 1981; Prokop *et al.*, 2008; Trowbridge & Mintzes, 1985, 1988; Yen *et al.*, 2007). Commonly, these misconceptions manifest themselves as under-generalisation of the ‘animal’ concept. For instance, children typically cite furry organisms with four legs as falling into this category, while others, such as birds, fish, insects, crustaceans, etc, are seen as not being animals. Instead, children create their own categories, each lying outside of the ‘animal’ set, not subsumed within the overarching ‘animal’ hierarchical level. Similarly, there are misconceptions related to lower taxonomic levels, e.g. a penguin is an amphibian because it lives on both land and water, a bat is a kind of bird, and a jellyfish is a type of fish.

Although previous research has studied these misconceptions both quantitatively and qualitatively in older children and adults, there is little previous work that has accrued a sample of pre-school children. In fact, this age group has been neglected generally in the field of substantive scientific conceptual research. This is likely in part due to the potential problems of eliciting scientific ideas from these youngsters, who typically find difficulty in expressing their scientific thinking either verbally or in writing due to undeveloped literacy skills.

Purpose

The objective of the current research was to undertake an exploratory study of the concept ‘animal’ and related entities using a sample of children aged 2-5 years. The study is embedded within the tenets of Prototype Theory (after Rosch, 1973). Research questions are:

- How do children aged 2-5 conceptualise ‘animal’, and related taxonomic entities?
- Are there qualitative differences between these entities and the entities conceptualised by older participants, as reported in the literature?

Sample

An opportunity sample of children from playgroups, nurseries and schools in the South East of England took part. Sample size was 110.

Design and methods

Each child was interviewed by two researchers using a structured schedule. Plastic models of each case were used as a cue to help children express their scientific ideas without the need to read text or write responses.

Results and conclusions

Data collection is presently taking place. Data will be analysed using quantitative and qualitative methods in order to determine both the frequencies and reasons for categorising each case. Findings will be discussed with reference to Prototype Theory.

References

- Bell, B. F. (1981) When is an animal, not an animal? *Journal of Biological Education*, 15, 213-218.
- Prokop, P., Prokop, M. & Tunnicliffe, S. D. (2008). Effects of keeping animals as pets on children’s concepts of vertebrates and invertebrates. *International Journal of Science Education*, 30, 431-449.
- Rosch, E. H. (1973). Natural categories. *Cognitive Psychology*, 4, 328–50.
- Trowbridge, J. E. & Mintzes, J. L. (1985). Students’ alternative conceptions of animals and animal classification. *School Science and Mathematics*, 85, 304-316.
- Trowbridge, J. E. & Mintzes, J. L. (1988). Alternative conceptions in animal classification: a cross-age study. *Journal of Research in Science Teaching*, 25, 547-571.
- Yen, C. F., Yaob, T. W. & Mintzes, J. L. (2007). Taiwanese students’ alternative conceptions of animal biodiversity. *International Journal of Science Education*, 29, 535-553.

Session 1 B Students' attitudes to science and science learning

Student experiences of 'real life' science after a national curriculum reform

Principal author: Indira Banner Co-authors: Jim Donnelly, Matt Homer, Jim Ryder

University of Leeds

Background

It is generally reported that students respond positively to learning context-led science through socio-scientific issues and other topical subjects. This paper looks at a recent mandatory curriculum change in England and explores the experiences of a range of students taking courses with a heightened emphasis of these approaches to science education.

Purpose

This paper addresses the following research questions:

How do students experience a national curriculum with an emphasis on a context-based approach?

How do different groups of students talk about learning about 'real life' science in the science classroom?

Sample, design and methods

Approximately 200 students from 19 schools completed questionnaires and were interviewed, in two groups of six, in their final two years of compulsory schooling (aged 14-16 years old). They were asked about their science lessons and the frequency and type of activities that they experienced. About 2000 students in their final compulsory school year also answered questionnaires about school science. Interviews were coded and analysed using a framework based on work on interest and relevance.

Results

Students' reported experiences of school science and, in particular aspects of context-based science including socio-scientific issues (SSIs), termed 'real life' science by some students, vary between student groups within and between schools. Many also appear to be different from intervention studies described in other work. Students taking the more academic science courses stated they preferred learning the canonical science to learning 'real life' science. Students taking courses with a lower academic status claimed to have little experience of activities and subjects associated with SSIs.

Conclusions

Students' experiences of school science vary, not only between schools but seemingly by the course that students are taking. It may be that students' classroom behaviour influences this so a context-based curriculum for all isn't what is happening in schools. Teachers may not have experience or feel confident to teach new approaches and subjects. It is more than likely that teachers influence ideas of their students, nevertheless our results indicate that different groups of students have different wants and needs from school science; context-based science and SSIs do not suit all students and the flexibility of the current curriculum should remain.

Students' attitudes to practical work in secondary school science

Rachael Sharpe, University of York

Background

This study aims to examine attitudes to practical work in biology, chemistry and physics lessons in secondary schools of students between Year 7 (aged 11) and Year 10 (aged 15) inclusive, in England.

Purpose

This article reports on the approach to investigating, and results of, students' attitudes to practical work in the three sciences.

Research questions

What are secondary school students' attitudes to school science practical work?

To what extent do secondary school students' attitudes to practical work differ across the three sciences and across the year group?

Sample

The sample involved students in Year 7 to Year 10 in five secondary schools in England. The sample is broadly representative with two urban comprehensive academies, a rural community comprehensive, a secondary modern and a rural selective academy. For the main study in three of these schools, 604 students answered the survey instrument, 90 students were observed and 12 students in three focus groups.

Design and methods

The study was designed around a phenomenological approach which developed a survey instrument to examine students' attitudes to practical work. Data collection involved: three survey instruments, observations of students conducting practical work in biology, chemistry and physics lessons with semi-structured interviews; and focus groups with students as well as field notes. Observations and focus groups were audio-recorded.

