The personal context of student learning for sustainability: Results of a multi-university research study

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Abstract: The UN Decade of Education for Sustainable Development (DESD, 2005-2014) was an important framework and catalyst for increasing Sustainable Development (SD) efforts within academic institutions, worldwide. Tertiary institutions began to embed sustainability into the curriculum, although the extent has varied within and between institutions with many adopting an ad hoc approach. Previous studies of student learning outcomes were generally limited in scope and reported mixed results. Few studies systematically investigated the influence of sustainability education (SE) on student views, attitudes and behaviour across a range of contexts. This study adds to the field by using a common instrument that explored how SE contributed to student learning across multiple disciplines, institutions and countries. A quasi-experimental approach was adopted with tertiary students in 'intervention' and 'control' units. Data was collected using an online two-stage pre-post survey and included the Inclusion of Nature in Self (INS) and New Ecological Paradigm (NEP) scales and measures of self-reported behaviour. A series of snapshots of pre-test and post-test perspectives were taken across various terms of study during 2013-2015. Students' initial sustainability perspectives were found to be influenced by personal and educational factors such as gender, age, "culture" and discipline of study. Environmental worldviews were characterised by jointly strong ecocentric and anthropocentric orientations that represented a "utilitarian" view of human-nature relations. After controlling for pre-test scores, SE significantly increased post-test scores for several NEP dimensions compared to the control group however, the effect was weak and moderated by students' personal and educational context. Students exposed to SE also reported a cognitive shift in their attitudes/perceptions to sustainability that was linked to an increased INS score. The ad hoc approach to SE, combined with students' strong utilitarian worldview and mixed effects of SE indicated learning outcomes were far from certain and probably weak. The paper argued for a rethink of current educational approaches towards a more coherent and targeted educational strategy and concluded with recommendations for policy and praxis to enhance student learning for sustainability in higher education.

***Highlights**

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Highlights:

- Student sustainability perspectives were influenced by personal and educational factors
- Student environmental worldviews were a "utilitarian" view of human-nature relations
- Tertiary education led to a convergence of student views to a more moderate stance
- Sustainability education had weak effects moderated by personal/educational factors
- Uncertain learning outcomes from ad hoc tertiary sustainability education approach

The personal context of student learning for sustainability: results of a multi-university research study (13622 words)

1 Introduction

Higher Education Institutions (HEIs) are expected to take a leadership role in producing future leaders capable of managing sustainability challenges underpinned by social, cultural, economic and environmental developments (GUNI, 2011). Over the last two decades, many institutions have signed declarations, charters, partnerships and accreditation standards that commit them to contribute to sustainability through their curriculum, campus operations, research projects and community engagement activities (Fisher and Bonn, 2017; Lozano et al., 2014a). An important recent initiative was the UN Decade of Education for Sustainable Development (DESD, 2005-2014), which had the goal of integrating the principles, values and practices of Sustainable Development (SD) into all aspects of education and learning (Holmberg and Samuelsson, 2006). It was an important framework and catalyst for increasing SD efforts and many HEIs around the world have begun to embed sustainability into key functional areas, initially in operations and gradually into their curricula. Three years after the DESD, one might ask how these HEI efforts are contributing to student learning.

HEIs often struggle in their attempts to integrate sustainability into and across functional activities, particularly in their teaching and learning practices (Fisher and Bonn, 2017; Leal, 2014). While many Australian universities have publicly endorsed goals and values related to sustainability, the commitment is not usually reflected in their vision, mission and graduate attributes (Lee et al., 2013). Furthermore, the integration of Education for Sustainable Development (ESD) into curricula is mostly weak or non-existent (Fisher and Bonn, 2017). Recent global surveys show the extent of ESD varies within and between HEIs (Lozano et al., 2014a) and are often implemented in an ad hoc, laissez-faire manner. Assessment of student learning outcomes are usually reported for a limited range of impacts and the effects are mixed (Shiel et al., 2015). Case studies are usually related to specific interventions in particular institutions and are often focused on unique characteristics of individual programs, limiting the direct comparability between studies (Stern et al., 2014). Some empirical studies used a common metric to report the influence of ESD on attitudes or behaviour but few have relied on a common instrument to report student views, attitudes and behaviour across a range of contexts (Sammalisto et al., 2016; Zsóka et al., 2013). In a review of the UN DESD, Leal (2014) reaffirmed the need to describe, document and disseminate state-of-the-art initiatives, empirical research and projects on ESD and concluded it still remains to be addressed in a systematic way. ESD researchers have also called for more longitudinal studies (WEEC, 2015).

This paper reports the results of a multi-university research study designed to systematically explore the relationship between Sustainability Education (SE) and tertiary students' worldviews, attitudes and self-reported behaviour towards sustainability. It used a common instrument across multiple disciplines, institutions and geographic locations in Australia, Europe and Asia. The study investigated the influence of tertiary education and SE (particularly when implemented in an ad hoc manner), by taking a series of snapshots at the beginning and end of term, during the period 2013-2015. The findings provided further insights into the evolving nature of students' sustainability perspectives and the contribution of higher education to student learning outcomes in the cognitive (thinking) and affective (valuing) domains (Reeves, 2006; Shephard, 2008; Shephard et al., 2015b). Results may be relevant to decision makers for the development of policy on ESD and for educational praxis.

