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Reconceptualising gardening to promote inclusive education for sustainable development

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The ways in which gardening has been interpreted by schools in western societies have changed over the past 150 years. The intended purpose of school gardening with children (aged 5–14) and the pedagogies which teachers have adopted has varied depending on social, cultural and political expectations. This paper argues that a reconceptualised version of school gardening could promote inclusive education in the UK so that it supports new pedagogical approaches to learning while seeking to fulfil international commitments that protect the environment and disseminate ecological understanding. The potential for children to develop ecological and place-based knowledge, competence to take action, skills relevant to environmental engagement and a value-system that may shape their future priorities are examined in this paper. A curriculum framework is suggested that promotes school gardening along with an understanding of the environment locally, nationally and globally. An exemplar is provided based on growing a bean crop, which puts school gardens in a pivotal position to aid the development of skills among children. The exemplar can be modified for any age group and to take account of local resources. Potential research to advance gardening and inclusive environmental and sustainable development education is suggested.

Keywords: community cohesion; education for sustainable development; inclusive education; learning outside the classroom; place-based education; school gardening

International commitments

One hundred and seventy-nine nations have ongoing commitments to Agenda 21 (United Nations 1993a). While Chapter 36 emphasises 'the importance of formal and informal education in making sustainable development central to the planning and conduct of activities in all spheres of life', UNESCO (1992) expected education for sustainable development (ESD) to involve a multidisciplinary curriculum approach that acknowledged social, cultural, and environmental dimensions and engaged children in planning and carrying out long-term improvements that protect the environment. Similarly, Article 13 of the 1992 Convention on Biological Diversity (United Nations 1993b) requires contracting parties to promote and encourage understanding of biodiversity and conservation in education programmes.

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These initiatives acknowledge that pressing environmental problems are a global reality, but that action to influence environmental understanding must be taken locally. The implication for national governments is that global objectives are integrated into education systems so that children take action locally and future populations live sustainably. Such actions vary in their complexity; saving energy and reducing water consumption may be achieved more immediately than changes in land management. To increase food production locally and simultaneously improve soil fertility, harvest water, manage pests and diseases, encourage beneficial wildlife and maintain high yields, are skills that develop over time. Essentially, these are gardening skills that cannot be acquired quickly or, as Johnson (2001) argues, without an apprentice element.

To live sustainably, individuals must understand that their actions affect the environment. Schools have a major role in this process and teachers' pedagogical approaches to ESD need to prepare all children to think about their actions in everyday life. Lessons out-of-doors in a garden introduce children to hands-on experience, observation of natural processes, change over time and overarching realities.

School gardens

The logic for including gardening in formal education now is the enduring nature of its ethos. In the 1690s, the Enlightenment thinker John Locke's (1632–1704) advocation of school gardening was motivated by a drive to conquer wasteland and divide it for the good of civilised 'man'. Later, and more in line with conservation and sustainable development, Rousseau (1712–1778), Pestalozzi (1746–1827), Froebel (1782–1852) and Montessori (1870–1952) recognised the importance of a garden as a dynamic resource for scientific observations and outdoor investigations. Accordingly, by the late 1800s when education became compulsory in many European countries, a philosophy and associated educational practice, including school gardening, were established. Further advantages of learning out-of-doors were explored by Rachel McMillan who opened her first nursery school in London in 1914. Here she included 'a natural, real life environment and not a task-centred environment divorced from reality' (Bilton 1998, 21). She felt that in a garden, children could express their feelings or find peace and tranquillity in which to reflect on nature every day. The garden was also an essential facet of the school's emotional support.

Gardening as a practical skill spans differing cultural contexts. Hennesey (1906) describes the context in England in the late 1800s when children's future livelihoods often depended on acquiring gardening skills. Non-academic children or those from poverty stricken backgrounds were more likely to be sent to work in the school garden. There was no reason to consider alternative approaches to their education because the knowledge gained by gardening would be 'of immense value in after-life for those scholars who are drawn from the poorer classes' (Hennesey 1906, 7). A parallel today would be those children growing up in places where an ability to identify specific plants as food, fodder, medicines, fibres and building material is essential to their survival.