Results

The results show that students' attitudes to practical work differ between the sciences and between the year groups, with physics showing significant statistical decline in positive attitudes between Key Stage 3 and Key Stage 4.

Conclusions

Students show positive attitudes to practical work in biology, chemistry and physics. However, these positive attitudes differ according to the age of the student and the particular science.

Student experience of school science and its relationship to post-16 science take-up

Shaista Shirazi, University of Leeds

Background Studies of science take-up within secondary education focus on student characteristics and seldom attempt to take account of the ways in which school experience can constrain or facilitate particular subject choices.

This study investigates student experiences of school science to find out if and how it is related to take-up of science in post-16 education.

Purpose The study aims to find how students' perceptions of school science change as they progress through secondary school and whether this influences their choice of science or not.

Sample Empirical work is two-phased:

Phase 1 - Survey questionnaires (n=569)

Phase 2 - Interviews (n=56)

Sample population is science and non-science students in Year 12 from mixed, mainstream, urban schools in the southeast and northeast of England.

Design and methods The survey questionnaire involves students drawing a storyline to show their school experience. Narratives obtained from the interviews enhance details of the storyline graphs.

Survey data is analysed using simple statistical methods (means, frequencies and percentages) while interview data is analysed in the grounded theory tradition.

Results Results show that students who choose to take science post-16 have a more positive experience of school science whereas students who do not want to continue with school science have a less positive experience of school science. A large number of students choosing to take science have made a decision to take science from an early age whereas students choosing not to take science are more likely to leave science-taking decisions until later. They are also more likely to be put off by school factors such as teaching methods and science content.

Conclusions A resilience factor consisting of three constructs; an interest in science, a value for science and success in science is found in students choosing to take science further. Students choosing not to take science may show a combination of one or two of these constructs but not all three.

Session 2A Socio-cultural contexts of science education

Divorce, common ground and talk of truce: Science and RE teachers' perceptions of teaching about themes that bridge science and religion

Principal author: Berry Billingsley, Institute of Education, Reading University,

Co-authors: Fran Riga, Faraday Institute for Science and Religion; Keith Taber, Faculty of Education, Cambridge University and Helen Newdick, University of Reading

Background

In England, Science and Religious Studies (RS) are taught in secondary schools by subject specialists, working independently. The potential for conflict to be perceived by pupils between the teaching they receive in Science and RS lessons is easy to underestimate. Firstly for some pupils, there is perceived to be conflict between the explanations from Science and Religion about our Origins; secondly for some pupils there is perceived to be a conflict between science and religion in terms of what each say about how we can know whether something is true.

Purpose

In this research study our first aim was to discover how teachers of Science and RS perceived their own teaching to relate to the teaching provided in the other classroom. We are aware that teachers tend to work in subject solos and we were secondly interested to know what the 'big picture' looks like if the teaching in each classroom is put together. How for example are terms like 'evidence' and 'enquiry' described in each classroom?

Method

One RE and one Science teacher in each of five secondary schools took part in semi-structured interviews. Participants were asked to describe children's thinking about science-and-religion, the teaching provided and the relationships between the classrooms.

Results and Conclusion

We will be continuing to analyse our results in the weeks leading up to the conference. Our findings thus far highlight that while RS teachers typically have a level of understanding about where science and scientific enquiry 'sit' in relation to religion, Science teachers are typically uncertain about how ideas in religion can be tested and even whether ideas from religion should be tested at all. Our view based on these findings is that the teaching in the two classrooms would be more coherent if Science teachers and RS teachers worked together to form a common and broader understanding of how different types of ideas can be tested.

Can science teachers afford to ignore students' religious beliefs?

Pam Hanley, University of York

Background

It is recognised that certain religious groups have worldviews which cannot be reconciled with particular scientific ideas (Poole, 1990; McGrath, 1999). Do their religious beliefs prevent engagement with school science? To gain insight, this study examines the teaching of the origin of life in English secondary school Science and Religious Education (RE).

Purpose

The research questions are:

- What are the differences, if any, in the approach of Science and Religious Education (RE) disciplines when dealing with the origin of life?
- Are there differences in how scientific and religious explanations are perceived?

Sample

1) Small national survey of science (55) and RE teachers (98).

2) Case schools (students aged 14-16):

- School A: Christian faith-based (2 teachers, 41 student questionnaires, 21 students in focus groups)
- School B: non-faith, majority Muslim students (3 teachers; 30 student questionnaires, 14 students in focus groups)
- Schools C and D: non-faith, mixed catchment (1 teacher + focus group; 138 student questionnaires, 29 students in focus groups)

Design and methods

Mixed methods:

- Postal survey of a national sample of Science and RE teachers
- Case schools: questionnaires and paired interviews or small focus groups with students; interviews with teachers
- Grounded theory (Corbin & Strauss, 2008) was used to inform the study design and analysis. The quantitative data were analysed using SPSS with appropriate statistical tests; the qualitative information was examined for themes and patterns arising from the data.

Results

- As school subjects, students perceive RE as explorative, open, discursive and Science as non-negotiable.
- There is a range of student views about the validity of scientific and religious explanations.

Conclusions

Perceptions of school Science as dogmatic, inflexible and in conflict with their religious beliefs can prevent some students engaging fully with the subject. Where there is overlap with RE, much might be gained from cross-curricular working.

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Exploring Science Education for Diversity

Lindsay Hetherington, Alun Morgan, Nasser Mansour, Keith Postlethwaite, Nigel Skinner, Rupert Wegerif, University of Exeter

Background and purpose

This paper describes a project called 'Science Education for Diversity'¹ which surveyed students aged 10 to 14 in six countries². The purpose of this survey was to ascertain the current situation with regard to science education in the partner contexts in order to support the development of a 'dialogic' framework for the design of science education in the context of diversity. Implementation of this framework is currently being investigated through the cooperation of practising teachers acting as co-researchers in each partner context. The SED project addresses concerns within the EU around declining interest in science and focuses on issues of diversity seeking to explore how Science Education interacts with diverse populations and how it could be re-designed to respond better to the challenges that diversity raises. The non-EU partners were selected because there is no discernible decline in the popularity of science at school level in these contexts and they provide a potentially valuable contrast with opportunities for international mutual learning.