The remainder of this paper is structured as follows. Section 2 provides a review of literature on students' knowledge, attitudes and behaviour towards sustainability, the integration of sustainability in the tertiary curriculum and the influence of sustainability education on students' sustainability perspectives. Section 3 presents an outline of the theoretical framework guiding this study. Section 4 describes the overall research design, research methods and limitations of the study. Section 5 presents the results and discussion of cross-sectional analysis of student data collected at the beginning of term (pre-test) and longitudinal (or diachronic) analysis of matched pre-post data collected across the term. Conclusions are drawn along with proposals for future research directions in Section 6.

2 Literature review

2.1 Environmental attitudes and behaviours

Environmental attitudes and concern for environmental issues have been investigated by researchers for several decades. Environmental behaviours are influenced by a range of personal, situational and contextual factors (Boeve-de Pauw et al., 2011; Franzen and Vogl, 2013; Swami et al., 2011; Turaga et al., 2010) with multiple motivations influencing behaviour in any particular setting (Steg and Vlek, 2009). In a review of research over the past 30 years, Gifford and Nilsson (2014) identified no less than 18 personal and social influences on pro-environmental concern and behaviour: childhood experience, knowledge and education, personality and self-construal, sense of control, values, political and world views, personal goals, felt responsibility, cognitive biases, place attachment, age, gender and chosen activities, religion, urban–rural differences, norms, social class, proximity to problematic environmental sites and cultural and ethnic variations. Such a multiplicity of individual and social influences complicated any certainty of predicting whether a given person will be concerned about the environment or act in pro-environmental ways, even less so their response to sustainability education.

2.2 Integration of sustainability in the curriculum

An integrated curriculum maximises coherence when integration occurs both vertically and horizontally in the curriculum (Drake and Burns, 2004). Ceulemans and De Prins (2010) offered such a framework to discuss integration of SD into the Higher Education (HE) curriculum. Horizontal integration occurs when SD concepts are interwoven into individual existing courses across the curriculum and vertical integration occurs when separate dedicated SD courses are added into the curriculum. Researchers have identified many barriers to such an integrated approach, including multiple interpretations and the complex multidisciplinary and contested nature of SD (Aznar Minguet et al., 2011; Gale et al., 2015). Instead, HEIs have adopted a range of approaches, namely:

1. Elements of SD are “added-on” to selected courses within a program;
2. Specialist cross-disciplinary SD courses are introduced within existing programs;
3. Sustainability principles are embedded into core subjects of a program (Sherman and Hansen, 2010);
4. SD is offered as a specialisation within an existing program of study; and,
5. SD is offered as a dedicated program (Lozano et al., 2014b).

A vast body of literature has developed in the realm of ESD in HE. In a review of current research trends in HE for SD, Barth and Rieckmann (2015) categorised the field into four foci: exploratory studies, explanatory studies, descriptive studies and conceptual papers. Key topic areas included integrating SD into HE curricula (Burns, 2015; Ceulemans and De Prins, 2010; Gagnon et al., 2010; Pellicer et al., 2016; Verhulst and Van Doorsselaer, 2015), theories of teaching and learning (Lozano et al., 2014b; Pappas et al., 2013; Stubbs, 2013), barriers and drivers faced by curriculum developers and educators (Bessant et al., 2015; Ferrer-Balas et al., 2010; Huckle and Wals, 2015; McKeown, 2015) and key outcomes in terms of student knowledge, attitudes and behaviours (Gough and Gough, 2016; Hasslöf et al., 2016; Tuncer and Sahin, 2016).

This paper follows Sterling (2004) in adopting the term “Sustainability Education” (SE) as a catch all phrase for environmental education (EE), education for sustainability (EfS), ESD, environmental and sustainability education (ESE) and variants thereof. The literature on evaluation studies of SE is dominated by empirical and descriptive studies of specific approaches and individual initiatives in particular institutions. Previous case studies reported mixed impacts from specialised sustainability courses as well as integration of sustainability elements/concepts and pedagogy into mainstream courses such as Business, Engineering, Design and Education: McMillan et al. (2004) found formal coursework in introductory environmental studies had a positive effect on students’ environmental values; Karol and Mackintosh (2011) reported weak impact of a more transformative approach in a sustainable design course; Teisl et al. (2011) found significant changes in students attitudes after attending environmental literacy courses, although the direction of change depended on the instructor; and Remington-Doucette et al. (2013) found sustainability competencies developed differently in students with different disciplinary affiliations following an introductory sustainability course. These studies focussed on one

aspect of environmentalism such as knowledge, or worldviews or behaviour. The most common measure of worldviews in evaluation studies was the New Ecological Paradigm (NEP) developed by Dunlap et al. (2000).

As the UN DESD drew to a close, studies used NEP to compare environmental worldviews of students in different disciplines and to examine the influence of their programs over time (Benckendorff et al., 2012; Harraway et al., 2012; Kuo and Jackson, 2014; Shephard et al., 2015a). Cross-sectional and longitudinal analyses showed significant differences in pre-test as well as post-test NEP responses that varied by discipline of study and demographic factors, principally gender. In some studies, students held a weaker pro-ecological stance after completing regular courses (Harraway et al., 2012); other research revealed little or no changes in attitudes after sustainability education (Dagiliūtė and Liobikienė, 2015; Jowett et al., 2013; Mintz and Tal, 2013; Rideout, 2014; Yavetz et al., 2009); some reported a mixture of responses (Dagiliūtė and Niaura, 2014; Felgendreher and Löfgren, 2017; Fisher and McAdams, 2015; Sidiropoulos et al., 2013) while a few reported improved self-efficacy and self-reported behaviours (Mullenbach and Green, 2016; Sidiropoulos, 2014). More recent studies addressed several aspects of students' attitudes and behaviour, again with mixed results. Fernández-Manzanal et al. (2015) found no change in behaviours in Spanish students; Robinson (2015) reported no behaviour change for UK students; Zareie and Navimipour (2016) found a positive effect on behaviour in Iran; studies by Nisiforou and Charalambides (2012), Hiller Connell and Kozar (2012) and Sammalisto et al. (2016) reported significant changes in students' knowledge over time but not in behaviour; while Zsóka et al. (2013) showed a strong relationship between the intensity of environmental education and the level of environmental knowledge and action.

