Achieving "Sustainability Education" in Primary Schools as a Result of the Victorian Science in Schools Research Project

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Abstract Science education in the Australian primary school curriculum is a relatively rare event. Several studies over the past twenty five years have all reported disappointingly low amounts of science being taught and the reluctance of primary school teachers to make science a priority in their teaching. Similar outcomes have been reported for environmental education. Even though primary aged children are very interested in science and the environment, primary school teachers often struggle to teach science/environmental education because they are not confident and competent in the content, lack curriculum resources and equipment, have inadequate time to prepare, and have difficulty finding a place for science/environmental education in what they perceive as an already overcrowded curriculum. The purpose of this paper is to discuss the experiences of primary schools involved in the Victorian Science in Schools Research Project which was concerned with improving science teaching and learning strategies but which also unexpectedly led to more environmental ("sustainability") education occurring. The paper will also suggest a curriculum strategy for achieving more widespread acceptance and implementation of "sustainability education" through primary school science curricula.

Background

Science Education, Environmental Education and "Sustainability Education"

The relationship between environmental education and science education is long and contested. The origins of environmental education in the curriculum can be traced back to the concerns about environmental degradation and decreasing quality of life expressed by scientists in the 1960s. In the wake of publicity and political actions attending these concerns, environmental education initially entered school curricula in the early 1970s through science education (Gough, 1997, p. 15). Indeed, at that time there was a broad acceptance in society that threats to human well-being and the environment could be countered through further scientific research and the application of technology. Such a belief is exemplified in the *Tbilisi Declaration* (UNESCO, 1978, p. 24) which states that "Education utilising the findings of science and technology should

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play a leading role in creating awareness and a better understanding of environmental problems". More recently, UNESCO has emphasised the link between environmental education and science education by changing the subtitle of its publication *Connect* from the "UNESCO-UNEP environmental education newsletter" (as it was from 1976-1996) to the "UNESCO international science, technology & environmental education newsletter" (since 1997).

However, some science educators questioned the relationship between science education and environmental education (see, for example, Ashley, 2000; Hall, 1977; Lucas, 1980; Robottom, 1983). Their argument was that science and environmental education were incompatible and that environmental education could more appropriately be implemented in curriculum areas other than science, because the science curriculum of the time was inhospitable to engaging with social issues.

Ashley (2000, p. 275) discussed the limitations of current science education practices but argued that "A scientific education for all that is more likely to result in [a more responsible attitude to science] therefore has to be a key objective for environmental education". Two decades earlier others had developed a similar position: Greenall (1979) and Fensham and May (1979) had argued for a closer relationship between environmental education and a reformed science education that they envisaged as being distinctly different from the version practiced in classrooms of the period.

The apparent distance between environmental education and science education in school curricula in Australia increased in the 1990s when the national curriculum nominally separated them into two distinct key learning areas: *Science* and *Studies of Society and Environment* (SOSE) (AEC, 1994a, 1994b). Science education was given a limited role in environmental education, with the main environmental education emphasis expected to come through SOSE. However, SOSE is often implemented in schools without an "environment" component, and environment rarely rates a mention in the science curriculum. The structure of the national curriculum was repeated at the state level in Victoria (Board of Studies 1995, 2000).

The re-naming of environmental education as "Environmental Education for Sustainable Development" (or "sustainability education") has not been without controversy, and much of the debate is quite polarised (see, for example, Carlsson & Mkandla, 1998; Fien, 1996, 1997; Knapp, 1995, 1998; Schreuder, le Grange and Reddy, 1998; Smyth 1998a, 1998b; van Weelie & Wals, 2000). However, the language of sustainable development is already part of environmental education policies and curriculum statements in Australia and internationally:

- The United Nations has declared 2005-2014 the Decade of Education for Sustainable Development, and UNESCO is currently working on an implementation scheme. "This vision of education emphasises a holistic, interdisciplinary approach to developing the knowledge and skills needed for a sustainable future as well as changes in values, behaviour, and lifestyles" (UNESCO, 2003, p. 4);
- In Australia, the 1999 Adelaide Declaration (*National Goals for Schooling in the Twenty-first Century*) includes a goal which states that "when students leave school they should... have an understanding of, and concern for, stewardship of the natural environment, and the knowledge and skills to contribute to ecologically sustainable development" (quoted in Environment Australia, 2000, p. 6); and
- The most recent Victorian policy statement on environmental education[1] (Education Victoria, 1998c, p. 4) refers to students developing "personal lifestyles compatible with ecological sustainability" and developing programs that consider the principles of ecologically sustainable development.

Traditional science education for an elite scientific workforce fits an economic view of sustainable development. In contrast, environmental education's view of sustainable development has an ecological bottom line, and it is this ecological view that underpins the UNESCO vision of a more holistic, interdisciplinary approach to education that is consistent with the approaches in the national Adelaide Declaration and the Victorian policy.

