Approaches to embedding sustainability in pre-service teacher education: A synthesis of the literature

Abstract:
This study investigated how teacher education academics embed sustainability education in learning and teaching, using a systematic literature review of peer-reviewed journal articles. A taxonomy of four distinctive approaches was developed: (1) embedding sustainability education widely across curriculum areas, courses, and institution; (2) through a dedicated core/compulsory subject; (3) through a component of a core/compulsory subject; and (4) through a dedicated elective subject. This paper investigates the differing rationales, theoretical frames and pedagogical approaches used and identifies the perceived challenges underpinning each of these approaches. The final section offers an analysis and discussion of the implications of our review findings for teacher education academics and researchers, and others in the broader academic community who are interested in change towards sustainability through education.

Keywords:
Teacher education, pre-service teacher education, initial teacher education, education for sustainability, environmental education, sustainability education, systematic literature review.

1. Introduction

Issues such as climate change, accelerating biodiversity loss, and food scarcity and security are receiving increasing attention as urgent concerns facing humanity. These issues are often framed within a sustainability discourse and education is often viewed as having a central role in building society's capacity to address them (Barth, Michelsen, Rieckmann & Thomas, 2016). The central principles that inform this sustainability discourse first emerged from the 1989 Brundtland Report, which emphasised intergenerational equity and the interconnectedness of environmental, economic and social systems as key sustainability concepts. Scholars such as David Orr (2004, p. 27) argue that the "problem of sustainability" is also "the problem of education" because education requires rethinking - from individual and nation-building emphases - to focussing on the critical issues of human survival. Such a shift presents major challenges for teaching and teacher education.

Sustainability education (SE), also referred to as Education for Sustainability (EfS), Education for Sustainable Development (ESD) and, previously, Environmental Education (EE), aims to help learners develop the necessary knowledge, understanding, skills, values, capabilities and dispositions to respond to the complex socio-ecological issues of the 21st century (Australian Research Institute for Environment and Sustainability [ARIES], 2009). The recently concluded United Nations Decade of Education for Sustainable Development (DESD) (2004-2015) and its follow-up UNESCO Global Action Programme on Education for Sustainable Development (GAP) highlight the international significance of integrating sustainability into the education of young people and, therefore, into the education of student teachers (Australian Government Department of the Environment, Water, Heritage and the Arts [DEWHA], 2009). This imperative is further emphasised by UNESCO's Education Strategy (2014-2021), which outlines three strategic objectives: (1) develop education systems and support educators to foster quality and inclusive lifelong learning for all, by improving learning processes and outcomes; (2) empower learners to be creative and responsible global citizens through, for instance, strengthening ESD; and (3) shape the future education agenda by rethinking education for the future. Sustainability is now widely recognised in many early education and school curricula, and in numerous university policy and graduate attribute statements and courses across the globe.

However, the complexity and contestation of sustainability issues such as climate change pose challenges for a range of disciplines that seek to develop students' understandings and capabilities for action. Researchers across business, engineering and initial teacher education report a lack of a consistent approach to SE and a similar range of barriers, including lack of staff with expertise, faculty support, and time/space in the curriculum, as well as staff and student resistance to the concepts and values of sustainability (Dawe, Jucker & Martin, 2005; Desha, Hargroves & Smith, 2008; Tilbury, Crawley & Berry, 2004; von der Heidt, Lamberton, & Wilson, 2012). Nevertheless, engineering provides the strongest reference point as a disciplinary field that requires graduates to demonstrate outcomes related to economic, social and environmental contexts. For instance, in the United States, ABET, Inc. (the body responsible for certifying engineering programs) requires that students exhibit "an ability to design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability" (ABET, n.d., p. 3).

Similar requirements are mirrored for engineering programs in the United Kingdom (see Engineering Council, 2015) and Australia (see Engineers Australia, 2016).

Within school education, the embedding of complex combinations of interdisciplinary knowledge, understanding, skills, values and dispositions into the curriculum is an important research focus and established challenge. For example, North American, European and Australian education systems have been concerned with developing strategies to integrate complex themes such as multiculturalism into education since the 1960s. More recently, in Scotland, Wales and Australia, cross-cutting themes (Education Scotland, n.d.; Welsh Assembly Government, 2008) or cross-curriculum priorities (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2013), which are intended to permeate all areas of the curriculum, aim to develop a set of key attributes for active and informed citizenship. The Scottish curriculum (Education Scotland, n.d.) identifies learning for sustainability, enterprise education and global citizenship as cross-curriculum priorities; the Welsh curriculum (Welsh Assembly Government, 2008) recognises consumption and waste, choices and decisions, health, identity and culture, climate change, wealth and poverty, and the natural environment; and the Australian curriculum, K-10 (ACARA, 2013) focuses on sustainability, as well as Aboriginal and Torres Strait Islander histories and culture, and Asia and Australia's engagement with Asia.

This paper focuses on the intersection between sustainability and teacher education to examine the range of approaches used by academics to embed SE in initial teacher education. By 'embedding sustainability', we are referring to the inclusion of sustainability as part of the core focus of teacher education policies and practices. Our concern was the extent to which teacher educators implement SE into the curriculum and pedagogy of their initial teacher education programs. Although our focus is on sustainability, the process for embedding any type of knowledge, understanding, skills, values or dispositions beyond subject-specific syllabi is a general concern for many educators (Fiford, 2011). Therefore, we consider the specificities of embedding SE investigated here are transferable to other cross-cutting educational priorities and, hence, may be helpful to teacher educators working across and outside the mainstream subject boundaries that continue to shape how most teacher education programs are framed.

Despite increasing demands and expectations to embed SE into teacher education, the extent to which it has been integrated is unclear (Wals, 2009), with some researchers (Esa, 2010; Author, 2009; Jenkins, 1999/2000) being critical of a lack of progress. A scan of the literature, however, reveals an increasing number of publications addressing SE in initial teacher education, which indicates that research on the issue is, at least, being undertaken. Nevertheless, without an accurate appraisal of what is being reported, it is difficult to ascertain the state of play in the field. We contend that such efforts should be informed by a thorough and grounded understanding of the foundations on which SE in initial teacher education is being applied. Through a systematic review of the extant literature, this research examines how initial teacher education academics embed SE in learning and teaching, their rationales for doing so, the theoretical frames and pedagogical approaches they draw upon, and the challenges faced in these endeavours.

Our review was guided by five research questions:

1. What programmatic approaches are being used to embed SE in initial teacher education?
2. What rationales are provided by teacher educators for embedding SE into initial teacher education?
3. What theoretical frames underpin the embedding of SE into initial teacher education?
4. What pedagogical approaches are used for embedding SE into initial teacher education?
5. What problems and/or challenges are faced by teacher educators who wish to embed SE into initial teacher education?

