Creativity, Continuity and Context in Teacher Education: Lessons from the Field

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Abstract Lessons from a pilot introduction of environmental education into a teacher education programme designed to address pupil disengagement from school science, are discussed in this paper. Pre-service teachers discovered that environmental education can be a potent context for creativity and continuity in curriculum planning. Interpretation of the responses demonstrates that environmental education can be used to develop scientific and eco-literacy and that pre-service teachers can be imaginative when offered the opportunity to link disparate areas of science in this context, but the timing of the intervention appears to be critical. Exposure to school culture appears to inhibit their ability to plan imaginatively. This has implications for pre-service teacher education and practising teachers internationally, if pupil disenchantment with science is to be halted.

Introduction

Some responses of pre-service science teachers to an opportunity to use environmental education as a context for learning science are presented in this paper. The purpose of the introduction of environmental education into their programme of study was to signpost for prospective teachers that, although many school pupils in England are positive in their attitudes to science, they are not "switched on" by school science as it is being taught currently. Although the study is based in the English context, the findings have a wider appeal as similar attitudes to school science are reported internationally.

In a review of the literature analysing attitudes to science, (Osborne et al., 2003) pupils report that they would like their teachers to engage them more creatively if they are to pursue the study of scientific subjects beyond any statutory requirements. Children reveal that they find practical activity the best way to learn, although a significant majority had not undertaken any regularly to support theory (Cerini et al., 2003). Furthermore, substantial numbers of school pupils internationally regard science as irrelevant to everyday life (Goodrum et al., 2001, Haste, 2004). This exposes a paradox for teacher educators. A crowded curriculum and teaching to the test are recognised features of school life both in England and Australia, where pupils accumulate facts at the expense developing scientific literacy (Goodrum et al., 2001). Furthermore in England, science education has been subjected to a centrally imposed

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strategy designed to raise achievement (Department for Education and Skills, 2001). These approaches contrast markedly with how pupils say they like to learn science.

Craft (2003), considers that tight control of both curriculum and pedagogy in England is contradicted by recent rhetoric. Creativity is advocated in recent reforms (DfES, 2003, 2004), yet a "standards mantra" still prevails. Furthermore, Craft (2003) identifies how atomisation into constituent subjects does not encourage a holistic view of the curriculum, and the pursuit of achievement leaves little time to forge any links between subjects yet, the great scientists recollect, having the time and space for visuo-spatial imagination impacted on their greatest insights (Shepherd, 1988). The development of pupils' imagination in science lessons is peripheral to the preoccupation with written work, calculation and logic according to Shepherd (1988), and creative curriculum planning may have been marginalised in the same way. Nevertheless, Jeffrey and Woods (2003) propose that recent reforms can be exploited to resist curriculum homogeneity, as well as being a means by which teachers reclaim a degree of professional artistry. The cry from industry according to Jones (2004) has been for schools to concentrate on literacy and numeracy, so any endorsement of teacher creativity signals a welcome return to broader educational goals. However, if more creative approaches to learning are to be adopted in schools, it is essential that student teachers are given opportunities to develop professional artistry when training. Ranson (2000) suggests that narrow, competence-based approaches to education need to be reconceived as pedagogy of capability if they are to result in active, participative citizens of the earth, a view emerging also in recent Australian education reform (Victorian Curriculum and Standards Authority, 2005).

Children reveal also that entry into adolescence is a key period if they are to maintain their interest in science (Cerini et al., 2003, EPPI Centre, 2003, Goodrum et al., 2001, Osborne et al., 2003,) and this period is marked for many children internationally by the transition between different phases of schooling. The response in England has been to devise bridging units to span primary and secondary school, but perhaps science needs to be viewed as a continuum of learning, rather than sections to be joined, if we are to maintain pupil engagement. This means that primary and secondary teachers need to appreciate their respective pedagogical approaches if they are to provide continuity, yet in England the number of pre-service programmes where this can occur is very limited since most primary and secondary teachers are educated separately.

As a response to the research literature on pupil disengagement from science highlighting the significance of practical work, creativity and discontinuity in learning between primary and secondary schools, three science teacher educators at the University of Hull brought student teachers from each of these sectors brought together with the purpose of designing imaginative fieldwork activities for pupils in this transition period.