Wandersee and Clary (2006) view diminishing plant knowledge as symptomatic of poor botanical education and few meaningful experiences with plants in industrialised and post-industrialised countries. The public lack of interest in plants underlines the reliance, for new medicines in particular, on peoples whose knowledge of plants is infinitely greater (Balick and Cox 1996).

A lack of specific reference to school gardening in a nation's curriculum may reflect pejorative links with peasant agriculture, subsistence farming or the type of school gardening prevalent in previous generations. Individual teachers may see the value of working regularly in a garden because children learn about the importance of plants as food or their relevance to biodiversity, but a brief case study of school gardening in England and Wales during the twentieth and early twenty-first centuries serves to highlight some of the barriers that were still raised, not only to school gardening, but also to ESD, place-based education (Ardoin 2006) and inclusive education.

England and Wales: a case study of the trajectory of school gardening between 1939 and 2009

The heyday of school gardening in England and Wales was from 1939 into the early 1950s when the wartime 'Dig for Victory' campaign was dominant and, whatever their age, children were expected to contribute to growing food crops. In the 1950s and 1960s, teachers did take children on nature walks; they followed the same paths frequently to improve observational and botanical skills (Heyd 2007) at a time when school resources were limited. However, the relationship between the school garden and the wider environment was not taught consistently. The Schools Council working paper (1969) concluded that the necessity for growing food during wartime masked the intellectual and cross-curricular possibilities of gardening and few teachers saw the potential to extend lessons out-of-doors to a long-term study of the local countryside.

Support for school gardening included advice from the county horticultural instructors, local authority seed distribution to schools and the Royal Horticultural Society (RHS) offered the *Examination for the Teachers' Diploma in School Gardening.* Teachers' capability is difficult to judge, but examiners report that candidates relied more on text books than on their own enquiry or observation. The number of teachers taking this RHS examination declined until, in 1974, the examination ceased. Formal recognition of school gardening as a special form of gardening ended with it (Johnson 2001).

An era of *ad hoc* school gardening and nature walks was replaced by scientifically grounded ecology as environmentalists, such as Carson (1962), published disquieting findings about the effects of DDT on wild bird populations. Ecology was based firmly in the science curriculum, but the science inherent in gardening was belittled because it did 'not require conceptualisation in the same way as the other sciences' (Association for Science Education 1987, 5). Carson (1978) deplored the notion that gardening was unnecessary for academic children arguing that they need sensory, aesthetic and practical experiences as much as less academic children are entitled to an education rich in scientific and technological themes.

The curriculum in England and Wales was further compartmentalised into discrete subjects when a National Curriculum was introduced following *The Education Reform Act* 1988. Science could have encompassed gardening because, as Bell and Gilbert (1996) point out, the expectation that children could make connections between fragmented pieces of knowledge in science, and then apply them in the real world, was unfounded.

Environmental education in the 1990s focused on the political and environmental economics of writers such as Sen (1988) with greater recognition of environmental issues arising from world poverty and industrial development in the 'Third World'. Dasberg (1991, 102) criticised this 'scattered image' of the world in which topics

like food shortages and urban slums in 'developing' countries overshadowed children's experience and local issues.

Towards the end of the twentieth century, learning out-of-doors was still seen as a means of developing children's proficiencies for later life but the emphasis had changed. Dearing (1996) expected schools to help children develop the knowledge, understanding and skills which they could apply, as adults, when making environmental judgements about local development plans or lifestyle choices. Fulfilment of such objectives relied on schools having teachers with the appropriate knowledge and skills to link lessons indoors with lessons in the school grounds or garden. The majority of teachers on continuing professional development (CPD) courses offered by the RHS between 1996 and 1999 had only personal gardening experience to draw on when planning lessons on growing plants and using the local environment as a resource (Johnson 2001). Mays' (1985, 27) suggestion that 'endless time is necessary' for perceptions about the local environment to 'pervade all activities, in and out of school' was lost in a packed curriculum. It was unlikely that long-lasting effects on environmental and scientific literacy could be achieved through the generally truncated experiences provided by schools at the end of the twentieth century.