1.1 Teacher education and sustainability

Initial teacher education curriculum is driven by government and university level policies and directives, teacher educator interests and teaching approaches, as well as student teachers' personal histories, experiences and interests. For example, in Australia, teacher education programs are developed by universities in consultation with national and state/territory education authorities, and teacher accreditation and registration bodies. For teacher education programs to be accredited they must demonstrate that, over the course of the degree, graduate teachers will acquire the appropriate levels of professional knowledge, practice and engagement mandated as a set of seven graduate professional standards (Australian Institute for Teaching and School Leadership [AITSL], 2011). How

student teachers acquire these is, however, largely left to universities, course/program teams, and individual lecturers, making for a relatively ad hoc approach across the nation.

Although SE may be mandated within school curricula, it is not a mandated component of initial teacher education or teacher professional standards in most countries and, hence, can be easily disregarded. Nevertheless, the importance of embedding SE in teacher education has been emphasised over many years through calls from international bodies (UNESCO-UNEP, 1978; 1990), the release of curriculum guidelines (United Nations Educational Scientific and Cultural Organisation [UNESCO], 2005), resources (Sterling, 2008; Swinburne University of Technology, 2011; UNESCO, 2005), scholarly publications (Fien & Maclean, 2000; Fien & Tilbury, 1996; Hopkins, 2001; Tilbury, 1992), and through support for various practice-based and research projects (for examples, see Author, 2007b). UNESCO has specifically advocated for the integration of SE in initial teacher education through the DESD (2005-2014) and the GAP program post-2015. However, reviews of such efforts report limited progress (Author, 2009; Falkenberg & Babiuk, 2014; Fien & Tilbury, 1996; Kapitulčinová et al., 2015; Nolet, 2009, 2013; Scott, Tilbury, Sharp, & Deane, 2012; Tilbury, Coleman, & Garlick, 2005; Van Petegem, Blieck, Imbrecht, & Van Hout, 2005). Where embedding SE activity is under way, attempts are generally haphazard, dominated by patches of isolated activity such as one-off curriculum development projects (Summers, Childs, & Corney, 2005), or integrated mainly into science and geography subjects (Van Petegem et al., 2005) rather than through a systemic approach (Author., 2006; Steele, 2010; Tilbury et al., 2005). According to Author (2007a; 2007b), systemic change involves the broad-scale adoption of a new idea across a whole system to the extent that it becomes embedded or mainstreamed into day-to-day programs and operations. In the context of initial teacher education, a systemic approach to embedding SE goes beyond embedding SE into the curriculum, to becoming an integral part of the school/departmental policies, core curriculum foci, and everyday pedagogical activities.

Examples of systemic approaches are available at the institutional level within an increasing number of higher education institutions across the globe. For example, Adomssent and Michelsen (2006) provide a case study of a German university that anchored the principles of sustainability as an overall concept for its research, teaching and everyday university activities. Blake and Sterling (2011), Cebrian and Grace (2013) and Dyer, Selby and Chalkley (2006) write about whole university approaches to

sustainability in the British context. In the North American setting, Finlay and Massey (2012) report that there is no single campus that has fully embraced every facet of sustainability, but they do provide examples of institutions that demonstrate strong sustainability initiatives with some resembling a systemic approach. Initially, we set out to find examples of systemic approaches to embedding SE in initial teacher education programs within universities. However, faced with a lack of such examples, this paper, instead, offers some clarity about how teacher education academics go about embedding SE. First, though, we provide an overview of the theoretical frame that underpins our research questions and the subsequent search strategy.

1.2 Rationales and strategies for embedding sustainability in education

The rationales underpinning arguments for the inclusion of SE in schools in Australia, British Columbia in Canada, and Scotland in the United Kingdom are that SE will develop the capacity for informed, active and global citizenship in school students (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2013; British Columbia Ministry of Education, 2013; 2015; Education Scotland, n.d.). According to the British Columbia Ministry of Education (2015) the broad core competencies of SE are "sets of intellectual, personal, and social and emotional proficiencies that all students need to develop in order to engage in deep learning and life-long learning" (Para 1). Education Scotland (n.d.) posits that the themes of learning for sustainability, global citizenship and enterprise in education offer "interesting ways to deliver the curriculum including aspects of global citizenship such as Scotland's culture and entrepreneurial learning and teaching" (Para 1). In addition, education policies have been enacted in these and other countries, many in response to the DESD, that are designed to encourage individuals and organisations to incorporate action for sustainability within their everyday practices (for examples from Australia and Canada respectively, see Lang, 2005, 2009; Swayze, Creech, Buckler, & Alfaro, 2012).

In Australia, the overarching goals of the three cross-curriculum priorities (CCPs) – Aboriginal and Torres Strait Islander histories and cultures, Asia and Australia's engagement with Asia, and Sustainability – are limited to "developing knowledge, understanding and skills" and providing students with "the tools and language to engage with and better understand their world at a range of levels" (ACARA, 2016, para 1). Notably, the affective dimension of values is not mentioned in these broad goals. However, in the case of the specific Sustainability priority, values and worldviews are

explicitly included in the aim to allow all young Australians to develop the knowledge, skills, values and world views necessary for them to act in ways that contribute to more sustainable patterns of living (ACARA, 2016). Whether teachers address this aim is uncertain given the now “precarious space in the emerging Australian curriculum” (Salter & Maxwell, 2015, p. 2) of the CCPs following the recent politically conservative review of the Australian Curriculum conducted by Donnelly & Wiltshire (2014) and the statement by the Chair of ACARA that there is “no requirement in the Australian curriculum that subjects be taught through the cross-curriculum priorities” (Salter & Maxwell, 2015, p. 2). Recent research on Queensland teachers’ treatment of climate change also reveals that teachers are unaware of the CCPs (Nicholls, 2016).

Reviews of SE in teacher education reveal that reform at the policy level is not reaching lecture and tutorial rooms (Christie, Miller, Cooke, & White, 2015; Tilbury et al., 2005; Steele, 2010). One reason may be a preoccupation with raising student test scores and improving national positioning on international league tables in literacy, numeracy, science and mathematics that now seems to dominate educational discourses around the globe (Smith, 2016).

Supportive policy and curriculum frameworks in countries such as Britain, Australia and Canada that were developed in the first half of the DESD have, in many cases, not been sustained. For example, a period of SE policy disruption in Australia, accelerated with the election of state and national conservative governments from 2011-2013, resulted in many SE-related policy documents being withdrawn from Australian government websites.

Another explanation may be the long history of educators’ aversion to teaching values, especially when associated with controversial issues. A recent report on integrating values in the New Zealand curriculum revealed that teachers “felt less confident when working with values of diversity and ecological sustainability” (Notman et al, 2012, p. 5). School teachers, of course, have long been identified as shaping their curriculum decisions and classroom practices based on their perceptions of community values. In higher education, both greater autonomy and separation from local communities as well as the sacrosanct claim of intellectual freedom usually mean that most teacher educators are less averse to discussing and trying to cultivate specific values in students.