However, simply blending pedagogical approaches may not be enough to address the downturn in pupil interest in science. As Millar and Osborne (1998, in Donnelly, 2004) observe, the disaffection of pupils with science may have resulted from misdirection in the aims of the curriculum itself, although current reforms to the curriculum designed to place science in a global context, mark an intent to halt this trend. Donnelly (2004) proposes schools adopt a more humanising approach to science, and that reforms to science education may enable its expression. Yet, as Donnelly (2004) observes, creating a workable pedagogy under conditions of radical indeterminacy caused by curricular reforms in a standards driven culture can be problematic, if not daunting, for teachers. Nevertheless, Shulman (1987) suggests that standards should not be confused with standardisation, and Jeffrey and Woods (2003) demonstrate that contextualised, holistic approaches to the primary curriculum do not necessarily compromise quality

or standards. The school they describe creates multiple, thematic opportunities for learning using its own environment, contrasting with atomistic methods of planning adopted by many schools. Malone (2004), working in the Australian context, demonstrates that urban, green spaces such as botanical gardens are ideal locations for learning and Bennett (2003) identifies how context-based approaches motivate pupils in their science lessons. Those pupils were able to make links between science and their everyday lives according to Bennett (2003), and there were no detrimental effects on their ability to learn scientific concepts. Utilising these ideas the student teachers in this study were offered the opportunity to use their emerging pedagogical skills to plan their activities for children using just such an urban green space, the University of Hull Botanic Gardens.

Peacock (2004) suggests that focusing on ethical, sustainable development is an ideal opportunity to utilise fieldwork. However, the ability to connect disparate concepts and bodies of knowledge is essential to effective teaching in this area. Such "connectionist" teachers, according to Edwards and Protheroe (2003), are able to link the curriculum to learning, rather than delivery, when the emphasis on pupil performance is at the expense of responsive, interactive pedagogy. A further aim of this study was to provide opportunities for student teachers to practise making connections between disciplines by arranging the groups of student teachers to make effective use of their differing subject specialisms in science, as well as across sectors of schooling.

In addition, the potential for stimulating pupil engagement in science by focusing on scientific and eco-literacy is formidable. Roth (2003) suggests the context informs the learner and can exhibit scientific literacy as pupils explore how changes in scientific knowledge influence the relationship humans have with the environment. As critical educators we should facilitate the emergence of personally experienced, collective praxis so that individuals possess a basic vocabulary of scientific concepts (Roth and Lee, 2004). Pupils learn science in the process of contributing to everyday life according to Vaughan et al. (2003), who propose that environmental education should be a continuous learning process, where individuals acquire knowledge, values, skills and experiences to solve environmental problems for the present and future. Schnack (2000), investigating students' involvement in environmental education in Denmark, names this participation "action competence". Gayford (1998) states that this could be a goal of environmental education, although it is one which involves movement away from the normal remit of science teachers faced as they have been, with prescriptive curricula (Gayford, 2002). In fact, Gayford (1998) identifies that many science teachers are intensely interested in environmental matters, so the potential value of environmental education as a context for learning science was identified explicitly by the teacher educators for the participants in this study.

Harrison and Clark (2003) demonstrate that children believe that they increase their knowledge of, and feelings of responsibility for, the environment when involved in simulated activities. Bonnet (2003) illustrates how it is possible to adopt different stances in environmental education, ranging from the anthropocentric to eco-centric or bio centric views, as well as considering aesthetic appreciation of nature. Furthermore, Fien (2003) comments that decisions to include or exclude topics in curricula are themselves value laden but, he argues that it is possible to approach value-laden issues in professional ways by planning learning experiences that consciously promote the ethics of care and that encourage reflection. This paper describes the responses of student teachers to the introduction of an ethical dimension to the curriculum planning process by informing them that the Botanic Gardens were to be redeveloped for housing. Their brief was to consider how they could plan opportunities for pupils to

develop their eco-literacy and action competence, as well as consider a range of views on the value of the garden environment to the community.

This training intervention also offered the student teachers an opportunity to become more confident in their own environmental knowledge since, as Papadimitriou (2004) indicates, although climate change is one of the most serious environmental problems challenging civilisation, many prospective teachers held some major misconceptions about key issues. If we are to educate our children to be eco-literate citizens, it is essential that their teachers are able to articulate accurately the causes of the greenhouse effect, ozone depletion and global warming (Papadimitriou, 2004). This view is supported by research with Australian primary teachers who, according to Cutter-Mackenzie and Smith (2003), were likely to be operating at a knowledge level of ecological illiteracy.