When this multi-university study was conceived in 2012, few studies had evaluated pre-test and post-test measures of student worldviews, attitudes and behaviours across a range of countries. It was distinguished by including multiple measures of worldviews for tertiary students in different courses, disciplines, institutions and countries so it filled a gap in the literature. The specific objectives of the study were:

- To determine tertiary students' sustainability perspectives in terms of their worldviews, attitudes and behaviours prior to a tertiary education intervention
- To investigate the influence of demographic, educational and situational factors on students' sustainability perspectives
- To assess the relationship between tertiary sustainability education and students' sustainability perspectives and identify the influences that moderate this relationship.

3 Theoretical framework

Previous studies showed environmental attitudes and behaviour were influenced by various factors including education and learning experiences (Turaga et al., 2010). Notwithstanding the difficulty in establishing a causal link between education and pro-environmental behaviour (Vicente-Molina et al., 2013; Zsóka et al., 2013), this study was premised on the proposition that Sustainability Education provides learning experiences that may alter student worldviews, attitudes and some types of environmental behaviour such as recycling and energy saving (Raymond et al., 2011; Steg et al., 2014; Turaga et al., 2010).

Accordingly, the study was informed by a conceptual framework that combined theories in environmental psychology and education. The study was guided by an established model of environmental behaviour, the Values Belief Norm (VBN) model (Stern, 2000), though not in a strictly linear fashion. The gap between environmental knowledge/awareness and pro-environmental behaviour is well known (Kollmuss and Agyeman, 2010) and a change in attitudes may not necessarily lead to changes in behaviour due to a variety of situational/contextual constraints, lack of information, psychological barriers, or lack of skills (Griswold, 2007).

The VBN model was chosen because it offered a comprehensive framework that conceptualised the influence of peoples' values, beliefs and situational factors on their pro-environmental behaviour. The model links value theory, specifically environmental worldviews, to beliefs, to norms/norm-activation theory and to environmental behaviour. It indicates possible points of influence by Sustainability Education on students' beliefs and potentially on their behaviour. In this study, the constructs of environmental worldviews were measured by the Inclusion of Nature in Self (INS) scale (Schultz, 2001) and beliefs were measured by the NEP

scale (Dunlap et al., 2000). These scales are reliable and validated instruments, commonly used in research studies in environmental psychology and education and both are outlined further in the next section.

4 Research Methods

4.1 Context for the study

This study builds on a Pilot Education for Sustainability study conducted in Australia in 2011, where tertiary educators investigated the influence of an introductory sustainability seminar and regular curricular interventions on students' pre-post knowledge and views about sustainability. Results showed students held different initial sustainability perspectives and responded differently to the same treatment (intervention) based on their gender, age, home region (culture) and level of study (Sidiropoulos et al., 2013). Findings were presented at the 2012 Australian Association for Environmental Education (AAEE) conference and a subsequent call was made across various channels inviting HEIs to participate in a wider study. Nine institutions from Australia, Malaysia and Italy participated in a wider study during 2013-2015. Ethical approval was obtained from the host institution CQUniversity, with reciprocal approval granted by all participating universities.

4.2 Survey design and methodology

The survey was developed by a consensus of staff at various participating institutions. It consisted of open and closed questions to determine students' worldviews, attitudes and behaviour towards sustainability and to assess the influence of demographic, academic and situational factors. Participants were asked about the importance of sustainability to their programme, their profession and their everyday lives: responses were scored as Unimportant (1), Slightly Unimportant (2), Don't Know (3), Slightly Important (4) and Very Important (5). The relationship with nature was assessed through several scales (INS, NEP). Self-reported behaviour was measured through statements on the frequency of personal self-reported actions for sustainability, with each item scored as Never=1, Rarely=2, Occasionally=3, Often=4, Always=5. Information was collected on demographic (age, gender, home region), educational (discipline of study, level of study) and situational characteristics (country of study, years in study country, mode of study). Pre and post surveys consisted of the same questions to enable comparisons over time. In addition, the post-test survey included a question on whether students experienced any cognitive changes in their views or perspectives about sustainability and the environment during the term.

4.2.1 Scales of environmental attitudes and worldview

The NEP scale is the most widely used measure (Dunlap, 2008) of an individual's value-based environmental worldview/attitudes towards the environment. It is widely acknowledged as one of the most reliable multi-item to measure peoples beliefs about the natural world in quantitative research (Lundmark, 2007). The scale was developed to measure endorsement of a coherent cognitive structure along a spectrum from an ecological view (ecocentrism), where humans are viewed as part of nature to a human dominant view (anthropocentrism), where humans are viewed as rulers of nature (Kopnina, 2011). The former view reflects the Dominant Social Paradigm (DSP) of individualism, free enterprise, endless progress, growth, abundance, confidence in science, and one that is contributing to environmental degradation, while the latter reflects the New Ecological Paradigm with nature a limited resource, delicately balanced and adversely affected by modern industrialised societies.