1.3 Theoretical and pedagogical approaches to Sustainability Education

SE, and EE before that, is a contested field. SE is rooted in the theoretical and pedagogical approaches of the older field of EE and includes a diverse range of conceptual approaches such as: outdoor/nature-based experiential learning (Van Matre, 1979), responsible environmental behaviour (Hungerford & Volk, 1990), action competence (Jensen & Schnack, 1997), place-based education (Gruenewald, 2003), problem/issue-based inquiry (Robottom, 1987), systems thinking (Sterling, 2003), and critical pedagogy (Fien, 1993). These approaches are not mutually exclusive and often embrace two or more theoretical underpinnings, such as critical place-based pedagogy (Gruenewald, 2003) and critical (issue-based) inquiry (Greenall Gough & Robottom, 1993; Author, 2007). Associated with most of these approaches are pedagogies based on constructivist learning theories (e.g., Vygotsky, Dewey and Bruner) and prioritisation of thinking, valuing and acting as fundamental to educational practice (Reid, 2002). Although not commonly reflected in practice in schools, inquiry-based and action-oriented teaching-learning processes dominate the scholarly and policy discourse on SE. Important to note, however, is that the discourse of SE creates a broader, more complex and more ambiguous agenda than EE (Author, 2007). SE expands the scope of the subject matter examined to include social, cultural and economic concerns in addition to environmental concerns, including such issues as global poverty and inequities.

A thought-provoking component of SE is the concept of sustainability literacy. According to Nolet (2009), student teachers who are sustainability literate possess “the ability and disposition to engage in thinking, problem solving, decision making and actions associated with sustainability” (p. 421). Further, sustainability literacy is seen as involving:

> knowledge, skills, and values that inform an individual’s mental models and day-to-day behaviours. It entails more than simply knowing things about the environment, economics, or equity and social justice issues, but rather involves a willingness and ability to engage intellectually and personally with the tensions that are created by the interconnectedness of these systems (Nolet, 2009, p. 421).

Building on the work of Edwards (2006), Nolet (2009) proposes a conceptual framework for sustainability literacy involving stewardship, respectful limits, systems thinking and interdependence, economic restructuring, social justice and fair distribution, intergenerational perspective, nature as model in teacher, global citizenship, and importance of local place. This thematic framework is consistent with the above SE

objectives of embracing a broad and complex range of knowledge, skills, dispositions, values and ways of thinking.

Considering the diverse interpretations and theoretical bases upon which SE is built, it could be expected that discussion of theoretical underpinnings and pedagogical orientations would be evident in authors' descriptions or explanations of the approaches they use to embedding sustainability into their pre-service teacher education efforts. Thus, as our starting point, we sought to examine the studies to identify such theoretical positionings and pedagogical approaches.

2 Method

The systematic literature review offers an organised and systematic method for selecting and critically analysing research (Petticrew & Roberts, 2006; Pickering & Byrne, 2013). A systematic review uses transparent procedures to find, evaluate and synthesize the results of relevant research with procedures explicitly defined in advance to ensure that the exercise is transparent and can be replicated. This practice is also designed to minimize bias (The Campbell Collaboration, n.d.). Briefly, a systematic review involves reviewing publications according to clearly specified criteria (Berrang-Ford, Ford, & Paterson, 2011; Petticrew & Roberts, 2006) and aims for exhaustive, comprehensive searching (Grant & Booth, 2009). We applied this method to critically appraise the approaches adopted by teacher education academics to embed SE into initial teacher education.

2.1 Data sources

Our review focuses on peer-reviewed journal outputs relating to embedding SE in initial teacher education. Only peer-reviewed journals were included because they reflect the interests and values of mainstream research communities and have a degree of control and credibility through peer review processes (Davis, 2009; Fox & Diezmann, 2007; Lubienski & Bowen, 2000). As SE is a broad field without a dedicated database, we used three key databases and a set of keywords in our search. We recognise that our search was not exhaustive and that the number of studies reviewed was small, however, this is reflective of the emergent nature of research into SE in initial teacher education. We performed keyword searches in Eric CSA, Informit and Jstor databases. These three databases were selected after careful review and consideration based on our own research experience. Eric CSA provides extensive access to a broad range of education literature, including that pertaining to school and higher education, teacher education, and

EfS; Informit supports education research including that relating to curriculum, teaching and teacher education; Jstor contains a wide range of archived interdisciplinary content. The following keywords were searched for in the title, abstract or keywords of journal articles: sustainability OR “environmental education” OR “education for sustainab*” OR “sustainable development” AND “pre?service teacher*” OR “teacher education” OR “prospective teacher*” OR “student teacher*”.

We note that the identified publications provide a representative sample only and, hence, are unlikely to reflect the full scope of work in this field. For example, we were only able to access papers written in English; hence, we have not been able to account for studies conducted outside mainstream outlets that could offer greater diversity of approaches and theoretical positions. We are cognizant that relevant publications could well appear in a number of different journals indexed in different databases. Nevertheless, our selection of databases was informed by advice from university librarians, preliminary searches and careful review of individual titles. While peer-reviewed journals are the most common, reliable and current dissemination methods, research on embedding of sustainability into initial teacher education may also be published in other formats.

2.2 Document selection

Our initial searches identified 907 potential English language publications. Document titles and abstracts were scanned online and, from this, 171 publications were downloaded. After duplicates were removed, 151 publication titles and abstracts were evaluated for relevance and inclusion in the final review set. Our interest lay in studies about embedding SE in initial teacher education; therefore, we included only publications reporting specifically on such initiatives. Publications covering other issues such as pre-service teacher knowledge, thoughts or beliefs about sustainability education were excluded. This resulted in 61 studies being retrieved for in-depth reading and consideration. Finally, 28 publications were retained for full review. An overview of the document selection process is presented in Figure 1.

Insert Figure 1.

2.3 Document review

A matrix, based on the research questions that informed the overall review strategy, was designed to systematise analysis of each of the targeted publications and to facilitate

comparison between these so that key data trends and associations could be identified and examined. The first part of the matrix noted authorship, publication year and geographical region. The next section recorded information about the study, including objectives, conceptual/theoretical and pedagogical approaches, main findings and conclusions. The matrix was used to ensure that an in-depth review was undertaken and findings systematically recorded.