In the twenty-first century, obstacles to task-based learning out-of-doors were challenged by the *Learning Outside the Classroom Manifesto* (DfES 2006). Many new initiatives from the Learning Outside the Classroom Council are still filtered into teaching and learning, but this attempt to interest teachers in environmental education falls into the three-stage pattern recognised by Goodson (1995), to which a fourth stage was added by Johnson (2001) as shown in Table 1. Aspects of these stages are evident in the foregoing case study for England and Wales, which outlined the entrenched nature of barriers to the inclusion of gardening in schools. The pattern needs to be broken if

Table 1. A model of the stages in the rise and fall of environmental studies.

Stage 1	Subject is on the curriculum on the grounds of pertinence and/or utility Learners attracted to it because content has relevance to them Teachers are rarely trained specialists but enthusiasts and pioneers Dominant factor – relevance to needs and interests of learners
Stage 2	A tradition of scholarly work emerges. Specialists trained – some become teachers Learners attracted because of interest and the subject's growing 'reputation' with growing academic status Subject still relevant to learners. Dominant factor – subject becoming more organised.
Stage 3	Professional body of teachers and values related to the subject exist Subject matter for examination determined by academic specialists Children initiated into a tradition Learning may be relevant to children or a means to an end – careers Possible disenchantment by children during the course Dominant factor – examination
Stage 4	Other subjects rise appearing to have more relevance and/or utility University interest is maintained but the subject becomes attached to various departments, thereby reducing specialisation Careers in the 'pure' field are limited and/or poorly paid Facilities for teaching the subject in schools are restricted Subject dilution in schools as it becomes a cross-curricular adjunct Dominant factor – subject marginalisation in schools

gardening, linked to ESD and inclusive education, is to be developed effectively in schools. However, one education initiative in England and Wales is unlikely to bring about radical change without changes to teachers' pedagogy and the allocation of teaching time in the curriculum.

Table 1 offers a key to augmenting environmental education. Stage 1 indicates reasons why a subject is included in a curriculum; pertinence and/or utility are apposite grounds. Gardening skills are pertinent to ESD because they are needed for food production. Perhaps if all children engage actively in growing food, their attitudes to the environment may change and gardening can be reconceptualised.

Learners may be attracted to gardening because the content has personal relevance and because it offers lessons taught in a style they prefer, in environments that stimulate both thinking and action. Those teachers starting school gardening are rarely trained specialists, but are the enthusiasts and pioneers who begin a process and act as role models.

CPD can build teachers' confidence and add to their competence, but gardening CPD may be under prioritised if the government constantly introduces initiatives that compete for teachers' time. Although directed at primary schools (5–11 year olds), but applicable to secondary schools (11–14 year olds), McNamara, Webb, and Brundrett (2008, 28–9) found that teachers 'need more responsibility and control over the focus, structure and timing of their professional development' so that they can become a community of professionals who have 'the capacity to solve problems and to be creative'.

Eventually, instead of relying on post-qualification CPD, gardening needs to become more organised and draw in academic interest that will provide it with a robust theoretical foundation. Propelled in the direction of ESD, action competence (Eames et al. 2006) can facilitate environmental literacy which, with growing academic status, may prevent school gardening from declining again.

The case for reconceptualising school gardening

Cullingford (1996) believes that children's inclination to take part in gardening presents itself long before it becomes theoretical and scholastic; they judge the value of an outdoor setting not by its aesthetics, but by how they can interact with it. Early school experiential learning may include gardening, but it is not an experience common to all.

To be accepted in schools, gardening has to be conceptualised not just as utilitarian, but as meeting many teaching and learning objectives. To achieve broad learning objectives, the role of adults in any gardening project must be considered because they are the 'gate keepers' of children's outdoor experiences (Skamp and Bergmann 2001; Malone and Tranter 2003). The role of the gatekeeper brings with it a huge responsibility for children's gardening experiences.