Ecocentric concerns center on the intrinsic value of plants and animals while anthropocentric concerns focus on the utilitarian value of nature for the benefit of humans (Schultz et al., 2000). The NEP scale contains 15 items rated on a 5-point Likert scale (strongly agree, mildly agree, unsure, mildly disagree, strongly disagree): each item is scored on a scale of 1–5, with the highest value corresponding to the most ecocentric response. The eight odd-numbered items indicate a pro-ecological view and seven even-numbered items indicate a pro-anthropocentric view. The NEP scale comprises five facets of an ecological worldview: limits to growth, based on constraints of nature; anti-anthropocentrism, is a rejection of human domination over nature; balance of nature, is the fragility and susceptibility of ecosystems to human interference; anti-exemptionalism, is a rejection of humans being exempt from constraints of nature; and eco-crisis, is the damage of human interference.

The NEP is not without its critics. Previous studies showed mixed results in terms of cross-cultural validity of NEP with lower levels of internal consistency in China, Latin American and Eastern European countries, suggesting it was not always translatable outside Western countries (Erdoğan, 2009; Kopnina, 2011). The main reason is the DSP and NEP were conceptualised in the United States and studies in Western countries supported a polarisation between anthropocentric and ecocentric worldviews. However, this polarisation is not universal and other studies suggest some integration of these two worldviews. Corral-Verdugo et al. (2008) showed the ecocentric view is compatible with anthropocentric beliefs in some cultures, as borne out by studies of Brazilian, Japanese and Mexican participants, and they suggest a conciliation of the eco-anthropocentric dichotomy. Dunlap et al. (2000) acknowledged variability of environmental perceptions in different contexts and suggested NEP be used as a multidimensional tool, to document variation in the structure and coherence of an ecological worldview across different cultures/contexts and any changes over time. Despite its shortcomings, using NEP as a single measure remains the "gold-standard" measure of environmental concern (Hawcroft and Milfont, 2010).

In this study, a range of aggregate NEP scores were used and complemented by two other indicators of an individual's relationship to nature. Students' connectedness to nature was measured by the 'inclusion of nature in the self' (INS) scale, which indicates 'the extent to which an individual includes nature within his/her cognitive representation of self' (Schultz, 2002). The scale consists of seven pairs of circles and respondents are asked to choose the pair that best represents the connection between their "self" and "nature". The INS scale is shown in Figure 1 with scoring ranging from A=1 to G=7.

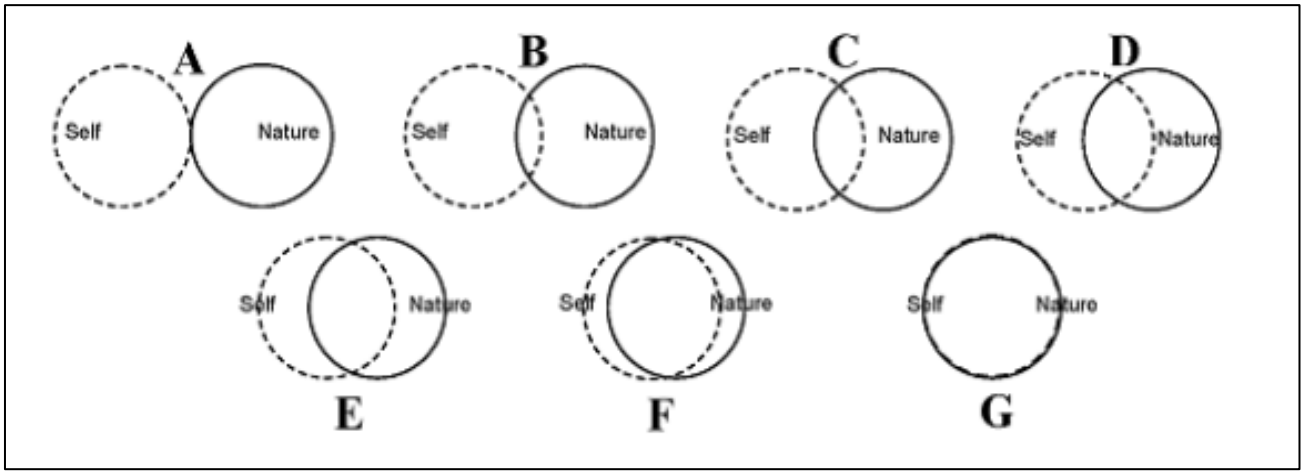

Figure 1. Degrees of interconnectedness with nature (INS; Schultz, 2002),

Students' relationship with the natural environment in terms of hierarchy (dominance) was also explored in a Hierarchy with Nature (HWN) scale, as proposed by the researchers (Sidiropoulos et al., 2014) and shown in Figure 2. Responses were scored for each set of circles from "nature-within-self" =1 (A), "nature-equal-self" = 2 (B) and "self-within-nature" =3 (C).

Figure 2. Hierarchy with Nature (HWN) scale

4.3 Sample selection

A quasi-experimental design was adopted (Steckler et al., 1992) with convenience sampling used to provide a wide representation of courses, disciplines and locations. Courses were included from a range of disciplines (engineering, architecture, business, sports medicine, health, biological sciences, education, etc.), modes of study, locations/countries, and also covered a range of approaches to SE. Malaysia and Italy were included in the

study as their students were enrolled in Architecture & Engineering courses that were included in Australia. This allowed for a comparison of responses within a particular discipline across different geographic contexts. Course coordinators allocated their units either to an "intervention" or "control" cohort based on course content: students in intervention groups were exposed to sustainability concepts that represented at least 10 percent of course content and/or assessment, while control groups had no element of sustainability. In most locations, samples were drawn across comparable "intervention" and "control" cohorts preferably within the same programme of study, although this was not always possible. Overall, the intervention cohort was representative of the "ad hoc" or laissez-faire approach to SE in HE (Leal Filho, 2014; Lozano et al., 2014a).