2.4 Classification of publications

Upon commencement of the review process, it quickly became apparent that the selected publications comprised descriptive, measurement and intervention research studies (see Figure 1). Descriptive studies explore and describe a problem, issue and/or situation. Measurement studies develop or test a measure to assess reliability and validity of interventions, while intervention studies examine impacts or effectiveness of programs and/or interventions (Sanson-Fisher, Campbell, Perkins, Blunden, & Davis, 2006). We, therefore, first classified the 61 publications as intervention, descriptive and measurement (Figure 1). Our focus in this paper is on the 28 intervention publications that report on various interventions to embed SE in initial teacher education. It is our contention that focusing on intervention studies is useful in improving our understanding of the embedding of SE (Hart, 2003; Kennelly & Taylor, 2007) because they provide insight into the enablers of, and constraints to, change in initial teacher education.

2.5 Analysis

Analysis of the intervention publications resulted in the development of a taxonomy for embedding SE in initial teacher education curriculum, consisting of four approaches[1] (Table 1). Approach 1 is concerned with embedding SE systemically across curriculum areas, courses or institutions. Approach 2 contains studies where SE is embedded through a SE dedicated core/compulsory subject. Approach 3 involves examples where SE is embedded into a component of a core/compulsory subject. Approach 4 includes instances where SE is embedded through a dedicated elective subject. Our analysis examines the four approaches in Table 1 through the five research questions outlined above.

Insert Table 1.

[1] It should be noted that one of the 28 publications (Nicholas, Oulton & Scott, 1993) was found to fit into more than one category and was, therefore, treated as two separate studies. This is because Nicholas et al., (1993) compare two separate and very different approaches to embedding environmental education in teacher education within the one publication.

Although on the surface distinction between core and elective status of SE offerings seems mainly a structural programmatic feature, we consider this to be an important difference. A *core* subject is undertaken by all students in a program of study and must be passed in order to fulfil program requirements. It is the core program that is designed to foster progressive and coherent development of the knowledges, skills, values and dispositions that are identified as essential to the discipline or profession at a given level of study. In the Australian higher education context, these essential elements are captured in program-level learning outcomes, which are required to be specified for every program of study (Department of Education and Training, 2015).

If SE knowledge, skills, values and dispositions are intentionally embedded within dedicated core subjects, or components of core subjects, across a whole-of-program, then this reflects a valuing of their integral role in shaping requisite graduate outcomes. Such an integral role is demanded by our definition of 'embedding' being the inclusion of sustainability as part of the core focus of teacher education policies and practices. In such cases, it is likely that explicit reference to sustainability will be evidenced in program learning outcomes. At the lead authors' university, for example, all Bachelor of Education early childhood and primary graduates are required to be able to demonstrate coherent understanding of underlying principles and concepts, and teaching and learning approaches, for the tropics in the areas of Indigenous education, SE, and rural and regional education. As such, the Bachelor of Education program includes two dedicated SE core subjects as well as embedded SE components across other cores within the program's professional and curriculum studies streams (see Author., 2015). This level of embeddedness contrasts with a program where SE is only pursued by some students through an elective offering, often facilitated by the single SE champion on the program team or taught by another department or faculty within the university.

3 Results

3.1 What programmatic approaches are being used to embed SE in initial teacher education?

As supporters of a systemic approach to the embedding of SE (Author., 2007a; 2007b), a key driver of our investigation was to find out the extent to, and way in, which teacher education academics apply such an approach. Very few of the publications we reviewed resonate with a systemic approach.

Embedding SE across curriculum areas, courses or the institution (Approach 1) most resembles a systemic approach. All papers concerned with Approach 1 emphasise the importance of pushing beyond 'silos' to take a more systemic approach to teaching and learning. Noteworthy, however, is that in nearly all cases, innovations are restricted to academics working within their own discipline or closely related discipline, rather than including other disciplines (Dawe et al., 2005). For example, Nicholas, Oulton and Scott (1993), Corney (2006), Corney and Reid (2007), and Bore (2006) report implementing EE across Post-Graduate Certificate of Teacher Education courses from a science and geography curriculum perspective. Paige, Lloyd and Chartres (2008) and Quinn, Littledyke, Taylor and Davis (2010) explain how they implemented SE across the curriculum areas of Science, Technology and Mathematics which traditionally are delivered in silos but, nevertheless, are complementary disciplines often grouped together under the acronym 'STEM'. A more systemic approach, reaching beyond curriculum innovation alone, is provided by Van Petegem, Blieck and Boeve-De Pauw (2007). They report on implementing or "institutionalising" EE across two different teacher education institutions through curriculum re-orientation, staff professional development, greening initiatives, and integrating expertise pertaining to EE into job descriptions.

Embedding sustainability through a SE dedicated core/compulsory subject (Approach 2) is unusual. Only four out of 28 total publications were found to fit this category. Of these, three (Kennelly & Taylor, 2007; Kennelly, Taylor, & Maxwell, 2008; Taylor, Kennelly, Jenkins, & Callingham, 2006) were produced by the same group of researchers based in an Australian rural/regional university, and dealt with different aspects of the implementation and refinement of the same core subject. The other paper using this approach (Burke & Cutter-Mackenzie, 2010) reports on a large university's multi-campus experience with a first year compulsory experiential EE subject.

Embedding SE into a component of a core/compulsory subject (Approach 3) is the most common approach. A total of 11 out of 28 total publications were found to fit this category. When SE is embedded into compulsory subjects, it usually takes the form of being included as one of several topics in lectures, workshops, seminars and/or online resources (Jenkins, 1999/2000) and assessment tasks (Åhlberg, Äänismaa, & Dillon, 2005; Aleixandre & Gayoso, 1996; Firth & Winter, 2007; Karpudewan, Ismail, & Mohamed, 2009;

Phelps, Maddison, Skamp, & Braithwaite, 2008; Varga, Koszo, Mayer, & Sleurs, 2007; Wright & Wright, 2010).

Lastly, dedicated SE subjects offered as electives (Approach 4) typically cater for students from varied disciplinary backgrounds in the final year of their initial teacher education courses or within a one year Graduate Diploma of Education (GradDipEd). Teacher educators taking this approach report that a dedicated elective provides the opportunity to do this embedding work without having to negotiate competing conflicts or interests, and to work with students who elect to enrol in the subject.

Our review thus indicates that there are four key approaches used to embedding SE in pre-service teacher education: (1) across whole curriculum areas, courses or an institution; (2) through dedicated core/compulsory subjects; (3) a component of a core/compulsory subject; or (4) a dedicated elective subject.