Sample, design and methods

The project used a sociocultural theoretical perspective and a mixed methods design. This paper focuses on results from the UK within the broader context of the project. In the UK, questionnaires were completed by 1618 students and 34 science teachers. 4 case studies were completed, in which 17 teachers and 46 students were interviewed individually, plus 4 group interviews with 4 students. This phase of data collection was designed to reveal attitudes towards science and science education amongst both students and teachers of science. Case studies in a primary and secondary school are exploring the impact of the framework which emerged from the analysis.

Results and conclusion

Preliminary analyses of our data suggests that young people in our samples were indeed less interested in science education as currently constituted than those in partner countries. We suggest that in the UK, this is linked to a narrow image of science which did not always fit with students' images of themselves and of what they wanted to be in the future. We propose that a dialogic approach to science education may be a useful approach to teaching science education since it values the diverse voices of students without prejudging the nature of that diversity, thus allowing students to develop a broader understanding of science and enabling them to relate to the subject. It can also develop high quality dialogue which is central to understanding of science.

¹ Funded by the European Union under the FP7 framework

² University of Exeter, UK; Tata Institute of Fundamental Research, India; Department of Education, American University in Beirut, Lebanon; Eindhoven University of Technology, the Netherlands; Tunku Abdul Rahman College, Malaysia; Pamukkale University, Turkey.

2B Impact evaluation of STEM related projects

Evaluation of European Industry-School Links in STEM Education

Irina Kudenko and Mary Ratcliffe, National Science Learning Centre

Background

Project InGenious is a European initiative in STEM education that brings together educators and businesses from 16 countries in a multi-stakeholder consortium, including Ministries of Education, National Platforms in Science Education and Industry Federations. The initiative aspires to address the future skill gap in Europe and increase young people's interest in STEM education and careers through fostering collaboration between schools and industry. Building on existing school/business partnership the project aims to expand existing STEM initiatives and encourage their wider use in European countries.

The project involves building a European repository of STEM education practices, testing their utility and applicability in different national and educational contexts in a network of 160 pilot schools and disseminating them to an extended network of 1000 schools.

Purposes

- To develop an evaluation framework and evaluation strategy to guide the evaluation of the impact of industry-school activities in STEM education on pupils and teachers in pilot schools, particularly in terms of encouraging more positive views of STEM and STEM careers
- To implement evaluation strategy in the first pilot year (of the 2.5 year project)

Sample

The pilot includes 160 schools in 22 countries, a third of which are primary schools.

Design and methods

The evaluation criteria and evaluation strategy for the pilot have been designed in close consultation with other European partners and project stakeholders. Their development involved the examination of relevant evaluation policies and practices in previous European and international projects in STEM education.

The evaluation criteria focus on four areas: Impact for pupils; Impact for teachers; Nature of the activity; Scale of implementation of the activity. The evaluation criteria have guided the design of evaluation tools, which mainly comprise of on-line questionnaires and the selection of case studies. Questionnaires are designed for teachers and pupils – on their first engagement with the project; during and after each activity; at the end of the pilot. Case studies will provide richer qualitative data for capturing the evidence of impact.

Results and conclusions

Data analysis is ongoing. Some emerging outcomes of the first year of the pilot testing of the activities in different European countries will be presented.

Towards profiling the impact of STEM enrichment programmes

Wai Yi Feng, University of Cambridge

Background

Despite the increasing amount of activity and investment in enrichment across STEM (Science, Technology, Engineering, Mathematics) fields in recent years, little is understood about the impact of enrichment programmes on teaching and learning, or how outcomes (balanced against cost) could be assessed by schools or providers.

Purpose

This paper presents work-in-progress from a study that is developing a framework for understanding the impact of enrichment programmes from across STEM fields, and thence, a set of indices which can be used to measure the impact of enrichment in its various forms.

Sources of evidence

400 programmes covering a wide range of enrichment activities were explored through internet research, guided by the STEM Directories. Analysis of programme-related web-material and documents was supplemented by a review of literature. Six programmes — chosen to exemplify different forms of Science/Technology/Engineering enrichment and to complement the four Mathematics programmes already examined in my earlier work — were selected as case studies for in-depth, qualitative investigation (to include observations, documentary analysis and interviews with providers, teachers and student participants). Completion of data collection and analysis is expected in late-2013.

Main argument

Emerging findings suggest five types of positive impact on students, which could form the basis for the framework and set of indices (presented as a quantitative questionnaire instrument):

1. Support for learning in school;
2. Enhanced understanding of STEM topic(s)/discipline(s) linked to improved perceptions and attitudes;
3. Development of skills and learning processes;
4. Personal and social development;
5. Insights into STEM-related study/careers leading to an increased likelihood of participation.

Conclusions

The refinement of both framework and indices will continue alongside empirical work. The resulting questionnaire will enable enrichment impact to be profiled, tracked, compared across programmes, and benchmarked. Ultimately, this work could inform both programme development and teachers' choice of programmes.

Engaging students with physics: a follow-up evaluation of the national “Action Research for Physics” programme’s impact on post-16 take up of physics

Principal Authors: Willeke Rietdijk, Caro Garrett Co-author: Marcus Grace
University of Southampton

Background

The government funded Action Research for Physics programme (ARPP) began in 2009, and was delivered through the National and Regional Science Learning Centres to build on the findings from the “Girls into Physics” programme (Daly et al., 2009).

Purpose

This follow-up evaluation of ARPP tracked students who had participated in the initial intervention and are now studying physics at post-16. The research questions were:

- What was the 2011 physics AS uptake compared to 2009 and 2010?
- What were students’ reasons for choosing physics post-16?
- What aspect of the classes and the teaching had contributed to this decision?
- How did students feel about Physics AS so far?