4.4 Data collection and statistical analysis

Data was collected online with Survey Monkey using the pre and post-test surveys at the beginning and end of term. Students were assured of their confidentiality and anonymity and participated voluntarily, so responses were genuine. Survey Monkey used batches of student emails to generate a confidential web link for each student. Computer generated matching processes were then employed across 18 data sets from 7 institutions to match pre and post-test responses, thus maintaining the integrity of anonymity and confidentiality of data at all times. The full dataset comprised 1,449 unique responses: 810 were pre-test only (Stage 1), 210 were post-test only (Stage 2) and 429 were matched pre-test and post-test (Stages 1 & 2). Cross sectional analyses were conducted on data from pre-test only (Stage 1) and matched pre-post responses (Stages 1 & 2), while longitudinal analyses were performed on matched pre-post responses (Stages 1 & 2).

Exploratory data analysis was conducted to investigate the data in terms of consistency, normality, skewness, kurtosis, missing values, etc. The incidence of missing values ranged from 14 to 24 percent for individual items in cross sectional data while in longitudinal data, the range was 7.5-12 percent for pre-test and 7-9 percent for post-test responses. Scores for aggregate and average measures of NEP and overall self-reported behaviour were calculated only if 80%+ of individual items were answered with missing data not replaced by means. This was due to the level of missing values from within individual responses and the wide variability of responses between participants. This approach was considered more robust and expected to provide more reliable results (Pallant, 2016). In total, around 20 percent of cases were excluded from the cross-sectional sample. For the longitudinal sample, 11 percent were excluded in the pre-test data and 7 percent in the post-test data.

Statistical analyses were performed with the use of SPSS v22 for WINDOWS (SPPSS Inc., Chicago, IL). Quantitative data analyses comprised descriptive and inferential statistics including a variety of parametric and non-parametric tests as required by normality of the data. Tests included correlations, t tests, analysis of variance, analysis of covariance and non-parametric tests (Chi-squared, Wilcoxon Signed-Rank tests, Mann-Whitney U tests). All tests were examined for significance at P values of alpha = .05. Post–hoc comparisons between groups were made using Tukey's HSD test for equal variances or Games-Howell test for unequal variances (Pallant, 2016). Reliability of various NEP scales were tested using Cronbach's alpha, where 0.7 indicated an acceptable value and Cohen's standard was used to evaluate the strength of relationships, or effect size (Pallant, 2016).

Pre-test data was analysed cross-sectionally to investigate students' baseline worldviews, attitudes and behaviour and to assess the influence of demographic, educational and situational factors. Matched pre-post data was analysed longitudinally to investigate changes in student perspectives over the term and to assess the influence of SE and demographic, educational and situational factors.

4.5 Limitations

Methodological limitations of this study relate to the representativeness of the sample and the generalisability of results, as follows:

- Lack of comparability in disciplines (except Architecture & Engineering) across the three countries;
- Lack of comparability in levels of study across disciplines;
- Lack of comparability in treatment groups (intervention and control) across institutions;
- Self-selection bias in respondents who completed the survey on-line;

- Variable student response rates across courses, levels and locations (2 to 75% in matched data); and
- Highly variable rate of missing values across dependent variable scores.

As with other educational research studies, this study was constrained by the nature of students that were accessible and the distribution of potentially confounding characteristics across the sample (Tolmie et al., 2011). Further, results reported here refer to quantitative analyses, which do not always capture the nuances of subtle changes in students' sustainability perspectives. Analysis using mixed/merged methods is preferred to "qualify" the results and provide greater depth and insights into student learning for sustainability (forthcoming paper).

Notwithstanding these limitations, the study encompassed several disciplines, levels and modes of study across a range of countries, providing a large sample size (1,239 respondents) that made it possible to conduct both descriptive and inferential statistical analysis and draw some general conclusions. While small sample sizes in some disciplines and self-selection bias limited the ability to draw strong inferences on the influence of SE in all settings, the study provided some useful insights.

5 Results and Discussion

5.1 Cross–sectional analysis of pre-test data

5.1.1 Description of the sample

The cross-sectional sample (N=1,239) was drawn from Australia (86%), Italy (10%) and Malaysia (4%). Table 1 shows the educational composition of the sample by "treatment" group in terms of discipline, level and mode of study. Courses were categorised into five broad discipline groups with some imbalance in the sample between control and intervention cohorts across disciplines and countries: Architecture & Engineering was the only discipline represented in all three countries; Arts students were all in intervention units while Education students were all in control units. The sample was also skewed in terms of level of study: Tertiary Preparation (TP) respondents were all located in Australia and enrolled in science (intervention) courses while PhD students were all in Italy in Architecture & Engineering (control) courses.