Powers (2004), reporting from the United States, suggests that further research is needed into the extent to which environmental education is included in teacher training curricula, however, time constraints were identified by Powers (2004) as a recurrent theme in preventing extensive coverage of environmental education in pre-service teacher training. In order to address both time constraints and atomisation of the curriculum into separate academic subjects, Powers (2004) suggests "infusion" of environmental education in to method programmes, and these lessons from the field show how two, successive cohorts of 120 Primary and Secondary Science pre-service teachers in England responded to the infusion outlined in this introduction.

A Description of the Environmental Education "Infusion"

The participants in this research study primary and secondary student teachers undertaking a Postgraduate Certificate in Education at the University of Hull, England in 2004 and 2005, who were permitted to collaborate in planning activities for children involving fieldwork. This involved collaboration also between three science teacher educators, one of whom educates primary students; the other two, including the author, work in the secondary teacher education programme. In order to undertake these activities, time had to be allocated to student teachers to work together involving a move outside of their normal programmes of study. All three teacher educators facilitated the exploration of exchanges in subject knowledge both in the field, and in planning sessions in the University. The participants were given "carte blanche" to be as imaginative as they wished.

Participation involved:

- a laboratory session exploring local flora and fauna;
- group fieldwork in the gardens to develop ideas;
- exchange of ideas in a virtual learning environment;
- a curriculum planning session; and
- presentation of ideas to peers.

Data Collection

The research identifying the value of environmental education to the development student teacher creativity and connectivity, increasing knowledge and awareness of global issues, providing a context for learning science as well as offering local opportunities for pupil centred practical work, are all identified in the introduction. Similarly, this research evidence had been shared with the participants. Consequently the student teacher presentations and virtual discussions were assessed by all three teacher educators for these themes. All presentations were preserved as a database for student teachers to use in their teaching in the future.

Interpretation of Responses

There were some interesting differences between the two cohorts' responses. The first cohort of students, who had undertaken substantial teaching practice, responded positively, but a minority found difficulty on entry to the intervention. Despite being briefed on the need for creativity, the prospect of the freedom and space to think caused consternation, and an inability to engage appropriately, in 15% of the primary trainees. However, the majority were able to engage fully and valued the opportunity to collaborate with students from a different phase of training. Biology graduates were comfortable with environmental science but more than half of the primary trainees without a degree in a science subject reported concern about their lack of expert knowledge. Recognition that they had access to expertise and could use the opportunity to develop their own subject knowledge allayed their fears. Despite overall enthusiasm, the prospect of making connections across the curriculum created a further barrier for the first cohort. Curriculum mapping techniques were demonstrated to illustrate how links can be forged between different subjects, but participants revealed that they perceived this as being unnecessary for their own planning, nor was it a process they had observed in school.

Similarly all groups in the first cohort, with one exception, appeared to be stuck in a "traditional ecological groove" and were unable to think outside of that paradigm. Unless a tutor intervened, the students proposed teacher-centred activities by directing pupils to well known practical tasks such as "compare the distribution of plant species in shaded and sunny areas" rather than acknowledging any possible pupil agenda. Only after discussion with tutors, they were they able to acknowledge children's perspectives, despite having worked with pupils for some time in school. Once tutors had intervened, the students adapted well and there were some very appealing and interesting responses. Significantly, the trainees began to plan holistically in a way they had been unable to do hitherto, a skill they described as transferable to, and valuable in, further curriculum planning for Science.

Most groups in the first cohort explored the themes of classification and some continued to limit their investigations to those associated with traditional ecological investigations by focusing on specific habitats such as the pond or lawn area. Worksheets with quizzes and identification guides were popular choices and connections to other parts of the curriculum were made by incorporating activities such as following compass directions or letters spelling out "conservation", and writing "persuasive" letters to local government representatives on the advantages to the community of saving the gardens from re-development. Continuity between phases was demonstrated by proposing investigation of organisms' adaptations by garden surveys at primary level, progressing to formulation of food chains or webs using this data. Pupils would explore how damage to habitats could affect the organisms and participate in debate.