In recent research (Kapelari et al. 2007), 52 teachers from Austria, Italy, Bulgaria and England who volunteered to assist with the Plant Scientists Investigate project 2005–2007, completed a questionnaire. They indicated, in order of priority, the topics of lessons they taught out-of-doors: habitats; plant form and function; seasons; food; native plants; environmental education; and horticulture. These teachers were interested in children's learning out-of-doors, but reasons for not going outside regularly included lack of time, particularly in the science timetable, and behaviour management. Two teachers thought that bringing plants into class was sufficient and considered

going outside 'unnecessary for understanding'. Comments like 'easier to teach indoors' and 'not a priority' indicate ambivalence. The weather and a lack of outdoor resources were obstacles for some.

Gatekeepers may also have 'fear and concern about young people's health and safety' (Rickinson et al. 2004, 43). However, such fears may be allayed if small groups of children go into a garden with a teaching assistant or parent. The advantage is that these individuals often work regularly with children who need the most help: children with special educational needs; lowest attaining children; children having difficulties with a second language; or children new to a school. Set against this kind of facilitation are the findings of Blatchford et al. (2009), which showed that the more time children spend with teaching assistants, the less time they spend being taught by the teacher. Support staff or parents who help regularly in the classroom may be less confident about taking a gardening lesson. Without preparation, there may be knock-on effects for group management and learning. If feedback to the teacher is *ad hoc*, but the work in the garden is done, teachers may make assumptions about children's capabilities and learning.

Teachers are accountable for children's conceptual development and progression but, without discussion about progression here, children may plant beans every year. Linking bean growing with the study of wild plants in the bean family in local habitats, or the reduction of biodiversity in distant locations cleared to grow fresh beans all year for transportation to local supermarkets, aids a process of reflection with place-based education (Kreisberg 1999). Jacobson, McDuff, and Monroe (2006) indicate that school grounds vary world-wide with the best providing a rich resource for investigations of living and non-living things, life-cycles, interdependence, food webs and biodiversity. Here too children have opportunities to learn about environmental responsibility, co-operation, ownership, belonging and respect. Whether a school garden is a cluster of containers, or five hectares of meadow and woodland, the quality of a schools' outdoor environment needs to reflect the ethos of the classroom because, as Titman (1994) suggests, poor school grounds convey negative messages to children that influence their attitude and behaviour.

Discussion involving teachers, teaching assistants, children, parents and the local communities might reduce apprehensions regarding behaviour and risk in lessons out-of-doors. Consultation may also enrich lesson content as outside agencies are drawn into specific gardening lessons. Analysis of such connections enables teachers to create a contextual framework for learning out-of-doors.

A contextual framework for inclusive place-based learning

An environmentally orientated curriculum should engage children in a developmentally appropriate way throughout their schooling. Any options introduced need to inspire a creative pedagogy that embraces a flexible framework of interactions with many local connections. Research by Eames et al. (2006) on how to develop action competence suggests that a teacher's choice of pedagogy affects the potential for children to develop skills and capabilities. They suggest that successful 'action competence' projects have small manageable goals which engage children emotionally and encourage co-operation and collaboration.

Teachers who adopt a contextual framework for their lessons are more likely to hold a constructivist view of pedagogy (Richardson 1997). They accept learning and action as inseparable from the way the mind is used and maintain that conceptual development

occurs through dialogue between learners and the resources provided. The wide range of experiences from which children accumulate knowledge should include those that enrich understanding of the environment and sustainability, but because teachers make most of the decisions about learning opportunities, their teaching practice and notions of curriculum progression are critical. Teachers need a clear rationale for including gardening when so many conflicting initiatives are being promoted (Marturano 1999).

A contextual framework and a thematic structure may help teachers plan and coordinate learning out-of-doors, allocate available resources and adopt flexible professional practices. In theory, it is easy to justify a contextualised curriculum, but in practice it would require a school to give the garden and gardening pivotal roles in long-term planning so that children can respond, learn to think logically and act in accordance with the subliminal daily and cyclical influences of their surroundings.

Johnson (2001) provides an outline of how gardening activities over time can engage all children and lead to a more holistic approach to teaching and learning. Table 2 illustrates the contextual framework and thematic structure advocated.