3.2 What rationales are provided by teacher educators for embedding SE into initial teacher education?

Teacher educators provide a range of personal and professional rationales for embedding SE into initial teacher education, but tend to be driven by an overall desire to equip student teachers with the capacity to implement SE in schools. Over half the authors (Bennett & Heafner, 2004; Cheong, 2005; Corney, 2006; Corney & Reid, 2007; Firth & Winter, 2007; Jenkins, 1999/2000; Karpudewan et al, 2009; Kennelly & Taylor, 2007; Kennelly et al., 2008; McConnell, 2001; Nicholas et al., 1993; Paige et al., 2008; Phelps et al., 2008; Taylor et al., 2006; Van Petegem et al., 2007; Varga et al., 2007) emphasise the importance of facilitating student teachers to develop the knowledge, understanding, skills and/or values to embed SE into their own teaching practices once in their educational settings. However, given the centrality of values (e.g., intergenerational and intercultural equity) in sustainability discourse, it is significant that values are not always explicitly included in these rationales. A smaller group of authors report acting in response to international educational policy priorities (Åhlberg et al., 2005; Collins-Figueroa, 2012; Quinn et al., 2010; Van Petegem et al., 2007), as well as to the often-cited criticisms about a lack of sustainability education in teacher education (Kennelly & Taylor, 2007; Kennelly et al., 2008; Taylor et al., 2006a).

A third group of authors perceive that they are disrupting the extant education systems that they see as irrelevant and disconnected from real-world issues (Alsop, Dippo, & Zandvliet, 2007; Nicholas et al., 1993; Paige et al., 2008; Wright & Wright, 2010). For example, Alsop et al., (2007) argue that the wide uptake of economised models of education with its global testing culture that equates testing with accountability - which has become synonymous with education quality (Smith, 2016) - provides a narrow, technical view of teaching and learning, and has set an instrumentalist agenda for teacher education that is unrelated to real-world issues such as ecological decline, climate change, poverty, disease and militarism. Similarly, Nicholas et al. (1993) are critical of conservative education forces that are overly preoccupied with learners' numeracy and literacy skills, at the expense of other important learning foci, a view echoed more recently by Barrett (2016) who comments on the contradictions of ESD scholarship with the results-based logic which currently influences global monitoring of education. Thus, the tensions explicated in Nicholas et al's (1993) paper remain, and indeed, have intensified in the past 20 or more years.

A small number of authors provide other rationales for why they sought to embed SE into their teacher education work. Whitehouse (2008), writing about EE through online learning, provides an equity perspective by arguing that delivering EE via an online platform provides an equitable solution to the problem of (limited) time and geographically spaced populations in vast countries like Australia. Another two authors (Jenkins, 1999/2000; Phelps et al., 2008) write that embedding EE into their respective subject areas of ICT and pedagogy provides an opportunity for student teachers who might not otherwise engage with EE to do so since, at the time of writing, teaching SE was not compulsory and, therefore, not necessarily addressed elsewhere in the curriculum. Lastly, Karpudewan et al. (2009) and Åhlberg et al. (2005) argue that embedding SE into the curriculum provides a more holistic understanding of the subject matter and increases capacity for academics to promote higher-order thinking in students by involving them in deep and relational learning.

Our review thus indicates that there are four key rationales provided for embedding SE into teacher education: (1) to prepare student teachers to develop the capacity and (in some cases) commitment to embed SE into their own teaching practices once in schools and other educational settings; (2) to respond to international educational policy priorities; (3) to disrupt instrumentalist, neoliberal education systems; and (4) for a range of other individual reasons.

3.3 What theoretical frames underpin the embedding of SE into initial teacher education?
We were also interested in investigating the extent to which teacher educators working to embed SE situate their research within a conceptual or theoretical framework. We found that most authors (23 out of a total of 28 publications) provide a conceptual framework to underpin their SE teaching and learning. These include: inquiry and/or place-based education (Alsop, Dippo & Zandvliet, 2007; Whitehouse, 2008; Cheong, 2005; Karpudewan et al. 2012; Nelson, 2010; Bore, 2006); experiential education (Burke & Mackenzie, 2010); constructivist and/or socially critical approaches (Aleixandre & Gayoso, 1996; Firth & Winter, 2007; Kennelly et al., 2008; Taylor et al., 2006; Paige et al., 2008); integrating theory (Åhlberg et al., 2005); and Palmer's model for teaching and learning in environmental education (Bennett & Heafner, 2004).

Notable, however, is that detail about their conceptual or theoretical frames varies considerably. Some authors name a conceptual framework without actually situating their teaching and learning work within the stated framework. For example, Nicholas et al., (1993) state that the subject about which they write takes an 'education *for* the environment' approach to empower and enable students to act as catalysts for action, but provide no information about how the approach is developed and connected to their teaching and learning, or what it means within the context of their subject. A small number of authors (three out of 28) do not explicitly name a theoretical framework, but do provide some detail of their approach. This subset includes Karpudewan et al., (2009) who explain how their Green Chemistry subject takes a student-centred, deep learning approach that is interdisciplinary. Two authors (McConnell, 2010; Phelps et al., 2008) provide no conceptual framework for teaching and learning of SE. A few authors provide in-depth detail of the key principles, underlying theory and application of their theoretical framework. Examples include Bennett and Heafner (2004), who describe the theory and application of Palmer's (1988) model to guide planning, teaching and learning in EE to plan for, implement and reflect upon an EE field day. Åhlberg et al. (2005) explain an integrating approach to action research through the use of concept maps and Vee heuristics in order to develop curriculum in education for sustainable living within a teacher education course. Kennelly and Taylor (2007) report on their application of Gutek's (1997) five-point framework of education to develop a compulsory teaching unit, while Burke and Cutter-Mackenzie (2010) describe the application of an innovative approach which they call a/r/t-e-ography.

Interestingly, although not a focus of our analysis, we found few detailed descriptions (only four of the total of 28 publications) of the research methodology used by authors to discuss their own investigations into their teacher education practice (Bennett & Heafner, 2004; Wright & Wright, 2010; Varga et al, 2007; Burke & Mackenzie, 2010). Three papers describe action research (Bennett & Heafner, 2004; Wright & Wright, 2010; Varga et al, 2007) and one, autoethnography (Burke & Mackenzie, 2010). However, the extent to which these authors situate their research within their chosen methodological framework also varies. There is either little or no rationale for the methodology or specific methods used to identify, collect and analyse data sources in light of the research question or problem. For example, Bennett and Heafner (2004) and Wright and Wright (2010) define and justify their action research approach, but fall short of explaining the process within the context of their unit or course. Varga et al. (2007), on the other hand, omit a definition, but justify and explain how the action research process develops in the context of their teaching and learning. Six papers offer descriptions of interventions only and provide no information on methodology or methods.

Although most authors named a conceptual or theoretical approach that underpinned their embedding of SE, the level of detail varied considerably with some authors not situating their teaching and learning work within a conceptual frame at all, and only a few providing in-depth detail of the key concepts or principles underlying their theoretical approach. The lack of descriptions or interpretations of named theoretical approaches made it difficult to differentiate between some conceptual approaches that share some common or similar characteristics, for example, inquiry and place-based education. Hence, it was not possible to create a useful taxonomy of theoretical approaches to embedding SE in teacher education from this review.