Programme description

The programme generally consisted of three one-day professional development sessions, focusing on action research theory, classroom strategies, and feedback from teachers’ action research findings. Teachers conducted action research between the professional development sessions.

Sample

The sample of the follow-up evaluation consisted of 147 questionnaire respondents studying AS physics, and 4 physics AS student focus groups from across the SLC regions.

Design and methods

The evaluation used questionnaires and focus group meetings with AS physics students, and interviews with teachers.

Results

A number of ARPP schools reported a higher post-16 uptake of physics compared to previous years. The *most frequently* mentioned reasons given by students for choosing physics post-16 were an interest in physics and the subject providing a good challenge. The *most important* reasons given were: the teacher, finding physics interesting, general enjoyment of physics, and needing it for university or careers. No statistical differences were found between ARPP participants and non-participants in terms of motivation to study post-16, but focus groups indicated that the attitude of the teacher appeared pivotal.

Conclusions

A direct impact of teachers’ interventions on students’ motivations was not found, but the programme may have indirectly affected students’ decisions positively through the increased teacher confidence and enthusiasm.

References

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Session 3A Pre-service science teacher education

How does that work? Developing pedagogical knowledge from subject knowledge in beginning science teachers

Judith Hillier, Oxford University

Background

Research has shown that students greatly value teachers who have the ability to explain (Ogborn et al, 1996; Bishop and Denley, 2007). However, amidst the plethora of pedagogical skills, curriculum and subject knowledge to be developed, this skill can be overlooked (DfE, 2011).

Purpose

How do beginning science teachers explain scientific phenomena?

Sample

Oxford University Department of Education (OUDE) has been running its one year initial teacher education (PGCE) course for twenty-five years, and is graded as 'outstanding' (Ofsted, 2011). The sample comprises 29 females and 20 males, all science graduates in a range of subjects from different universities, ranging in age from 21 to 51. A number of them also have higher degrees in one of the sciences.

Design and methods

Four demonstrations were given during workshops over the course of one term. In each case, the student teachers were asked to write an explanation of the phenomenon suitable for students aged 11-14 years. These written explanations were submitted to a course tutor, the students received individual written feedback, and the explanations were analysed using iterative comparative coding. The student teachers were asked via an evaluation questionnaire as to the extent to which they had learnt from and valued this process. These responses were explored further in four focus group interviews comprising a balance of genders, subject specialisms and educational backgrounds.

Results

It was evident that the student teachers clearly valued the process, despite finding it challenging, and the analysis revealed their growing understanding of the concepts under study and how to explain them to school students.

Conclusions

It is important to develop student teachers' concept fields: their subject knowledge **and** pedagogical content knowledge, in preparation for developing the concept images held by school students.

References

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Auditing the science subject knowledge of beginning teachers

Robin Millar, University of York

Background

Adequate subject knowledge is widely seen to be a necessary condition for effective science teaching. Assessment of teachers' subject knowledge is often based on self-audit. For both pre- and in-service teacher training courses, there is growing interest in the use of diagnostic questions to audit subject knowledge, and support teachers' learning.

Purpose

This study is a preliminary exploration of the following questions:

1. How well do science PGCE students perform on diagnostic questions in major physics domains?
2. Does students' highest formal qualification in physics correlate with performance?
3. How good are students at judging their own subject knowledge?

Sample

Secondary science PGCE students (biology, chemistry and physics) towards the end of their course in 3 HEIs in England: 106 for electric circuits test, and 55 for forces. Convenience sample of HEIs and of students.

Design and methods

Responses were collected to short (15 minute) diagnostic tests in the domains of electric circuits, and forces and motion. All questions were selected response. Students were asked to indicate their level of confidence in each answer on a 0-10 scale.

Results

Answers to both tests showed common misconceptions in both domains. Performance on the forces test was higher. For both domains, performance increased with physics qualification. Students' confidence ratings did not indicate good awareness of areas of relative weakness.

Conclusions

Diagnostic tests provide useful insights into PGCE students' subject knowledge. Students see these as helpful, if formative feedback and learning support is provided. Self-audit is an unreliable guide to students' understanding.

Problem-solving with a simple electric circuit: a study of pre-service science teachers in London and Ramallah

Ralph Levinson, Steven Chapman, Paul Davies, Institute of Education; Maher Hashweh, Musa Khaldi, Nader Wahbeh, Bir Zeit University, Ramallah

Background

Pre-service science teachers (PSTs) in the Institute of Education London and Bir Zeit University, Ramallah, were asked to predict and explain observations when lamps of two different ratings were placed in series and parallel in an electric circuit.

Purpose

- i. What knowledge do student teachers draw upon to solve a problem in an ostensibly simple and familiar context?
- ii. Which mediating factors support or constrain successful problem-solving in this particular context?

Sample

The PSTs were videoed working in groups of 3 or 4 to solve the problem; six mixed gender groups in London and four groups of females in Palestine. The U.K. students were convenience-sampled as part of a wider problem-solving session at an early stage in the PGCE course. One of the PSTs in each group had physics as at least a major specialism in their undergraduate degree.

Design and methods

In London each group was presented with components of a simple electric circuit and asked to predict what they would see and then explain their observations when the circuit was constructed with bulbs first in series and then in parallel. PSTs were not told that the similar-looking bulbs were of different voltages. The Palestinian groups did the same tasks except that they were told the voltages of the two bulbs. Individual experienced physics teachers in both countries were asked to solve the problem and their reasoning tracked.

Results

No PSTs managed to explain the observations satisfactorily.

Conclusions

Initial analysis suggests that PSTs find it difficult to reconstruct their scientific knowledge to solve an unfamiliar problem in a familiar context. Experts draw flexibly on knowledge through the world of ideas in applying them successfully to the 'real world'. When PSTs find their available canonical knowledge is inert they often resort to non-scientific explanations.