The majority of activities proposed were teacher directed, however, one suggestion was notable for its inclusivity and originality because pupils had to listen, a skill not frequently attributed to observation in science curricula. Pupils were to build a parabolic microphone to listen to birdsong prompting pupils to link biology and physics.

Pupil-centred approaches were characteristic of the second cohort of participants who adopted the humanising approach commended by Donnelly (2004) identified earlier. Decisions about investigations would be generated by pupils; teacher-designed worksheets were less evident. The second cohort appeared able to think both in the "ecological box" and beyond, contrasting with the first cohort who adhered more rigidly to a traditional fieldwork paradigm. Pupils would be allocated species on different trophic levels and collaborate to produce arguments against the proposed development

based on emerging knowledge about feeding relationships. Pupil role play would be used to investigate adaptation; survival predator/prey games at an overnight camp, or development of a trail where pupils had to select an appropriate adaptation in order to survive as they moved through the range of habitats, epitomised this imaginative approach. Rather than start with the premise that all conservation is a "good thing", pupils were to identify human interventions in the landscape of the gardens, e.g., bird boxes or litter, cultivated or unmanaged woodland. Pupils would explore the consequences of habitat management for sustainability or mismanagement, such as deforestation.

There were also some elegant examples of planning for longitudinal continuity, such as exploring seasonal changes, life cycles and nutrient cycling through visits at different times of the year. Collaboration between pupils in different phases featured strongly in the second cohort's responses. One group suggested a transition camp or the construction of an interactive website about the gardens. Both demonstrated creative data collection techniques. The first employed sensory awareness through the use of sound clips, listening in the field and observation of nocturnal species. The second utilised data logging to establish databases for long term study of patterns. One group linked learning about ecosystems to biocentrism by engaging pupils in "life as a tree" through the use of drama, music and poetry, leading into more conventional scientific activities such as exploring germination, photosynthesis and pyramids of number and biomass. Participants reported that working collaboratively enabled them to perceive the need for continuity more clearly.

Discussion

The differences between the two sets of responses merit examination. The entry criteria to the programme are standardised and both groups had similar academic profiles. As far as possible, the approach of the teacher educators to the trainees was similar each year so the principle variable between the two cohorts was the timing of the infusion. Exposure to substantial school practice by the first cohort appeared to limit the ability of the students to think as freely as the second group, who had yet to teach. Discussions with the first cohort indicated that exposure to atomistic, target-driven planning in schools was contributing to their use of teacher-directed techniques. The approach recommended in the infusion conflicted with their practical experience. The second cohort, who had not yet been exposed to orthodox approaches to planning, appeared to be free to explore a more radical pedagogy.

One could argue that it is too risky to be creative in a standards-driven climate, and just expecting trainees, or practising teachers even, to be imaginative after exposure to this culture is likely to cause many of them not to be successful. Creativity is context-driven and contexts have to be provided in teacher education if creativity and connectedness are to be introduced without the risk of failure. If student teachers are to learn to connect disparate areas of science to generate imaginative opportunities for pupil learning, they need time and confidence in their value. The freer responses of the second cohort of trainees may be interpreted as indicating security in the value of their planning, since they were still occupying a "risk free" zone of the programme. They had yet to be exposed to a content-laden curriculum where teaching to the test lowers the odds for perceived school, or teacher failure. It can be argued that, intuitively, they were able to offer learning activities in science aligned more closely with those that pupils articulate as priorities for themselves (Cerini et al., 2003). This perspective on learning was more participatory and reflects those advocating this as a goal for environmental education such as Gayford, 1998, Fien, 2003, Hart, 2000, Schnack, 2000, and by Ranson (2000) and Goodrum et al. (2001) as being essential for active citizenship. Exposure to

these ideas needs to be incorporated early in to teacher education programmes if our new teachers are to retain the freedom to be imaginative.

Despite these differences, there are some encouraging aspects in both sets of responses. Emotional, aesthetic and spiritual perspectives were presented for pupils, and student teacher eco-literacy was enhanced by identifying how it can be developed in pupils. Similarly, the synergy generated by sharing ideas contributed to "wholes" that were greater than the sum of their parts. These responses demonstrate that environmental education provides a rich contextual landscape where pupils can learn that science is both fun and relevant to their lives.

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