Actions taken in a school garden are given a purpose and children have the opportunity to develop not only gardening skills, but also higher order thinking as they design small-scale experiments, explore natural cycles and challenge the beliefs and values of others. There is the potential for progression from the personal to the civic or global dimensions for all age and ability groups. Moving through the levels and linking chains of experience, many children make small contributions to the whole school's action competence. Individuals learn to co-operate and collaborate with their peers and make democratic decisions as they organise the garden and workload. Decision-making and engagement in environmentally significant action may flow into all lessons as children write well-argued letters or e-mails, gather ecological evidence from the Internet to support their arguments, engage in related role play or research sustainable practices. Children can be prompted to consider their attitudes and values and acquire skills that enable positive environmental behaviour.

Within this contextual framework, children are expected to work independently and/or collaboratively as they plan a task-based programme. Discussions need not be teacher led, but action requires multiparty planning. Individual interests are matched with tasks that consolidate or extend a child's capability and individual confidence in ESD. Thinking skills are promoted continually so that connections are made that lead to further enquiry, more questions, testing ideas and collaboration with experts so that children become part of a community that knows one place well and are able to share environmental experiences there.

Table 2. A contextual framework and thematic structure for school gardening.

Pedagogical goals		Knowledge content	Developing learning skills	Developing values and ideas
		Relating a specific concept to:		
		↓	↓	↓
Areas of Activity, Skill and Competence development	→	Personal matters	Information gathering	Personal values and beliefs
	→	Civic concerns	Problem solving	Public policies
	→	Global issues	Decision-making	Cultural perspectives

Table 3. An example of a contextual curriculum: growing beans.

Teaching and Learning	**Knowledge relating to beans**. Growing beans. Bean life cycle. Interdependence of plants and animals. The bean family. Selective breeding (Darwin/Mendel). Seeking project-relevant knowledge about beans from experts – ***gardening organisations, member s of local gardening clubs, allotment holders, gardeners, parents, grandparents***. Knowledge is interdisciplinary with child-centred, practical gardening projects. Group and individual work	**Development of learning skills**. Investigation skills: how to grow beans, bean life cycle, bean pests and diseases, insects, birds, mammals associated with beans. Learn practical skills from others – ***local gardening clubs, allotment holders, gardeners, parents***. Internet research – *seed companies*, measuring plot, calculate numbers and distance between plants. Social skills: co-operation, collaboration. Language development. Transferable skills developed	**Development of values**. Teachers/pupils develop their beliefs and values together. Environmental concerns turned into action – young people growing, cooking and eating crops they have grown. Values relating to organic gardening and alternatives. Climate change and community values
Beans and ESD	**Concepts of sustainable development**. Physical conditions – soils, water, nutrient cycles. Growing beans in different conditions. Pollination and interdependence – ***beekeepers***. Yields. Storage. Cooking – ***chef***. Waste, composting – ***Gardening Organisations***. Water harvesting. Phenology and long-term garden experiments.	**Processes of inquiry**. Observation. Measuring. Recording. Memory skills. Generating questions. Science skills. Collaboration. Classification. Experimentation, e.g. reduction of yield due to weeds or pests. Internet research. Geographical distribution and historical influences on plants grown.	**Interaction of people with the environment**. Environmental effects of high yield processes. ***Parents'*** attitudes to these processes? Feedback into enquiry. Large scale growing – ***Farmer or organic grower***.