Decisions about likelihood of veracity of news reports of science: The contribution of advanced knowledge of science

John Kirkman, University of Birmingham

Background

The topic of the study is the nature of scientific literacy and the usefulness of scientific knowledge in everyday life.

Purpose

This study explores the differences advanced study of science makes to the reasoning people demonstrate as they explore the likelihood of veracity of news reports of science. In other words, does an advanced education in science make a difference to what participants believe and why they believe it? The work seeks to examine what, if any, unique contribution scientific training might offer.

Sample

The sample comprised 26 trainee teachers (14 science and 12 history) all registered at a Midlands university and studying for a 36 week Masters level teacher training qualification (PgDipEd).

Design and methods

Semi-structured interviews were conducted toward the end of the PGDipEd year. During interviews participant read four news reports about scientific research and made decisions about likelihood of veracity of knowledge claims. The interviews were recorded and transcribed. In analysis, units of data were identified where a conclusion about veracity was coupled with a cue or condition.

Results

Findings indicated that science trainees were more likely to examine relationships between variables, express concerns about control groups and look for causal factors. They are also more likely to be concerned with sample size and issues of writing/reporting. History trainees were more positive about the scientific methods adopted in reported studies and more likely to point out the presence of evidence or results.

Conclusions

Cues used by interviewees could be divided into two groups, those that increased epistemic distance and those that decreased epistemic distance. Epistemic distance indicates whether claims are fully accepted (an epistemic distance of zero) or entirely rejected (an epistemic distance of one). An outcome of the study is a range of Lines of Reasoning (**If** cue **then** conclusion about epistemic distance) which will form a framework to further explore, through case studies, how people read news reports of science with likelihood of veracity in mind.

Session 3 B Measuring and explaining attainments in post-16 science education

Investigating influences on post-16 progression in science in England using quantitative national data

Principal author: Matt Homer Co-authors: Indira Banner, Jim Ryder
University of Leeds

Background

Increasing participation in post-16 science, particularly physics, is an ongoing national policy objective in England. However, there is limited understanding of the current influences on progression from a national perspective.

Purpose

This paper addresses the following research questions:

1. What are the relative influences on post-16 participation in science (e.g. prior attainment in science, gender, socio-economic status, KS4 pathway)?
2. How does science compare in this regard to other subjects?
3. How can analysis of national data contribute to the formation and evaluation of national policies with regard to increasing post-compulsory science participation?

Sample

This study uses data from the national pupil database to follow a single cohort of students in England who took KS4 assessments in 2008. It tracks them across the KS4/KS5 boundary (A-levels 2010) to investigate a range of student-level influences on participation in A-levels in biology, chemistry, physics, mathematics, psychology and history.

Design and methods

Analysis includes descriptive statistics comparing participation rates by a range of student characteristics between particular A-level courses. More complex modelling techniques are also employed to predict the independent effect on participation of a range of student characteristics.

Results

Progression rates vary widely across post-16 sciences by gender and socio-economic status, but other non-science subjects too vary in these regards. Once prior attainment is factored out, the gender differences across science and some other subjects largely remain but those due to socio-economic status are to some extent ameliorated. Those students doing 'more' science at 14-16 are found to be more likely to progress to science post-16.

Conclusions

Research carried out using national data necessarily has its limitations. However, stakeholder understanding of the current national 'picture' with regard to patterns of post-compulsory participation in science can be improved through analysis of such data.

Teaching approach and attainment in A-level Biology

Martin Braund, Judith Bennett, Gill Main, Gillian Hampden-Thompson and Anne Scott
University of York.

Background

A common debate in science education is whether context-based (STS) teaching impacts examination performance. The problem for research has been one of equivalence. Context taught students do better on context-based questions and, likewise, concept taught students on concept-based ones.

Purpose

Uniquely, in this study, candidates taking EDEXCEL Biology A-level in 2010 took the same examination papers irrespective of what teaching approach was used. Results were analysed to see if teaching approach; context-based (SNAB), concept-based/ traditional or a mixed economy, drawing on both approaches, impacted performance and what in-school factors might explain differences in results.

Sample and methods

Examination results from 7,561 students in 344 schools/colleges were analysed. Schools were issued with a questionnaire probing teaching methods used and factors they thought might bring about student successes. Teachers in 15 of these schools (5 for each of the three teaching approaches) were interviewed. Quantitative data were analysed using t-tests, ANOVA, χ^2 and linear regression. Qualitative results from questionnaires and interviews will be analysed using emergent coding.

Results

Teaching approach, as between context-SNAB or concept-traditional, has no impact on performance. Students of all abilities (based on their GCSE points' scores at entry to A-level courses) do equally as well in both approaches. However, the mixed-economy approach confers a definite advantage as tests (ANOVA, χ^2) show these students showed a statistically significant positive difference to the other two approaches both in mean scores achieved and for the numbers of higher grades (A/A*) attained. Linear regressions showed that these differences remained significant when GCSE scores were controlled for.

Conclusions

A mixture of teaching approaches drawing on a variety of resources seems to offer the best chance of examination success in Advanced level Biology. Following a context-based course does not disadvantage students at any range of ability and, as many other studies show motivation is higher in such courses, they can be recommended. Results from questionnaires and interviews with teachers should reveal more about school-based factors underpinning examination success.