Table 1. Educational profile of survey participants in the pre-test sample by group

	Type of group*		
	Control	**Intervention**	**Total**
Discipline of Study			
Accounting, Business Management & IT	288	251	539
	52.4%	40.1%	45.8%
Science	154	118	272
	28.0%	18.8%	23.1%
Architecture & Engineering	60	183	243
	10.9%	29.2%	20.7%
Arts	1	70	71
	.2%	11.2%	6.0%
Education	47	4	51
	8.5%	.6%	4.3%
Total	**550 (48.6%)**	**626 (53.2%)**	**1176 (100%)**
	100.0%	**100.0%**	**100.0%**
Level of study			
Tertiary Preparation (TP)	2	18	20
	.4%	2.7%	1.6%
Undergraduate (UG)	400	557	957

	71.4%	84.1%	78.3%
Postgraduate (PG)	139	85	224
	24.8%	12.8%	18.3%
PhD	19	2	21
	3.4%	.3%	1.7%
Total – level of study	**560**	**662**	**1222**
	100.0%	**100.0%**	**100.0%**
Mode of study			
Off campus	165	248	413
	29.5%	37.3%	33.7%
Mixed mode - both	6	18	24
	1.1%	2.7%	2.0%
On Campus	388	399	787
	69.4%	60.0%	64.3%
Total – mode of study	**559**	**665**	**1224**
	100.0%	**100.0%**	**100.0%**
* Differences in the totals for each variable within each group reflect the number of students who provided information			

Table 2 shows the demographic profile of respondents by treatment group in terms of age, gender and home region. Gender distribution was typical of distance (off-campus) enrolments, particularly in regional universities (such as CQUniversity and USQ) in Australia although gender was more evenly balanced for cohorts in Italy and Malaysia. Main country of residence, i.e., where students lived most of their life, was used as a proxy for home culture, with countries grouped into regions of similar values according to the World Values Survey (WVS). The WVS showed a pronounced culture zone pattern where countries with similar cultures (grouped as English speaking, Confucian, Islamic, Latin American, etc.,) clustered around key values associated with sustainability such as universalism and self-expression (Inglehart and Welzel, 2010).

Discipline of study was skewed across regions with Accounting, Business Management and IT accounting for almost all students from North Asia, the Subcontinent and Latin America. Age distribution was skewed with almost all respondents under 18 years of age being from Anglo-Saxon countries, while all PhDs were from EU.

Table 2. Demographic profile of survey participants in the pre-test sample by group

	Type of group*		
	Control	**Intervention**	**Total**
Age group			
Less than 18 years	32	18	50
	7.3%	3.5%	5.3%
18-24 years	179	246	425
	41.1%	48.0%	44.8%
25 - 40 years	193	170	363
	44.3%	33.1%	38.3%
More than 40 years	32	79	111
	7.3%	15.4%	11.7%
Total	**436**	**513**	**949**
	100.0%	**100.0%**	**100.0%**
Gender			
Male	167	213	**380**
	33.1%	36.3%	34.8%

Female	338	373	**711**
	66.9%	63.7%	65.2%
Total	**505**	**586**	**1091**
	100.0%	**100.0%**	**100.0%**
Home Region - main country of residence			
Australia, NZ, UK, USA, Canada	212	312	524
	49.3%	61.4%	55.9%
North Asia (China, Taiwan, Vietnam, South Korea, Hong Kong, Japan)	73	43	116
	17.0%	8.5%	12.4%
European Union	50	63	113
	11.6%	12.4%	12.0%
Subcontinent (India, Pakistan, Nepal, Bangladesh, Sri Lanka)	42	27	69
	9.8%	5.3%	7.4%
South Asia (Malaysia, Indonesia, The Philippines, Singapore, Thailand)	23	39	62
	5.3%	7.7%	6.6%
Africa, Middle East	16	16	32
	3.7%	3.1%	3.4%
Latin America	7	5	12
	1.6%	1.0%	1.3%
Other (Russia, Belarus, Pacific Islands, PNG)	7	3	10
	1.6%	.6%	1.1%
Total – Main country of residence	**430**	**508**	**938**
	100.0%	**100.0%**	**100.0%**
* Differences in totals for each variable within each group reflect the number of students who provided information			

5.1.2 Findings of cross sectional analysis

Students' sustainability perspectives are presented in three sections, namely their worldviews/attitudes, self-reported behaviours and the relationship between worldviews/attitudes and self-reported behaviours. Table 3 presents a summary of significant effects of demographic, educational and situational factors on various scores with differences between groups represented by a tick.

Table 3. Significant differences in mean scores between groups (factors) in the pre-test sample

Factors SCORES	Group	Gender	Age	Home region	Level of Study	Discipline of study	Country of study	Years in study country	Mode of study
Average NEP	√**	√**	√**	√**	√**	√**	√*	√**	√**
INS			√**	√*	√**			√*	
HWN			√**		√*	√*			
NEP- Limits	√**		√**	√**	√*	√**	√**		√**
NEP- Dominance	√**	√**	√**	√**	√*	√**	√**	√**	√**

NEP- Balance	√**	√**	√**	√**	√*	√**	√**	√**	√**
NEP-Constraints	√**	√**	√**	√**	√**	√**	√*	√**	√**
NEP-Ecocrisis	√**	√**	√**	√**		√**		√**	√**
Average ECO Orientation	√**	√*	√**	√*		√**			
Average HUMAN Orientation	√**	√**	√**	√**	√**	√**	√**	√**	√**
Importance of sustainability-study programme			√*	√*	√*		√*	√**	√**
Importance of sustainability-profession			√**		√*	√**		√**	√**
Importance of sustainability-everyday life			√**		√*	√*		√*	
Behaviour - total			√**	√**		√**	√**	√**	
A variety of parametric tests were used to compare means including one-way ANOVA t tests (normal data), as well as non-parametric tests such as Kruskal-Wallis and Mann-Whitney U Test (skewed data)									
√*Sig at 0.05 level, √**Sig at 0.01									

1. *Worldviews and attitudes*

a. *Importance of sustainability, INS and HWN*

Students rated the importance of sustainability to their study programme, profession and everyday lives. For the Architecture & Engineering cohort located in three separate countries, no significant differences were found by country of study for any score of importance of sustainability, although responses varied significantly by age, gender, home region and level of study. For the overall cross-sectional sample, respondents in Australia reported higher scores than in Italy and Malaysia (F=3.246, df=2, p=0.039 with an Eta=0.078) for the importance of sustainability to their study programme. Level of study also influenced scores for the importance to their study programme (F=3.334, df=3, p = .019 with an Eta of 0.01); their profession (F=3.395, df=3, p=.017 with an Eta of 0.01); and everyday lives (F=3.079, df=3, p=0.027 with an Eta of 0.01).