Areas of emphasis and activity			
	Personal matters. Personal impact on the environment. What are the connections when I eat beans? Growing and cooking beans. Waste, composting. Use of water and energy. Sewage. Buying beans: freezing, cans and wrapper – waste recycling. ***Local waste managers, politicians***. Visit to sewage works	**Information gathering**. Argumentation: reasons for changes in garden size. How and where do beans grow throughout the year? Testing technologies to grow beans out of season. Questioning the cost of alternative technology (energy)? Internet research. Scale of bean growing and quality control. Investigating packaging and waste management	**Personal values and beliefs**. My eating preferences affect other people. Visit a botanic garden. Eating and culture. Survey of eating habits. Questions posed feedback into enquiry. Discussion: past, current and future influences on eating habits
	Civic concerns. How can/should everyone have access to land on which to grow crops? Garden size, allotments. Local planning – ***Local planners***. Local environmental issues – ***Wildlife organisations, local people, farmers, businesses, shops. Local and regional newspapers***	**Problem solving**. Alternatives, e.g. foraging instead of gardening? ***Wildlife organisations***. Questioning the nutritional value and yield of sprouting beans over the same period? ***Local doctors/nutritionist***. Internet. Investigating new methods of cultivation, e.g. *hydroponics, irrigation* or *permaculture*. Saving seeds	**Public policies**. Planning policy – link with local authority. Posing questions to ***local councillors***. Land rights. Why/how might councils acquire more land for growing food? Costs/benefit – visit to or by ***allotment holders***. Funding sustainable technologies and waste projects
	Global issues. Beans grown in developing countries to sell globally. Soil fertility; water use; trade; pollution; climate change. *World growers*. Action for Fairtrade locally	**Decision-making**. What can be done to support local food production/local markets? Individual action. ***Supermarket and shop managers*** – the effect on shopping habits. Action to change habits. Action to grow or buy local food	**Cultural perspectives**. Biodiversity and multi-cultural knowledge. Gardening in the past. Eating beans out of season – ***global charities***. War-time gardening. Video, ***personal memories of people***, visit to vernacular museum

Key: Skill development and action taken are underlined. People involved outside the school are shown in italics and bold.

Note: There are no restrictions on the topics explored – in the following years other crops are grown – potato family, herbs, fruit trees, flowers. Other groups might grow these in their plots instead of beans. The groups come together for festivals. Containers, garden or allotment plots in rural or urban locations determine the scale of projects.

With school gardening as a central tenet of a curriculum, place-based learning can shape values and behaviour and examine attitudes to sustainable living. Direct, personal contact with living organisms affects people in ways that vicarious experiences cannot and perhaps the most important shift Heyd (2007) contends is towards value systems that accept humans as part of and not separate from nature. Also, a school garden can become a familiar place which throws up constant surprises and hindrances that intrigue children. They get the chance to work on practical projects and solve problems that motivate them to think, develop specific competences and skills needed to overcome challenges. Individual children may prefer to take on specialised responsibilities which brings 'self-efficacy' (Bandura 1997), but they also have to co-operate with others to reach a goal.

Throughout small-scale school gardening projects, such as growing beans, children see their impact on a familiar place, express their attitudes to that place and are unlikely to be detached observers. The school garden represents an unfinished venture, shaped at a point in time by their actions and the result of a shared commitment which, as Pyle (1993) suggests, increases intimacy with the living world and reduces the potential for 'extinction of experience'.

Table 3 outlines ways in which children can gain experience in a contextualised curriculum in which a group, cohort or all classes grow beans and teachers work towards wide educational expectations.

Application of a contextualised framework

By the way they are taught, children also learn how they are expected to behave (Richardson 1997) and Freeman (1999, 186) argues that 'spoon feeding' ill prepares children for real life. Having no experience of alternative ways of reacting, passive individuals may support poor judgments. A curriculum that enables children to learn through interaction with resources is different from one that expects them to absorb abstract facts. A contextualised framework encourages children to seek project-relevant knowledge for themselves. Their search is context-driven and they acquire knowledge of beans for a reason. The intention is that school gardening stimulates all children to learn and understand environmental concepts and here they make connections after discussion and interpret their findings critically.

What children already know, think and can do, has implications for what and how they learn. Children's ability to select information, in order to interact with the environment can lead to learning out-of-doors at any point because individuals have reflected and want to solve problems. Teachers will assess what meaning children are deriving from such learning resources by listening to their exploratory, analytical and reflective dialogue. Endless facts or mindless applications of technology do not ensure an ability to solve problems; solving problems requires a breadth of knowledge to be applied in an integrated manner. By stressing *how* children learn rather than *what* should be learned, there is a greater possibility that they make connections and develop transferable knowledge and skills.

Gardening projects can run in many time frames and children can be offered a range of opportunities for learning intellectual and practical skills as their plants grow. Building on investigations out-of-doors over a number of years becomes the basis of ecology and all data collected will have value for current and future learning. In this way, school time scales are restructured; each record of bean yield for instance is a single point on a sustainability graph with a 50 year time axis. The data gathered becoming extrinsically

worthwhile, locally, nationally or globally and reason enough to develop good recording skills.