Schools that make a difference to post-16 uptake of physics and chemistry

Principal author: Judith Bennett Co-authors: Gill Hampden-Thompson and Fred Lubben
University of York

Background

Post-16 uptake of physical science subjects

Purpose

Project aims:

- To identify schools that are more successful in encouraging young people to pursue their study of chemistry and physics beyond the compulsory period
- To identify educational features and practices within these schools that make them more successful

Sample

Case studies of four pairs of schools, matched on a range of indicators, but with one school having high uptake and the other having low uptake of chemistry and physics

In each school: interviews with three key school staff, interviews/focus groups with six-to eight post-16 students

Design and methods

- Schools identified through interrogation of the National Pupil Database (NPD)
- Case studies of four pairs of schools, each pair containing one more successful school and one less successful school in encouraging post compulsory study of chemistry and physics
- Interviews with three key school staff (head of science, member of school senior management team responsible for the curriculum, school careers adviser); interviews/focus groups with post-16 students (both science and non-science choosers); contextual data (school examination results, levels of qualification, subject specialism and experience of science teaching staff)

Results

Case study data indicates that high uptake school are characterised by the following features that are not apparent in low-uptake schools:

- curriculum diversity pre-16
- higher expectations in relation to AS admission grades
- appropriate and targeted careers advice from science teachers
- appropriately-timed work placements, mapped to student interests
- a range of opportunities for student to interact with the world of work.

Conclusions

The study indicates that a positive impact on post-16 uptake is linked to a school policy on curriculum structure pre-16, appropriately high expectations in relation to AS admission grades, and opportunities for students to interact with the world of work and undertake science-related placements before making AS-level and A-level subject choices.

Note: The contribution on the project given at last year's conference in 2011 focused on the first part of the study, the analysis of the National Pupil Database. This contribution focuses on the second part of the study, the case study data, and presents the overall findings and conclusions.

Deconstructing the socioeconomic gap in science attainment

Katherine Richardson, Teach First

Background

The quarter of UK children who grow up in poverty have lower chances of educational success than their peers (C4EO, 2011). Recent policy rhetoric has focused on 'closing the gap' in attainment between pupils from high-income and low-income backgrounds, with measurements of this gap included in recent Performance and Attainment Tables (DfE, 2012). However, the size and shape of any 'gap' is strongly influenced by our selection of attainment measures and proxies for low-income background (Rothstein, 2004). Further, most measures of the 'gap' measures have considered overall attainment, obscuring subject-level differences. This research explores the nature of the 'gap' in science attainment at Key Stage 4. For Teach First, a clear and nuanced picture of this 'gap' is vital to deciding how we can best address educational disadvantage.

Purpose

This research explores:

- how choice of measurement affects the attainment gap in KS4 science
- how the attainment gap in science contributes to the overall attainment gap

Sample

The study draws on national Year 11 cohort data for England in years 2009, 2010 and 2011.

Design and methods

Pupil-level attainment and demographics were taken from the National Pupil Database, while school-level data were obtained from the Performance and Attainment Tables and Edubase.

We compared the size of the gap in science attainment using different attainment thresholds and socioeconomic indicators, including the impact of excluding GCSE-equivalent qualifications such as BTEC Science. We also assessed the contribution of the science 'gap' to the overall attainment 'gap'.

Results and Conclusions

Interim analysis shows that the size and shape of the gap varies widely depending on the measures chosen, and that excluding GCSE-equivalents will more than double the gap in science. Full results, conclusions and implications will be presented at the conference.

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Session 4A Changing science teaching: the school context

The effectiveness of the 'Getting Practical' Continuing Professional Development (CPD) programme

Principal Author: Ian Abrahams, University of York

Co-authors: Michael Reiss, Institute of Education, University of London; Rachael Sharpe, University of York

Background

The national Getting Practical: Improving Practical Work in Science project was designed to improve the effectiveness of practical work in English primary and secondary schools through a national programme of Continuing Professional Development (CPD).

Purpose

This article reports on the extent to which the programme of CPD was effective in meeting the aims of the Getting Practical project.

Programme description

The CPD programme under evaluation, which employed a cascade model of training, was of six hour duration and was delivered either as a single session; two 3 hour sessions or three 2 hour twilight sessions depending on the requirements of local teachers.

Sample

The sample involved teachers, of varying teaching experience, in 20 secondary and 10 primary schools across England. Broadly speaking the sample was representative of state funded primary and comprehensive secondary schools and included rural, urban, co-educational and single sex schools.

Design and methods

The study was designed around a multi-site, condensed field work, case study approach. Data were collected using audio-recorded, semi-structured, interviews with teachers, their colleagues and their students as well as through field notes made during lesson observations.

Results

It was found that, broadly speaking, the CPD was successful in achieving levels 1,2 and occasionally 4 in Guskey's (2002) hierarchy although in one case level 3 was also observed. The findings suggest that the impact of the CPD was dependent on who undertook the training, e.g. whether they were a head of department or a Newly Qualified Teacher (NQT), and the extent of SMT support.

Conclusions

Lasting change in teachers' practice is likely to require a more extended and sustained training programme.

References

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Mind the gap

John Oversby, University of Reading

Background

The perception of a gap between education practitioners and researchers has been a source of commentary for over 100 years (e.g. Korthagen, 2007, Vandelinde & van Brake, 2010). More recently, this has been more tightly described in terms of impact on practice, especially in teacher education programmes.

Purpose

The research question is: how does a community of researchers and practitioners in a teacher researcher group engaging in and with science education research facilitate impact in the school classroom?

Design and methods

The research methodology is Case Study, with a significant range of documented evidence from the group web site, emails and reports of activity, and a questionnaire to elicit participants' views on the impact, a published article and conference presentations at conferences. The web site contains notes of intended action, reports of activity, and reflective contributions. Care has been taken to assure participants of anonymity where information is not in the public domain. Documentary evidence, such as reports of meetings, was examined to extract positive and negative instances attending to the following sub-questions:

1. Did attendees engage in discussion of published research that focused on aspects of deciding research questions, critiquing methods for validity, reliability and reliability, and were conclusions appropriate for the data provided?
2. Did attendees adopt approaches to their own research that were designed to match those in published research?
3. In their completed questionnaires, did attendees provide evidence of value achieved, such as commitment?