The Project discussed in this paper, through its focus on effective teaching and learning in science, has resulted in a reformed science education that has enabled a closer relationship between science and environmental or "sustainability education"[2].

Science and Environmental Education in Primary Schools

Both science education and environmental education in Australian primary school curricula are a relatively rare event. This is not a recent phenomenon. Several studies over the past twenty five years have reported disappointingly low findings for the amount of science being taught and for the willingness of primary school teachers to make science a priority in their teaching (Appleton, 1977; DEET, 1989; Gough et al., 1998; Tytler & Griffiths, 2003). In a recent national research study (Goodrum, Hackling & Rennie, 2001, p. 93) primary teachers estimated that the average time spent teaching science each week was 59 minutes. Even though primary aged children are very interested in science and the environment (see, for example, Ainley et al., 1998), and there is a science curriculum document in each state and territory, primary school teachers often struggle to teach science because they are not confident and competent in science content, lack curriculum resources and equipment, have inadequate time to prepare to teach science, and they have difficulty finding a place for science education in what they perceive as an already overcrowded curriculum.

A similar picture emerges for environmental education. Environmental education also has long struggled to find a place in what is perceived to be an already overcrowded curriculum in both primary and secondary schools. There is no recent published research on the extent of implementation of environmental education in Victorian primary schools, but research in New South Wales and Queensland indicates that there have been problems with implementing environmental education in primary schools there (Cutter, 2002; Spork, 1992; Walker, 1995, 1997). In Victoria there is a curriculum statement for science (Board of Studies, 1995, 2000[3]) and an environmental education policy for schools (Education Victoria, 1998c). This policy is advisory rather than mandatory but it encourages schools to implement environmental education within the school curriculum and in their management practices. Thus there is a framework in which teachers could implement environmental education in schools, but with the requirements to teach the learning outcomes of the eight key learning areas of the state Curriculum and Standards Framework there is little space for environmental education.

However, as part of their participation in the Science in Schools Research Project some Victorian schools reformed their science curriculum and successfully implemented environmental science education (or "sustainability education"[4]). These schools' experiences are discussed below.

The Science in Schools Research Project

The Science in Schools Research Project (SiSRP) was the largest science education project in Australia for three decades. Commencing in 2000 with 27 schools (18 primary and nine secondary), 224 primary and secondary schools participated in the project in 2002. In 2003 300 primary and secondary schools across the state were involved in

implementing the outcomes of the Project, including the School Innovation in Science Strategy and associated professional development programs. Additional schools are joining the roll out of the initiative in 2004.

The project was funded by the Victorian Department of Education and Training as part of its *Science in Schools: SET for Success* Strategy (Education Victoria, 1998a). This Strategy is part of the *Science Engineering and Technology Strategy: SET for Success* (Education Victoria, 1998b) which describes Victoria's performance in the areas of science and technology as a key factor in the State achieving future prosperity and quality of life. The goals of the *Science in Schools: SET for Success* Strategy are:

- To raise the profile of science in schools, with increased commitment to science as a priority;
- To increase the numbers of students choosing studies in science-related subjects, particularly at VCE level;
- To improve the understanding of science among teachers, parents and the public;
- To improve the effectiveness of science teaching and learning in schools;
- To foster partnerships between schools and school communities, and groups such as science associations, tertiary institutions, business and industry, and science communities;
- To ensure that research into science continues to inform the direction of science education in schools; and
- To encourage students to take up science studies in tertiary institutions, and to make career choices in science-related fields (Education Victoria, 1998a, inside back cover).

These goals framed and guided the Science in Schools Research Project to develop a system wide reform in science teaching and learning. The Project's goal was to effect significant change in the teaching and learning of science in primary and secondary schools, and specifically to:

- improve teaching and learning of science;
- improve student learning outcomes in Science at all year levels; and
- increase student access to, and participation in science learning from Prep through to Year 10, and hence in the VCE as well (DEET, 1999).

A key aspect of each school's involvement in this Project was the strategic planning process that leads to a three-year Action Plan for science renewal in the school. Through this process the teachers reflect on the meaning of effective teaching and learning in science in their schools and develop and implement an Action Plan to achieve agreed goals in *their* context.

These Action Plans address the eight SiS components which, within the Project context, represent what a teacher needs to put in place in the classroom to maximise the learning and increase student engagement with and enjoyment of science[5].

Of the eight SiS components the following four[6] have been of particular importance for the development of environmental science education in the primary schools:

- students are encouraged to actively engage with ideas and evidence;
- students are challenged to develop meaningful understandings;
- science is linked with students' lives and interests; and
- the classroom is linked with the broader community.

