

Formative assessment using Concept Cartoons: initial teacher training in the UK

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Abstract

The research explores the use of the innovative Concept Cartoon strategy for probing understanding of science, focusing on student teachers in the UK. It examines the impact of the strategy on their attitudes to assessment, whether it helps them to begin to restructure their understanding, and whether it might provide a possible strategy for them to use in their own teaching. The data suggest that the strategy is potentially valuable as a means of assessment of student teachers.

Introduction

Concept Cartoons extend the range of pedagogical strategies available to teachers. They present learners with a set of alternative ideas about a scientific concept in visual form (see Figure 1). They are used mainly in the classroom to support teaching and learning in science by generating discussion, stimulating investigation and promoting learner involvement and motivation. Previous research (Keogh and Naylor, 1999) indicates that Concept Cartoons are useful for elicitation of understanding and might be used for the assessment of learning.

The research took place in the context of changes to the requirements to be met by student teachers in England. These requirements are defined in Circular 4/98 (DfEE 1998), which includes the requirement to audit student teachers' scientific knowledge and understanding and identify gaps in their knowledge. No specific mechanism is required or proposed for this auditing process. The value of concept cartoons as an auditing mechanism formed the focus for the research in four University Schools of Education.

Numerous authors point to the significance of subject background knowledge for primary teachers (Osborne and Simon, 1996; Shulman, 1986). Mant and Summers (1995) claim that subject background knowledge enables teachers to diagnose pupils' learning, plan for progression and provide activities which help them to acquire the scientific view. Lack of a sound grasp of the scientific ideas which they are expected to develop in their pupils is a problem for many primary teachers and can lead to a lack of confidence in teaching science (Harlen and Holroyd, 1995). Research into student teachers' scientific knowledge and understanding shows that many of the alternative

conceptions described elsewhere for children (eg Driver et al, 1994) have persisted into adulthood (Carré, 1993).

Black (1998) notes the impact of assessment on motivation and self-esteem. Many student teachers enter initial teacher training (ITT) courses with negative attitudes to science, often perceiving themselves as “failed learners” in this subject (Parker and Spink, 1997). Poor performance on an initial audit which simply tests their knowledge could reinforce their sense of failure, strengthen negative attitudes to science and provide poor conditions for learning about science.

Concept Cartoons (Keogh and Naylor, 1997) were selected as a mechanism for auditing the student teachers’ scientific knowledge and understanding. Potential advantages of using the Concept Cartoons included the fact that they are very different from most of the forms of assessment which student teachers would have experienced in the past, so that they would be less inclined to make premature judgements about this approach. The Concept Cartoons were viewed as having the potential for promoting metacognition in relation to the assessment process, which is an important aspect of student teacher development (Bell and Gilbert, 1996). The strategy was consistent with Bishop and Denley’s (1997) claim that an effective auditing strategy will both diagnose the students’ level of understanding of science concepts and help them begin to reconstruct their understanding. The Concept Cartoons are easy to use in the classroom, so using them for assessment also provided the student teachers with potentially valuable classroom materials.

Research methodology

The research addressed three specific questions in order to make a judgement about the extent to which concept cartoons might provide a useful auditing tool in ITT. These were:

- To what extent might the use of Concept Cartoons avoid student teachers developing negative attitudes to being assessed?
- Does the use of Concept Cartoons in assessment help the student teachers to begin to restructure their scientific knowledge?
- Does the use of Concept Cartoons help to provide a model for assessment, teaching and learning in the classroom?

The research took place over two years, with some modification of the approach occurring during the second year in the light of the evidence obtained. The different circumstances within each University led to some variation in data collection methods, with each researcher using the approach which was most relevant to their own circumstances, and this allowed a degree of triangulation of the data. The data sources were a mixture of undergraduate and postgraduate student teachers with a range of personal histories, experience and science backgrounds.