Results

The evidence points to an existing interest in engaging deeply with research linking researchers and teachers, leading to the establishment of a long lasting and self-sustaining group. A collaborative atmosphere developed where a group research project was identified, and tasks allocated by agreement. The group shared the process of reviewing the literature at group meetings. Methods of data collection to explore specific research questions were devised by the group, and subject to intense discussion to ensure the highest validity and reliability. Data was analysed jointly at group meetings, but each segment was owned by an individual or a small group. This ensured that there was validity in the analysis. Interpretations were presented at group meetings and subject to scrutiny.

Conclusion

Some recommendations are:

1. Research into teachers' and practitioners beliefs must continue.
2. Teachers and researchers must work together more as equally valued partners, principally to understand each other and generate more respect.
3. Those who provide professional development must have a foot in the researcher ethos, as well as a foot in the practitioner ethos.
4. Mediators, such as teacher educators, must be supported in their efforts to bridge the gap.

Multiple policies in the workplace: Teachers' responses to science curriculum reform

Principal author: Jim Ryder Co-authors: Indira Banner, Jim Donnelly
University of Leeds

Background

We examine teachers' experiences of a major reform of the school science curriculum for 14-16 year olds in England. This statutory reform enhances the range of available science courses and emphasises the teaching of socio-scientific issues and the nature of science.

Purpose

This paper examines teachers' experiences of the reform over a three year period, and the factors that condition these experiences.

Sample, Design and Methods

The paper is based on an analysis of selected interviews with 50 teachers from 19 schools in England. Teachers were interviewed each year, over a three year period. Our analysis considers how the external and internal structures within which teachers work interact with the personal characteristics of teachers to condition their experiences of the curriculum reform.

Results

We find that teachers' responses to the science curriculum reform are conditioned by personal perspectives on the goals of science education, internal departmental working contexts and a broad range of external policy pressures. In some cases, these influences can align to support teacher change. However, in other cases competing influences create tensions that constrain teacher change. We characterise teachers' responses to this curriculum reform as taking place within a 'policy network'. This emphasises the ways in which curriculum reform involves teachers responding to pressures from a network of inter-related institutions and associated policies.

Conclusions

We argue that curriculum reformers need to recognise the range of personal, internal and external contexts in which teachers work. They need to consider how teachers in different working contexts are likely to respond to a specific curriculum reform. In part, this involves trialling reforms within a sample of schools designed to represent these range of working contexts. The relationship of a specific curriculum reform to other educational policies in the school workplace also needs to be considered.

Session 4B In-service science teacher training

Teachers of Physics CPD project: setting the context of physics specific CPD in England

Anne Bowker, King's College London

Background

Recent concerns regarding the lack of physics-qualified teachers in schools and the difficulties facing non-specialist teachers teaching physics, have prompted a number of nationally available continuing professional development (CPD) programmes that appear to be well received by teachers. However the current economic climate together with structural changes to the school system may conspire to counter such initiatives.

Purpose

Teachers of Physics CPD ('ToP CPD') is a 2-year funded research project which explores the nature of provisions of physics-specific professional development and investigates science teachers' ability to access such provisions.

The three phases of research respectively:

1. Develops a robust framework for understanding physics-specific CPD, based on a systematic analysis of international literature and interviews with a range of leading practitioners.
2. Refines the framework through case-study research, drawing on documentary, observational and (teacher- and CPD leader-) interview data from three CPD schemes identified for good practice.
3. Formulates and administers a science-teacher questionnaire-survey, underpinned by the framework, to identify issues in accessing CPD and gaps in available provisions.

The material presented here represents the preliminary stage of work in progress, focussed on the selection of schemes and emerging issues.

Design, methods and sample

The study uses a mixed-method approach. Initial analysis of websites offering physics-specific CPD to teachers in English schools is supplemented by both observation of the schemes and interviews with 20 key informants drawn from different levels within each scheme. Data will be analysed thematically with respect to models of professional development located within the literature. The findings will then feed into the development of a survey questionnaire for science teachers (n>1000) regarding their experiences of CPD and their current ability to access provisions.

Results

This presentation offers a work-in-progress discussion based primarily on initial desk research.

Moving from Professional Development to Sustained Practice

Chris Harrison, King's College London

Background

There is an extensive body of evidence describing the effectiveness of assessment for learning (AfL) as a pedagogical tool. While there has been large and small scale moves to implement AfL practice in schools in England, the reports from several sources indicate that the implementation is sporadic and underdeveloped.

Purpose

How do science teachers take ideas generated in professional development meetings and establish them in practice?

Sample

Six teachers took part; this paper explores the assessment practices of one experienced science teacher.

Design and methods

This was a mixed methods qualitative study. Data was collected through audio-recordings and field notes of the six teacher meetings, a constructed portfolio of evidence, pre- and post-project interviews and two lesson observations. Each data set was examined for arising themes and cross checked chronologically, between data sources and with the corresponding data for the other project teachers. The data was reconfigured using the themes as a framework to form a case study.

Results

This paper supports the idea of on-going professional development through collaborative endeavour. The findings show how possibilities and actions can be influenced both by the reaction of teachers within the teacher's school and by teachers from other schools. The process therefore challenges the literature on communities of practice suggesting both internal and external verification is required for teachers to make sustained changes to their practice.

Conclusions

In many classrooms, formative and summative assessment are not polar opposites but exist as a mix of strategies within the pedagogy. Teaching is a highly personal activity where teachers bring together and make sense of notions of curriculum, pedagogy and assessment and requires both internal and external validation by colleagues.

Developing web-based CPD for groupwork and argumentation in science

Principal author: Professor Shirley Simon Co-authors: Dr Paul Davies, Jillian Trevethan

Institute of Education, London

Background

In spite of established CPD programmes based on a curriculum development called IDEAS (Osborne, Erduran & Simon, 2004), research continues to show that certain aspects of teaching argumentation remain challenging for many teachers. It is proposed that the development of focused tasks based on carefully designed video materials can support teachers in three specific areas. These are:

- The planning and organisation of groupwork.
- The teacher's role in introducing argumentation, sustaining small group discussion and conducting a plenary.
- The design and interpretation of argumentation resources.