Any experiments in the garden can remain visible after a lesson; they become part of the fabric of school life. If children and teachers observe phenomena out-of-doors and co-construct knowledge, using reasoning and social skills, they are modelling methodologies of scientists like Darwin (Johnson 2008). Children give the real world meaning as they draw out the principles underlying ecosystems or evolution for themselves. Providing children with access to positive experiences of growing plants and natural environments in urban areas may be challenging but, with community partnerships, should not prove an insurmountable challenge. Where environmental values have no foundation at home, the school may be the only place to learn them.

A global dimension is encouraged by networking, which extends the scale of research about gardening and prepares children to recognise what people have in common. Children use the Internet not only to observe other people's gardens world-wide, but to develop links with them (McAllister 2009). Drawing on such experiences, children can find distributed knowledge that engages them emotionally and clarifies their place in the world, their values and attitudes. Growing a wide range of vegetables tests, for example, Shiva's (2000) arguments against monocultures of genetically modified crops and puts food supply, food security and nutritional quality in perspective. Encouraging all children to raise challenging questions may lead to experimentation with compost mixtures, hydroponics, water harvesting, disease and pest-resistant plants or extending the growing season. They can decide for themselves the value of new technologies or techniques, using evidence they generate to support or challenge the claims made about them in terms of sustainable development.

Reconceptualising gardening: challenging barriers

Reconceptualised, school gardening can aid inclusive ESD through scientific and environmental literacy as children begin to understand the effect of day-to-day actions on the environment. Regrettably, some teachers may have fragmented environmental or ecological knowledge which reduces their confidence to use creative pedagogy. For this reason, teachers need encouragement to construct knowledge in the same way as children; by working from what they do know and gaining experience over time. Perhaps doing so will change teachers' conceptions of what children can accomplish and reconceptualise their own learning and teaching as they work together.

While teachers may accept that gardening is relevant to inclusive education, Stevenson (2007, 148) suggests that a teacher's criterion for a pedagogic strategy can 'create control problems' in respect of children's tasks. A task-centred curriculum requires investment of personal, subjective, practical and commonsense knowledge and when children use their innate knowledge, they transfer some cognitive control in a lesson away from the teacher. Planning is essential to allow time for children to explore, challenge received wisdom and express their own understanding and misconceptions. The useful personal, social and common sense knowledge, often given low status in schools, is respected. Children can develop understanding of processes and practices as they get feedback to their questions, add their input and learn at different rates. They are deciding what is worth learning in being part of a community, what is necessary to sustain it and, by connecting with its community in a long-term commitment, a school promotes community cohesion.

Gardening takes the focus away from placeless abstractions in a classroom to grounded cross-curricular teaching and learning in authentic situations and through authentic tasks. Gruenewald (2003) argues that educational experiences stem from the distinctive characteristics of a place which in turn compel place-based pedagogy to be wide ranging. Much of the input children have in school garden development is at the planning stage while the hard work of land management is left to parents or professionals. Mannion (2003) found that typically children plant, weed and water but are denied the learning that comes from organising complex activities. Coping with uncertainty and disappointment or success and elation are significant life experiences.

Isolation of children from food growing, for instance, can restrict their understanding of food production globally and food marketing. Parochial environmental access in schools is a sustainability issue and broadly, Lingard (2007) argues, teachers use few global examples relating to topics they teach. As Brundtland (1987) suggests, skills taught in schools need to prepare children for a world in which there may be a scramble for food in a crisis or if disease crosses international borders. Children will also need skills that avert the devastation of biodiversity by people ignorant of their personal impact and challenge those who seek financial gain from degrading the environment unopposed.

If children are being encouraged to think about the environment and how they protect it, individuals will interpret the same information differently. What questions individuals ask in order to reach a decision, coupled with a style of learning that focuses on practical activity, will require new forms of evaluation. Socially mediated learning and learning out-of-doors, in particular, have to be assessed differently. Children need to record their interpretations and understandings of what they encounter out-of-doors. Harlen (1985) suggests that if offered several hundred disparate items to incorporate into formative assessment, teachers may perceive the task as a time absorbing chore. Class discussion exemplified by Simon et al. (2011) about tasks or experiences may be one way to assess explicit understanding and identify individual misconceptions.