Thirteen Concept Cartoons were used with the groups of student teachers, covering a broad range of science concepts such as electricity, forces, thermal insulation and ecological interactions. The Concept Cartoons provided a rich source of data for

student teacher understanding of science concepts and for the types of alternative conceptions which were common, but this data is not the subject of this paper. Other complementary approaches to data collection included:

- Questionnaires (n = 318)
- Semi-structured interviews with students (n = 15)
- Informal feedback from all groups of students
- Taking note of references to concept cartoons in written assignments

A total of 635 audits have been analysed to date. The audits were given to the student teachers at the commencement of their course. Most of the data were gathered shortly after the completion of the audit. Informal feedback was elicited throughout the course and as part of final evaluation of the taught courses.

The data from the interviews, the questionnaire and the informal feedback were analysed in relation to the research questions using a combination of qualitative and quantitative analysis. Areas of agreement from these data sources were noted, what appeared to be significant issues were identified, and any major discrepancies between the data sources were identified. The use of a range of data collection methods, a variety of data sources and interviews to follow up issues raised elsewhere enabled the data to be triangulated (Denzin, 1970) and helped validate the analysis.

Data and data analysis

1. Student teacher attitudes to assessment

The data showed that 47% (n = 333) had negative feelings about the idea of being assessed at the beginning of their course. Their views ranged from “apprehensive” or “nervous” to “anxious” or “horrified”. They felt that assessment would demonstrate how little they knew, thus undermining their confidence and reinforcing their feelings of inadequacy in science.

Their feelings about the use of the Concept Cartoons as an assessment method were more positive, with 89% having positive feelings about this approach. Typical comments were that the approach was “more user friendly”, “enjoyable and light hearted”, “easy to understand” and “less threatening and more stimulating”. It appeared that the experience of being assessed using the concept cartoons was more positive than many of the students had anticipated. The use of the Concept Cartoons appeared to have avoided the development of negative attitudes for the majority of the student teachers.

2. Restructuring understanding

More than half of the student teachers (69%) thought that using the concept cartoons helped them to think differently about the situations and to begin the process of restructuring their understanding. Several indicated that they had continued thinking and talking about the questions after the audit, and in some cases had gone home and set up a practical investigation to clarify their thinking and find out more about the situations. Some felt so positive about this aspect of the Concept Cartoons that they used them in schools for the same purpose, echoing Gunstone (1988) who noted the

overlap between the methods used to probe understanding and those used to develop understanding. Comments made by the student teachers included

the Concept Cartoons promoted my thinking
they allowed me to visualise the concepts
I'm looking at forces and weights in a different way
they made me think more widely
they made me question what I thought I knew

Self-reporting may not necessarily be a reliable indicator of an individual's level of understanding. However self-reporting of a change in thinking is much more likely to be significant, particularly when the frequency of changes in thinking is relatively high. In this study the directed attention of the student teachers, their active involvement with the Concept Cartoon situations and the opportunity for metacognition make conceptual change more likely.

It is particularly noteworthy that any conceptual change reported by the student teachers has been brought about by assessment, not by direct teaching.

3. Modelling assessment, teaching and learning

Nearly all of the student teachers (97%) held positive views about the value of the Concept Cartoons as a teaching approach at this point in their course. None expressed any negative views. They could often see multiple uses for the Concept Cartoons in the classroom, including elicitation, providing a context for discussion and identifying starting points for investigation. Many of them described how in their experience elicitation led naturally into wanting to find out more about the situation and to more focused investigation. They described how the Concept Cartoons were not only an assessment mechanism but that they could challenge learners, encourage thinking and stimulate them to justify their thinking more fully. They were able to identify parallels between the auditing approach used in their course and their classroom practice. Many of them had gone on to use the strategy in their own teaching, and in some cases had transferred the approach to another curriculum area. Typical comments included

they give me ideas about how to set up lessons
they create initial interest and gain attention
get children thinking openly and brainstorming ideas

These positive views are consistent with previous research in which the use of concept cartoons led to some student teachers developing their views of how constructivist approaches to teaching and learning might be implemented in the classroom (Naylor and Keogh, 1999).

Conclusions and implications

The Concept Cartoons do appear to be potentially valuable as an assessment method in initial teacher training. Although the student teachers were not uniformly positive in their responses, their attitudes to this approach to assessment in science were generally favourable. The use of the Concept Cartoons for assessment purposes may

offer the possibility of promoting positive attitudes to science teaching and learning amongst student teachers.