These distinguishing characteristics of the Project Strategy differ significantly from most conceptualisations of science teaching and learning in schools, yet it is these differences which make environmental science education possible.

Several of the primary schools involved in the Project have implemented environmental science initiatives in their Action Plans for achieving their agreed school goals. These initiatives provide some hope and some possible pathways for other primary teachers also interested in developing both science education and environmental education.

The teachers' and schools' experiences can be seen as being congruent with the work of Wals and Albas (1997) in that the teachers in the schools are consciously engaged in an action research based model of curriculum change in science teaching and learning. Their experiences are also complementary to those of schools involved in the OECD "Environment and Schools Initiatives' programme (ENSI) (Elliott, 1998). The following discussion of their experiences also acknowledges the critiques of critical theory in environmental education (see, for example, Walker, 1997) and the possibilities for a socially critical approach in environmental education (see, for example, Gough, 1997) within a context of the limited opportunities for both science and environmental education in primary schools.

Action Research in Practice

The main mode of inquiry for schools participating in the Science in Schools Research Project was action research (Kemmis & McTaggart, 1988). Each school had a coordinator who worked as a facilitator with others teachers in the school to develop an Action Plan for effective teaching and learning in science consistent with the SiS components (which are a significant part of the change strategies of the Project). The coordinator was a teacher from within the school staff who worked with both the school staff and their Project support person to document the changes occurring in the school as a result of their involvement in the Project. He or she was a regular member of the school teaching staff who had time release (of between half a day and three days per week, depending on the size of the school) for working on the Science in Schools Research Project. The Project support person (generally an academic associated with Deakin University or a regional project officer funded by the Victorian Department of Education and Training) had the role of critical friend. In many cases this person was also the presenter of a range of professional development programs designed to support teachers with pedagogical changes. The three year action plan developed by the school was to be enacted, observed, reflected upon and revised at the beginning of each year, and during the year in some schools.

This model is, coincidentally, similar to that described by Wals and Albas (1997) in their case study of school-based research and development in environmental education in a secondary school. In SiSRP schools there has been a coordinator with time release and funds for releasing other teachers from classroom duties for meetings, professional development and curriculum development work. In Wals and Albas' (1997, p. 257) study "teachers in a school were given 1 day a week for a 6 month period to analyse current teaching materials, reflect on their own teaching experiences, develop new materials, use and redevelop new materials and to share their findings with other colleagues in the school". Other similarities between Wals and Albas' study and the SiSRP schools' environmental science initiatives are that in both projects teachers engaged in a five step action research spiral, they have started with the local community and, in both instances, "The research does indicate that actively involving teachers in curriculum development through praxis does challenge them to take a critical look at their own teaching and teaching objectives" (Wals & Albas, 1997, p. 265).

Given the innovative nature of the SiS components and the strategic focus of the Action Plan in the SiS strategy, it is probably not surprising that a number of the

schools used the environment as a vehicle to develop the components in their teaching programs.

Schools' Experiences

The schools who have engaged in environmental science education as part of their SiSRP Action Plans demonstrate that, consistent with the findings of Clark and Harrison (1997), there are primary school teachers and students are able to engage in meaningful environmental science education. This has happened in these schools because

- the whole school staff has engaged in a strategic planning process to work towards improving science teaching and learning in their school;
- the SiS components have provided an enhanced view of science which has provided the opportunity for environmental education; and
- there has been a teacher released from normal classroom duties for at least part of the week to provide support to other teachers in their (environmental) science activities.

The support of the school's leadership, particularly the principal, has also been significant.

The need for a reconceptualisation of the problem of implementing environmental education was recognised by Walker (1995), but the experiences reported here are beyond what she envisaged. Walker's solution to the lack of implementation of environmental education in schools incorporated four dimensions of school education: practice, curriculum, policy and teacher education. In the SiSRP changes in *practice* have been supported through the project structure and a shared participation in the change process. Teachers have grown in both confidence and competence in teaching science and environmental education. For their environmental science initiatives there was no need to redefine action "in such a way that the definition cohered with practitioners' theories of teaching and learning, and took account of their constraint structure" (Walker, 1995, p. 125) as the action component of their initiatives was seen as a natural outcome of their engagement with the SiS components. In the SiSRP changes in science *curriculum* to include environmental education initiatives was not seen as a constraint. The science education they were enacting is in many ways consistent with Gough's (2002) reconceptualisation of the two fields.