Figure 3 shows responses for the importance of sustainability by discipline of study. Significant differences were detected in importance to their profession (n=991, F=4.016, df=4, p=0.003 with an Eta of 0.127) and everyday lives (n=990, F=2.499, df=4, p=0.041 with an Eta of 0.100) with no differences detected by study programme.

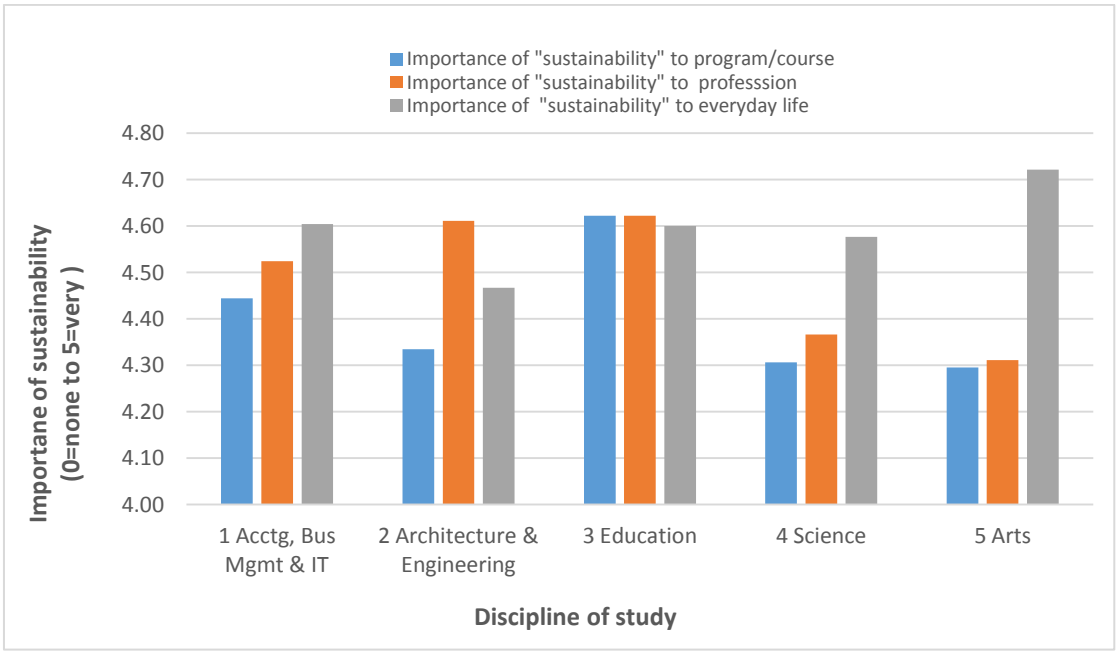

Figure 3 Importance of sustainability scores in the pre-test sample by discipline

Figure 4 shows the distribution of student responses for the personal HWN scale, where A represents the left diagram, B the middle diagram and C the right diagram. The results suggested students generally did not view nature as subordinate to themselves however, the result may differ depending on whether respondents interpreted "self" as relating to them personally or as representing all of humanity.

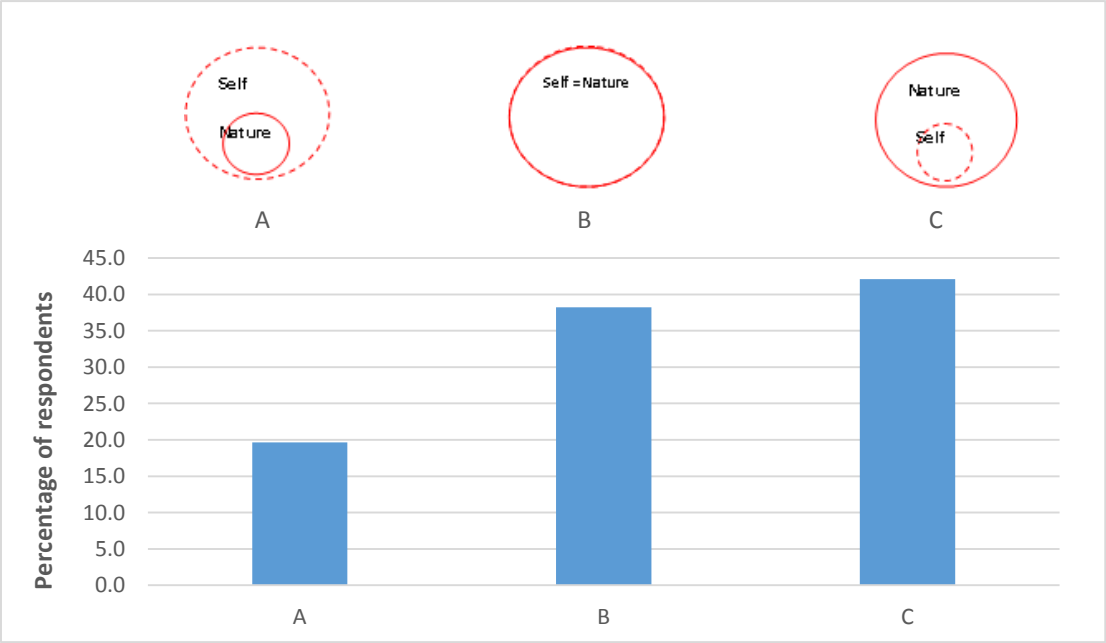

Figure 4. Distribution of personal hierarchy with nature (HWN) scores in the overall pre-test sample

Significant differences in HWN scores were observed by discipline of study (n=881, F=2.696, df=4, p=0.030, eta = 0.110), although no differences were observed in INS scores.