3.4 What pedagogical approaches are used for embedding SE into initial teacher education?

Most teacher educators whose work was reviewed for this study offer details about their pedagogical approaches and strategies. Many emphasise engaging students in place-based, experiential and/or inquiry methods, and modelling strategies for teaching SE that student teachers can apply in schools. Such strategies include: discussion and reflection techniques (Aleixandre & Gayoso, 1996; Bore, 2006; Firth & Winter, 2007; Jenkins, 1999/2000; Corney & Reid, 2007; Jenkins & Callingham, 2006; Karpudewan et al., 2009;

Nicholas et al. 1993; Taylor et al., 2007; Wright & Wright, 2010); brainstorming (Aleixandre & Gayoso, 1996), concept mapping (Aleixandre & Gayoso, 1996; Åhlberg et al., 2005), place-based outdoor experiences such as field investigations/ inquiries or projects (Paige et al., 2008; Bennett & Heafner, 2004; Kennelly & Taylor, 2007; Whitehouse, 2008), values analysis (Kennelly & Taylor, 2007), role plays (Aleixandre & Gayoso, 1996), problem-based inquiries (Bore, 2006; Jenkins, 1999/2000; Karpudewan et al., 2009) and problem solving activities (Jenkins, 1999/2000), lecture-style delivery of information about SE (Firth & Winter, 2007; Phelps et al., 2008), and futures scenario writing (Paige et al., 2008).

Some innovative approaches are provided by Cheong (2005) and Burke and Cutter-Mackenzie (2010). Cheong explains a community problem solving pedagogical strategy, which involves student teachers working with community members to address local sustainability issues through an action research process employing participatory investigative, creative and critical thinking skills. Burke and Cutter-Mackenzie (2010) apply what they refer to as *experiential learning through immersive art pedagogy*, which involves lecturers and students collaboratively and critically examining the pedagogical and value basis of environmental and place-based picture books. The process is immersive in that the focus is on the visual qualities of children's picture books through encouraging "sensory, experiential, perceptual, relational, cultural, and socially critical" (P. 312) investigation of the environments, places and themes featured in the books. In many cases, lecturers blend pedagogies, sometimes within the same session. For example, Jenkins (1999/2000) utilises the transmission mode of teaching to deliver content, engages in group and whole-class discussion to encourage students to unpack this content, as well as hands-on, problem-based inquiry teaching methods, which require students to plan for EE through a lesson-based hypothetical scenario.

It is not possible as a result of our review to comment on the effectiveness of these strategies because the publications describe, rather than evaluate, the approaches used. It is, at the very least, possible to conclude that the variety of approaches indicates a volume of diverse pedagogical activity and experimentation by academics, which is useful for informing an evolving area of research.

3.5 What problems and/or challenges are faced by teacher educators who are embedding SE into initial teacher education?

The range of problems and/or challenges discussed by teacher education academics when they attempt to embed SE is well established in the literature. These are located across system, institutional, faculty/school, subject/course and personal dimensions. For example, McConnell (2001) and Alsop et al. (2007) write about working within restrictive education systems where the scope of their efforts is constrained by “market driven, instrumentalist, commodity fetishist” education policies which, they argue, serve to “systematically distract from and undermine meaningful considerations of education for a sustainable future” (P. 218). Nicholas et al. (1993) are also cognisant of the impacts of wider political and mainstream forces, including the continued marginalisation of many EE courses, and a general misunderstanding of the purpose of EE.

Institutional constraints can also limit individual teacher educator choice (Hunt, 2006). Identified institutional constraints include the dilemma of trying to incorporate broad SE outcomes within tightly mandated and circumscribed professional courses (Quinn et al., 2010) and inflexible and obstructive workloads, staff timetables, and staffing structures which restrict opportunities for collaboration (Paige et al., 2008). Lack of time and timetabling issues are regularly raised as institutional constraints. McConnell (2001), Taylor et al., (2006) and Cheong (2005) consider that institutionally-set course/subject hours limit capacity for deep learning. For example, teacher educators report insufficient time to interrogate and change entrenched student views about the nexus between sustainability and education (Taylor et al., 2006) and to enable student teachers to develop sufficient skills to successfully teach SE (Cheong, 2005).

Some teacher educators appear less constrained by systemic impediments to SE, or at least are not critical of institutional constraints. Instead, these authors discuss challenges at the subject and personal level. Whitehouse (2008), for example, writes about the challenges related to online delivery of SE. These include limited synchronous contact with students that restricts effective exchange of ideas and checking for and clarification of understandings, and the dilemma of how to meaningfully engage students with place-based learning in an online learning environment. For Cheong (2005), constraints are related to limited student teacher capability in group and project work. Karpedewan et al. (2009) find that the Green Chemistry approach to embedding ESD enhances students’ understanding and awareness of sustainability concepts but does not enable pre-service teachers to act on environmental problems. Varga et al. (2007) and Bore (2006) recognise that student teachers are not used to student-centred and constructivist inquiry-based

learning and teaching approaches and, hence, often encounter difficulties using such processes and tend to resist such methods. For some teacher education academics, individual professional challenges relate to lack of knowledge and experience in SE, fear of higher workloads, a 'silo mentality' or a lack of collaboration amongst colleagues who do not perceive SE as relevant to themselves or to pre-service teacher education (Van Petegem et al., 2007; Quinn et al., 2010), as well as the need to ensure the focus of SE remains on the *for* (action) component rather than merely raising awareness (Nicholas et al., 1993; Corney, 2006).

In summary, teacher educators report facing a range of constraints at the institutional, faculty/school, and subject/course levels, as well pedagogical and individual professional challenges in their efforts to embed SE in initial teacher education. No patterns were found that might suggest a link between any one particular approach to embedding SE and the problems and/or challenges faced by teacher educators. We also found no patterns linking rationales with any one particular approach to embedding SE. We consider the implications of these findings below.

4 Discussion

This review has offered an analysis of approaches by teacher educators to embed SE into initial teacher education programs. We set out in the hope of developing taxonomies of programmatic approaches, rationales, conceptual framing and pedagogical strategies being implemented in efforts to embed SE in initial teacher education. Only the first two were feasible, given the lack of sufficient and consistent details for the latter two intentions. Similarly, owing in part to a lack of detailed explanations, no patterns were evident that might suggest a relationship between any one particular approach espoused for embedding SE and the rationale, theoretical frame and/or pedagogical strategies adopted by teacher educators.

In this final section of the paper, we consider the findings of our review through a critical analysis and discussion of the implications for teacher education academics, researchers and others in the academic community interested in SE. Collectively, the strategies suggest that SE in initial teacher education:

- is still an emerging area of curricular activity driven by individual academics;

- is underpinned by a range of pedagogical approaches and strategies that are uncritically applied;
- has a very small research base, mostly coming from the traditional sources of the United States, Europe and Australia; and
- is generally under-theorised and descriptive.