To reconceptualise school gardening entails a shift to multimodal approaches to learning (Moreno and Mayer 2007). This is because gardening encourages individualistic and idiosyncratic creativity and thinking while offering diverse learning skills that enhance a domestic level of land management and environmental interaction. If schools provide opportunities to see many perspectives and contexts associated with a single plant, they empower children to make their own connections and inferences.

The future

There has been little recent research into the theoretical basis for gardening, the capacity of schools to incorporate gardening, the impact of gardening on teachers' practices or children's learning outcomes from different levels of engagement with gardening in school. Similarly, the pedagogies associated with gardening have rarely been critically examined and endorsed by educational researchers and practitioners. For instance, currently there is no subject domain which connects gardening and experiential education so as to advance academic careers in the UK. Gough and Scott (2007), accordingly, maintain that appropriate higher education courses are required. This recommendation in turn highlights the need for higher education institutions to consider how they include ESD in all their courses.

Since schools define the culture they are communicating and the breadth of environmental vision they present to children, they need to be cognisant of the importance of sustainability. For many schools, the lack of infrastructure to support school gardens, gardening projects and programmes over many years is a fundamental shortcoming. If school gardening simply depends on a single teacher there may be no continuity of environmental education and degradation of habitats can ensue. Consequently, outdoor resources may be of limited value for teaching ESD because they have evolved *ad hoc*. Exploration of how schools are using their grounds for gardening is also limited and no baseline exists from which to gauge how far schools are moving towards a more place-based ESD rich curriculum. A significant infrastructural issue then is cost which prompts the question: does gardening have to be universally available and integrated into learning opportunities for all children or simply engage those who show interest? Sterling (2001) argues that ESD has the potential to create valuable learning experiences and to reduce costs. Inclusive education is not an extra and Table 4 shows the research potential for establishing gardening in schools.

To ensure long-term environmental well-being, the Brundtland Commission (1987) recommended that all countries, not just those characterised as 'developing', take alternative approaches to development and acknowledge the importance of the environment. What these approaches entail depends inextricably on the interpretation of the intended purposes and processes. The interpretation here is that changes in schools will encompass authentic place-based experiences linked with community involvement in ESD. Intended processes arise as teachers' pedagogy changes to support inclusive education. In this context, decisive action is important. As Wellington and Britto (2004) have argued, changes to children's experiences may be limited if teachers, particularly those who see the classroom as their main professional base, only alter their existing practice tentatively.

Table 4. Research potential.

Theoretical research	School-related research	Pedagogical research
Establish a robust theoretical basis for school gardening	Spaces that schools use on site and locally to inspire learning out-of-doors and gardening	Review provision of ESD and school gardening in teacher education
Baseline studies of gardening offered in schools followed by longitudinal studies	How schools plan effective and flexible learning experiences out-of-doors	Review CPD provision for ESD and school gardening
Compare understanding of ESD for children involved in gardening and those who have no such experiences. *Ad hoc* visits to environment centres, botanic gardens and zoos	Means by which schools engage with school gardening over time and with a range of facilitators	Establish how teachers plan effectively for progression in gardening
Compare how children relate to the nature they experience in a garden, with nature presented in children's literature, film and in cyberspace	Means to assess learning out-of-doors effectively	Establish how teachers identify critical incidents as children learn gardening skills and ESD

Pragmatism in schools can crush any change, but Brundtland's conception of environmental well-being is set against the urgent need for environmental literacy for all children. In many countries, a massive growth in other sites of learning has transformed pedagogy and practice and here frequent gardening experiences have the potential to confront environmental complacency particularly when everyone has a responsibility to live more sustainably. If children are to learn how to evaluate evidence well and participate in decision-making to affect long-term environmental stability, the onus is on schools to reconsider their role. Accountability, for the role schools are able to take, extends to teacher education, curriculum developers and policy-makers.

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