For professional development to be effective these practices need to be reflected upon analytically. The research for this paper has been carried out alongside three workshops, one on each aspect, involving teachers from both primary and secondary schools, using new video material and appropriate professional development activities.

Purpose

How do teachers, working independently or collaboratively, carry out and reflect on the teaching strategies developed in focused workshops based on video material?

Sample

Eight teachers (four primary and four secondary) from six schools in Harrow.

Design and methods

The research is intended to be exploratory. Each teacher has been provided with a flip camera to record in whatever way they choose an account of the lessons they have designed and implemented between each of the three workshops, and their reflections on those lessons. The analysis of this video material will focus on the criticality of reflection, collaborative working, and challenging aspects of practice.

Results

The analysis is ongoing, but the combination of specific video footage and focused tasks suggests that teachers have been confident to engage in new teaching strategies. Collaborative working between pairs of teachers has enhanced confidence.

Conclusions

The workshop contents and teachers' reflections can be used to design appropriate tasks to be integrated with the video material on a web-site.

Reference

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Designing and implementing innovative curriculum materials and associated professional development to enhance biology teachers' pedagogical knowledge and skills in Tanzanian secondary schools.

Principal author: Wadrine Maro, Co-authors: Marcus Grace and Jenny Byrne, University of Southampton

Background

The predominant teaching and learning methods in secondary schools science classrooms in Tanzania are didactic and teacher-centred. Due to inadequate provision of regular in-service training, teachers continue to teach 'traditionally' and this has contributed to the failure of students in their final national examinations. Furthermore, curriculum materials that have an educative focus on teachers' practice are relatively new.

Purpose

This study aims to address these issues by exploring the procedures involved in designing innovative curriculum materials to support activity-based biology teaching and learning in Tanzanian secondary schools. The guiding question was:

How can innovative materials be designed and implemented to enhance biology teachers' pedagogical knowledge and skills?

Sample

Three experts, 29 biology teachers, and 120 students were obtained through purposive sampling.

Design and methods

Design based research methodology guided the iterative process of developing the materials. Qualitative and quantitative data were collected at different stages of development via interviews, questionnaires, classroom observation checklist, and field notes to gain insights about the validity and practicality of the materials.

Results

80% of teachers indicated they gained additional instructional knowledge and skills. The inclusion of 'excitement' component to each lesson inspired both teachers and students as it contributes to lesson interest and attention. 92% of students claimed improvements in the understanding of the lessons. 86% of teachers agreed that the approach could be realistically implemented in their classrooms.

Conclusion

Innovative curriculum materials were developed through a collaborative prototyping approach supported by the 5Es instructional sequence. Teachers perceived the materials as supportive for practising the new approaches for teaching and learning biology that actively involves their students, but they needed more time to implement them effectively.

5A Round table discussion

Connecting Science Education with Health Literacy

Marcus Grace and Jenny Byrne, University of Southampton

Background

With the recent national and global rise in health risk behaviour and non-communicable diseases (NCDs) (e.g. obesity and diabetes), it is an important time to determine the role of science education in supporting health and wellbeing. Many health issues impact on the social and economic wellbeing, and science education should help students develop skills to support health literacy.

Purpose

To hold a round-table discussion about the part science education can/should play in supporting 'health literacy', and reducing risky behaviour - and a way forward.

Sources of evidence

Science literacy is essential to understand health issues, and stem the recent rise in NCDs, which now cause 63% of deaths globally - 80% of which could be prevented through behaviour changes (WHO, 2008). Educational attainment is one of the strongest determinants of poor diet (Robinson et al, 2004). The UN (2011) Summit on NCD Prevention, and health experts have called for critical health literacy (WHO, 2008; Nutbeam, 1998, 2000) involving accessing, critically analysing, and applying health-related information to create healthier lifestyles.

Main argument

There is a need to map out fundamental connections between scientific literacy and health literacy – perhaps through a bridging pedagogy of 'science education for health literacy'. We have delivered effective health modules within the school science and ITT curricula, drawing on transformative learning models (Mezirow, 2000), biopsychosocial perspectives (Engel, 1977; Lee 2011), and elements of CPD, learning outside the classroom, and using experts (Byrne, et al., in press; Grace and Bay, 2011). However, we'd like to discuss other approaches, and collaborate with other colleagues to consider an appropriate strategy for delivering science education for health literacy more widely.

Conclusions

The connection between science literacy and health literacy is vital to modify health-related attitudes and behaviours. We need to map this overlap and consider a bridging pedagogy which supports science education for health literacy.

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5B Round table discussion

Education for Social Justice and Professional Development

Principal author Maarten Tas, University of Leicester

Co-author Caro Garrett, University of Southampton

Background

Since the coalition government came into power there have been a lot of changes in education. Although we have been asked to respond to consultation documents, this seems to be a top down policy and we intend to initiate discussions to supplement this. Our ultimate aim is to develop the equality of opportunity that is offered in our education system and how it can be utilised to afford each individual the possibility of achieving.

Purpose

This round table discussion will engage colleagues in working collaboratively to identify the skeleton for a 'manifesto for Education' built on the principles of Education for Social Justice. Intervention strategies and the allocation of school resources will be important here.

Developments

This first step in constructing a bank of statements aims to encapsulate a clear vision of Education for the 21st Century. Similar workshops will be run at other meetings and conferences. Subsequent discussion with a range of other stakeholders in Education will focus on developing this vision. These will then be communicated and consulted upon with a wider audience via a range of media.

Aim

Our aim is to work towards establishing a short list of key principles, expressed succinctly and with clarity, supported with evidence found in academic publications. An expanded discussion of each principle would be made freely available to a wider public. Engagement with policy makers and politicians could form a part of the discussion. It is important to consider how this research and its findings are conveyed to teachers and how to assess the impact on, and development, of their practice.