In considering the first point, that embedding SE in initial teacher education is an emerging area of curricular activity, this review suggests that the field is characterised by 'patches of green' (Elliott, 2003) driven mainly by the passions and concerns of individual teacher educators. Overall, these concerned academics experiment with embedding SE at the micro level, enacting change within their own spheres of influence, rather than through a more systemic, broad-scale approach to creating change. For example, teacher educators tend to embed SE into their particular subject area rather than work with others across diverse subjects, schools and/or disciplines. This is not surprising, but is reflective of the history of SE across higher education generally and, more broadly, the silo delivery of disciplinary programs within universities (see Dawe et al., 2005; Filho & Carpenter, 2006; Tilbury, Keogh, Leighton, & Kent, 2005). Nevertheless, we did identify one attempt to implement EE across a teacher education institution (Van Petegem et al., 2007). We consider this a positive example that reflects emerging understanding by a few academics about the importance of systemic embedding approaches. Moving forward, teacher educators can look for inspiration to such cases.

We were also interested in exploring the locus of the 'patches of green'. A pleasant surprise was the finding that SE is hosted within a range of curriculum areas, other than those where it is traditionally applied (Science and Geography), including English, Pedagogical Studies, Home Economics, Chemistry, and the Arts. We contend that developing knowledge and understanding of any specialist area is an incremental process. Therefore, it seems logical that enabling student teachers to develop the knowledge, skills and understandings to embed SE into their future teaching and learning practices will require multiple and varied opportunities over time. Hence, it is clear that the earlier that student teachers are introduced to SE the more beneficial for developing the necessary knowledge, understandings, skills and values of SE. In this regard, our findings are relatively positive. While SE is offered in the final year of a B.Ed. program in many instances, there are numerous examples of implementation across first, second and third years.

Overall, though, there is a clear need to extend the curricula and pedagogical work that is in progress beyond ‘patches of green’ towards more systemic approaches. To achieve this, teacher education academics interested in embedding SE can take their lead from those already embedding SE across curriculum areas, courses or institutions as well as from others working to promote more strategic approaches (eg., Author., 2016; Author, 2012; Author, 2009; Author., 2007a; Author, 2007b; Author, 2006; Steele, 2010; Author, 2015). We, therefore, acknowledge and commend the work undertaken by those teacher educators working at the individual subject level. However, we wish to re-emphasise the importance of using systemic approaches. At the curricular level, for example, this can include planning for developmental progression across courses where, for instance, SE knowledge, literacy, understanding and skills are introduced to student teachers in first year, developed in second and third years, and intensified in their final year.

The second discussion point is that authors report the use of a diverse range of pedagogical strategies broadly located within constructivist, inquiry, and/or experiential approaches to education. However, they offer little or no critical reflection upon, or evaluation of, these strategies and approaches in terms of their effectiveness in developing the knowledge, skills, values and dispositions required to implement SE. While the strategies employed are in keeping with the types of interactive and discursive teaching methods called for by sustainability scholars (Bosselmann, 2001; Cotton & Winter, 2010; Sterling, 2012), our reading of the articles denotes that most authors still largely employ transmission modes of teaching and, where sustainability pedagogies are enacted, authors do so uncritically. Some authors appear to assume that pedagogy, or specific types of pedagogies and/or the acquisition of relevant sustainability knowledge and skills, is a catalyst for the development of graduate teachers who will implement SE in schools once they become classroom teachers. It was concerning in these and other cases to note the absence of the affective dimension in authors’ discussions of their rationales, conceptual frames or pedagogies. Valuing of, for example, biodiversity, intergenerational and intercultural equity, and developing such dispositions as a commitment to engaging in individual and collective action are central tenets of sustainability education theories, discourses and policies.

We acknowledge the difficulty of enacting pedagogical innovation in a restrictive higher education context (Cotton & Winter, 2010) and stress this is not a criticism of the teacher

educators themselves. Rather, this is a call for teacher educators to undertake empirical research, inclusive of critical reflection and evaluation, in a field that lacks evidence-informed research and where many uncertainties exist about effective approaches (Cotton, Bailey, Warren, & Bissell, 2009; Dyball & Carpenter, 2006; Eilam & Trop, 2011; Higgins & Kirk, 2006). We contend that research-led investigations that interrogate the efficacy of accepted sustainability pedagogies can substantiate (or challenge) current theory on sustainability pedagogies in practice.

Thirdly, this review confirms what we know anecdotally, that is, that SE in initial teacher education has a very small research base. This is not surprising considering the field is relatively new and still developing, but is nonetheless disappointing. Australia emerges as a leader in the field with almost half the publications (12 out of 28) originating from Australian universities and with Australian research featured in each of the four identified approaches. In comparison, Europe, North America and Asia share the remaining 16 publications with each featuring research in only two of the four possible approaches. The standing of Australia as a leader in the field is in contrast to Wals and Blewit's (2010) earlier analysis of research on sustainability in higher education generally, which found that most of the publications emanate from North America and Europe. Although the two reviews are focused at different scales within higher education (i.e., Education discipline vs the whole higher education context), it does indicate that Australia can be considered an emergent force in SE for initial teacher education. The implication of this third point is for teacher education academics to respond to the call for more research and to expand the research base in SE within initial teacher education globally.

The final point relates to the under-theorised and descriptive nature of SE in initial teacher education. Half of the authors using Approach 4 (a dedicated elective subject) and almost one third of authors of all four approaches omit any theoretical and conceptual details about how they plan for and teach SE. Many authors whose work was included in this review appear most concerned with the pragmatics of embedding SE, providing descriptive rather than analytical accounts of interventions and paying far more attention to pedagogical practice than the theories underpinning the pedagogies. For example, a number of authors within each identified approach provide descriptive reports that explain the processes and outcomes of their interventions, but offer no information on the theoretical frameworks underpinning what they do or on the research aspects of their evaluative work, such as methods or methodology. This could be taken as a sign of an

emerging field that is progressing through phases of development, commencing with descriptive accounts of practice.

The lack of attention to theoretical underpinnings of approaches to embedding EfS in teacher education can be contrasted with a review of 67 articles published in the Australian Journal of Environmental Education from 1990-2000. The review revealed that one of the two most common areas of focus were theoretical (or philosophical) analyses that critiqued and/or reconceptualised either worldviews of human-environment relationships or environmental/sustainability education theories, discourses, policies or curriculum practices (Author, 2011). This highlights the need and possibilities for expanding the scholarship on sustainability in teacher education to give more attention to theorizing different curriculum and pedagogical approaches that are trialled or adopted. As Dillon (2003) comments, a lack of theoretical detail, particularly in empirical research, is a concern, and makes it difficult for other researchers who wish to make sense of emerging understandings of the conceptualisation and contextualisation of SE. Hence, there is a strong rationale here for teacher education academics to engage more strongly with educational and environmental theory. This will enable the field to become more mature, robust and diversified.