Many of the student teachers perceived the initial audit as a starting point for their learning. In principle the purpose of an initial audit should be to enhance professional development (Bishop and Denley, 1997). In at least some cases the audit based on Concept Cartoons helped the student teachers to understand their learning needs and to begin the process of restructuring their understanding.

The use of the Concept Cartoons appeared to have a strong link with professional practice. They enabled most of the student teachers to identify links between assessment, learning and teaching and to recognise how they could provide possible models for assessment, teaching and learning in the classroom. Anecdotal evidence indicates that many of them have built on this experience and gone on to use the concept cartoons successfully in the classroom.

Some limitations of the research are evident. No comparisons were made with other assessment mechanisms, and this may have influenced the student teachers' views. The study does not attempt to provide any long-term view of student teachers' thinking or ideas, nor the extent to which student teachers' attitudes to assessment and their classroom practice have been modified. Minor variations in approach across the four University sites made it difficult to standardise the data analysis, though this proved helpful for triangulation purposes. Issues such as whether the student teachers are allowed to talk as they complete their audits and whether they can take the audits away overnight may also have a significant effect on their anxiety levels and on the nature of their responses to the Concept Cartoons.

The implications for future teaching appear to be that the Concept Cartoons have clear potential value as an auditing mechanism in science for student teachers in England. They appear to avoid the risk of reinforcing negative attitudes to science and potentially can have a positive impact on professional practice. Although the range of Concept Cartoons used was not enough to give comprehensive coverage of the National Curriculum for ITT, they appear to provide valuable starting points for student teacher professional development. They provide a useful mechanism for probing student teacher's understanding of scientific ideas; data collected on these ideas will be written up for publication elsewhere.

References

- Bell, B. & Gilbert, J. (1996) *Teacher development: A Model from Science Education*. London: Falmer.
- Bishop, K. & Denley, P. (1997) The fundamental role of subject matter knowledge in the teaching of science. *School Science Review*, 286, 65-71.

- Black, P. (1998) Formative assessment: raising standards inside the classroom. *School Science Review*, 80, 291, 39-46.
- Carré, C. (1993) Performance in subject-matter knowledge in science. In N. Bennett & C. Carré (Eds.) *Learning to Teach*. London: Routledge.
- Denzin, N.K. (1970) *The Research Act in Sociology: A Theoretical Introduction to Sociological Methods*. London: The Butterworth Group.
- Department for Education and Employment (1998) Circular 4/98. *Teaching: High Status, High Standards*. London, DfEE.
- Driver, R., Squires, A., Rushworth, P. & Wood-Robinson, V. (1994) *Making sense of secondary science*. London: Routledge.
- Gunstone, R. (1988) Learners in science education. In P. Fensham (Ed.) *Development and dilemmas in science education* (p73-95). Lewes: Falmer.
- Harlen, W. & Holroyd, C. (1995) *Primary teachers' understanding of concepts in science and technology*. Scottish Council for Research in Education.
- Keogh, B. & Naylor, S. (1997) *Starting Points for Science*. Sandbach, UK: Millgate House.
- Keogh, B. & Naylor, S. (1999) Concept Cartoons, teaching and learning in science: an evaluation. *International Journal of Science Education*, 21, 4, 431-446.
- Mant, J. & Summers, M. (1995) Some primary school teachers' understanding of the Earth's place in the universe. *Research Papers in Education*, 8(1), 101-129.
- Naylor, S & Keogh, B. (1999) Constructivism in the Classroom: Theory into Practice. *Journal of Science Teacher Education*, 10(2), 93-106.
- Osborne, J. & Simon, S. (1996) Primary science: past and future directions. *Studies in Science Education*, 27, 99-147.
- Parker, J. and Spink, E. (1997) Becoming Science Teachers: an evaluation of the initial stages of primary teacher training. *Assessment and Evaluation in Higher Education*, 22 (1), 17-31.
- Shulman, L.S. (1986) Those who understand: knowledge growth in teaching. *Educational Researcher*, 15, 4-14.