According to Walker (1995, p. 127), "policy is a powerful strategy to bring about improvement in the teaching and learning of environmental education". Although Victoria does have a state *policy* on environmental education (Education Victoria, 1998c) this was not even considered by the SiSRP teachers. Their initiatives were instead grounded in the SiS components and engaging the community, students' lives and interests and meaningful understandings. Within the SiSRP, *teacher education* has been occurring through professional development, on a needs basis, matched to the priorities identified in the school Action Plan and related to the SiS components. Reflection is a major component of the planning process to select appropriate professional development programs for the teachers in the school. A significant characteristic of the SiSRP schools is that they have been working within a model of effective teaching and learning in science which has provided the rationale and framework for implementing environmental education within a science education context, thus achieving two (political) agendas with minimum effort. Their experiences indicate that other primary schools interested in increasing the quantity and quality of science being taught in their schools should also look to environmental science education as a way forward.

The environmental science initiatives in the schools strongly engage the traditional objectives for environmental education (UNESCO, 1978) and for "sustainability education" (UNESCO, 2003), and education in, about and for the environment (Lucas, 1979). Each of the schools has their students engaged in environmental problem solving outside the classroom as part of their environmental science initiative. This is not accidental. The four SiS components that underpin these schools' initiatives provide the basis for engaging environmental problems as part of their science programs. The problems are not "too big" for the teachers in these schools – they are manageable (cf Walker, 1997, p. 161).

There appears to be a number of reasons for the experiences of these SiSRP primary schools being so different from the NSW schools studied by Walker (1995, 1997). Walker (1997, p. 155) commented that research in environmental education has "little influence on the teaching and learning of environmental education in schools". In the SiSRP schools research into effective teaching and learning in science has led to the implementation of environmental education in many schools. Walker (1997, p. 158) also comments that "emancipatory action research is about inquiring into practice, not necessarily solving the problems that result from the inquiries". In the SiSRP schools, through the action planning process, there was both inquiry into practice (the audit) and addressing of the problems that were found (through the reviewing, prioritising and writing of an Action Plan). In the second and third years of the project schools have reviewed their initial action plans and revised them to address new priorities and problems. Most significantly, the Action Plan, the curriculum initiatives and the whole action research process, are owned by the school staff.

Walker (1997, p. 159) also identified that "literacy and numeracy are the essential parts of the school curriculum and while children are not achieving in these areas environmental education is peripheral to the school curriculum". In the SiSRP schools science education has been put on the same plane as literacy and numeracy as a curriculum priority area and is thus taken seriously. Environmental education has become part of this priority area in many of the schools as they have developed initiatives around the SiS components. For example, science is often incorporated into the literacy programs through using stories that have environmental themes. No longer were there constraints to the development of environmental education in the schools – a space had been legitimated within the science Action Plan initiatives to implement the SiS components.

Conclusion

The Science in Schools Research Project, which is now being implemented as School Innovation in Science in Victoria, is an exciting development for stimulating effective teaching and learning in science in schools. That the Project provided a space and a stimulus for the development of environmental education was a bonus, but a very welcome one. For years environmental educators have been trying to find a space for environmental education in what is perceived to be an overcrowded curriculum, and have been arguing for reform of science education to accommodate environmental education. This Project has created this space in many participating schools. While some might argue about the types of initiatives that are being undertaken in terms of their view of environmental education, I believe that the initiatives meet the traditional criteria for environmental education.

Although the "good news" stories come from schools that are participating in a well resourced research project, we believe that there is much here that can provide guidance for others trying to find a place for both science and environmental education in their curricula.

Keywords: environmental education; science education; sustainability education; primary schools; environmental science education; action research; school change.

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Endnotes

1. While I recognise that New South Wales has its own policies and developments in environmental education, the focus in this paper is what has happened in Victoria in science education within the context of the Victorian environmental education policy.
2. The concept of environmental science education assumed in this paper is one which considers environmental education or "sustainability education" as education for the environment, not just education in or about the environment (Lucas, 1979; Gough, 1997).
3. The Victorian Science: Curriculum and Standards Framework documents (Board of Studies 1995, 2000) divide science into four strands – biological science, chemical science, earth and space sciences, physical science. The Goodrum et al (2001, p. 94) research findings indicate that the national average number of topics taught per year in primary science is biological sciences (1.12), earth sciences (0.65), physical sciences (including chemistry) (1.23).
4. The remainder of this paper will refer to environmental science education as this is how it was conceptualised by the schools at the time. However this can also be read as "sustainability education"/education for sustainable development as defined by the United Nations and in national and state documents.
5. A description of how these components were arrived at can be found in Science in Schools Research Project Manual (2001), Gough, Tytler & Waldrip (2002) and in the position papers on the project website www.scienceinschools.org.
6. Three of the components have not been so much in evidence in relation to the development of environmental science education in the primary schools are: assessment is embedded within the science learning strategy, science is represented in its different aspects, and learning technologies are exploited for their learning potentialities. The eighth component, "students" individual learning needs and preferences are catered for", is an occasional focus for the environmental science activities, not a prime one.