5 Conclusion

What do the findings of this review mean for SE within initial teacher education? We recognise that the limited number of papers in our study, as well as some of their limitations, reduces our capacity to offer specific transferable insights; nevertheless, there are broad lessons to be learnt. Debate on the implementation of SE in initial teacher education is revealed in the diversity of curriculum approaches, rationales, conceptual framings, pedagogical strategies and challenges described in this review. To build on this existing work, there is now a necessity for academics working at the program and individual subject levels to extend SE practice to be more systemic and cross-disciplinary. There is also a need for deeper evaluation of the effectiveness of the pedagogies that are currently in play. While many teacher educators report their use of participatory, inquiry-oriented and other teaching and learning methods that are well-grounded in the SE and broader educational literature, a lack of reflexivity and critique limits the transferability of many of these efforts and the development of an in-depth understanding of SE practices in initial teacher education. Finally, as we have noted, research in this emerging area of teacher education practice is small-scale and theoretically weak. While we acknowledge that this is most likely because of the relative newness of the field, we believe that

extending both the quantity and quality of investigations into teacher education practices in SE will significantly inform and strengthen efforts in this space and add legitimacy to the important work that many teacher educators are engaged in in contributing to global sustainability through education.

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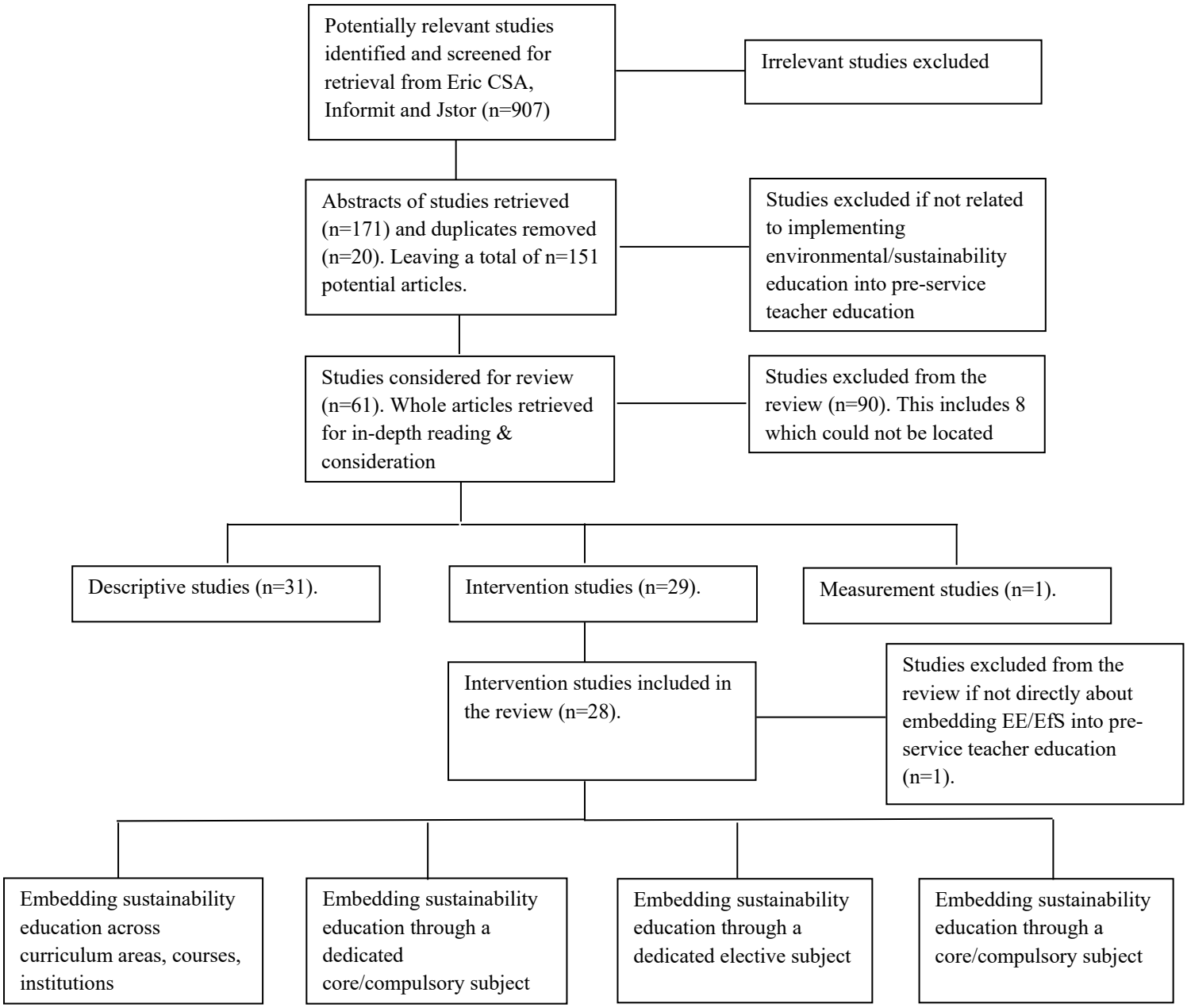

Figure 1. Summary of research process

Table 1

Taxonomy of approaches to embedding sustainability education in reviewed studies

Approach 1 Embedding sustainability education widely **across curriculum areas, courses, and institution**	Nicholas, Oulton & Scott, 1993 (Bath only); Corney & Reid, 2007; Corney, 2006; Van Petegem, Blieck, Boeve-De Pauw, 2007; Paige, Lloyd & Chartres, 2008; Quinn, Littledyke, Taylor & Davies, 2010; Bore, 2006; Collins-Figueroa (2012).
Approach 2 Embedding sustainability education through a **dedicated core/compulsory subject**	Burke & Mackenzie, 2010; Kennelly & Taylor, 2007; Kennelly, Taylor & Maxwell, 2008; Taylor, Kennelly, Jenkins & Callingham, 2006.
Approach 3 Embedding sustainability education through a **component of a core/compulsory subject**	Jenkins, 1999/2000; Karpedewan, Ismail & Mohamed, 2009; Wright & Wright, 2010; Firth & Winter, 2007; Varga et al, 2007; Ahlberg, Aanismaa & Dillon, 2005; Phelps et al, 2008; Aleixandre & Gayoso, 1996; Author (2013); Nelson (2010); Kapudewan, Ismail & Roth (2012).
Approach 4 Embedding sustainability education **through a dedicated elective subject**	Alsop, Dippo & Zandvliet, 2007; Nicholas, Oulton & Scott, 1993; McConnell, 2001; Whitehouse, 2008; Cheong, 2005; Bennett & Heafner, 2004.