Gender differences were not found for any measure of the importance of sustainability, INS or HWN scores. However, respondents' age group was a significant factor with mean scores for all measures rising with age:

- the importance of sustainability to their study programme (F=3.233, df=3, p=0.022 with an Eta of 0.101), their profession (F=4.319, df=3, p=0.005 with an Eta of 0.117) and everyday lives (F=7.687, df=3, p=0.000 with an Eta of 0.156);
- the INS score (F=4.851, df=3, p=0.002 with an Eta of 0.125); and
- the HWN score (F=4.822, df=3, p=0.002 with an Eta of 0.127).

Home region (culture) also revealed significant differences for the importance of sustainability to their programme (F=2.448, df=7, Eta2=.018) and for INS scores (F=2.178, df=7, p=0.034 with an Eta of 0.117).

b. NEP scores

Table 4 presents results of nine types of NEP scores and related Cronbach's alpha scores across the pre-test sample. Given the high incidence of missing data for individual NEP items, aggregate scores for Total NEP, ECO orientation and HUMAN orientation were used to calculate Cronbach's alpha scores and not for further analysis.

Table 4. Mean scores for various NEP measures and Cronbach's reliability scores in the pre-test sample

	Total NEP	Average NEP	LTG Limits	AA Dominance	BN Balance	AE Constraints	Eco-Crisis	ECO orientation	HUMAN orientation
Pre-test (mean)	53.63	3.61	3.24	3.78	3.83	3.40	3.78	32.05 (4.05)	21.69 (3.10)

	SD n	8.21 966	0.54 966	0.76 968	0.88 968	0.70 966	0.72 968	0.78 964	4.88 957	5.72 968
	Cronbach's Alpha	0.776	-	0.374	0.624	0.366	0.356	0.513	0.744	0.789
	Total sample (n=1239), Intervention (n=586), Control (n=505)									

Student environmental attitudes were not polarised between ecocentric and anthropocentric orientations. Instead, views were jointly strong in ECO (4.01) and HUMAN (3.10) orientation that represented an "instrumental" or "utilitarian" view, with nature valued in terms of benefits to humans. Cronbach's alpha scores for reliability of the total NEP scale (0.776) and for ecocentric (0.744) and anthropocentric (0.789) orientations confirmed the strong 'utilitarian" view. This view was also reflected in Cronbach's alpha scores for each of the five dimensions of NEP where views were strongly aligned with Anti-Anthropocentrism or Dominance (0.624) and Eco-Crisis (0.513) but there was much less coherence for Limits to Growth (0.374), Balance of Nature (0.366), and Anti-Exemptionalism or Constraints (0.356). This finding contradicted the claim of a shift in the SD discourse from an anthropocentric to a more ecocentric worldview (Baker, 2006). Instead, it revealed a convergence characterised by an increased sensitivity to environmental damage and a growing confidence in human ingenuity to overcome environmental limits or constraints. The finding concurred with the earlier pilot study (Sidiropoulos et al., 2013) and confirmed other research reporting a growing 'anthropocentric environmentalist' or 'utilitarian' view in students around the world (Bechtel et al., 2006; Corral-Verdugo et al., 2008; Dervisoglu, 2010; Erdogan, 2013; Erdoğan, 2009; Kuo and Jackson, 2014; Teisl et al., 2011), and particularly in developing/transitional economies.

Gender

Gender had a pervasive effect across several demographic and educational contexts. Females reported significantly higher scores for Average NEP (M = 3.68, SD = 0.53, n=607) than males (M = 3.48, SD = 0.53, n= 345), F(1,951) = 31.22, p=0.000. Gender differences were most pronounced in the Average HUMAN Orientation score for females (M = 3.22, SD = 0.81) compared to males (M = 2.89, SD = 0.78); F(1,952) = 36.58, p = .000) although the effect was small (Eta2= .04) (Pallant, 2016). The same pattern was observed for all NEP dimensions and most behaviour items. It was evident across age groups (except under 18 years) and discipline groups (except the control cohort in science) but not in different cultures. These findings confirmed studies of marked gender differences in pro-environmental stance and behaviour (Dijkstra and Goedhart, 2012; Erdogan, 2013).

Age

Respondents aged over 40 years had significantly (p< .005) higher scores than all other age groups for Average NEP scores and for all NEP dimensions. Significant differences in Average NEP scores were found across age groups, F (3,943) = 23.95, p = .000) with a moderate effect (Eta2= .07). The overall results revealed a notable dip in Average NEP scores for early/young adults (18-24 years) as shown in Figure 5. Post-hoc comparisons showed scores for students aged 18-24 years (M = 3.51, SD = 0.52) was significantly lower than in the 25-40 years group (M = 3.61, SD = 0.51) and people over 40 years (M = 3.98, SD = 0.57), but not different from students under 18 years (M = 3.63, SD = 0.52). The same dip pattern was observed in the Average HUMAN Orientation score but not the Average ECO Orientation or INS scores, both of which increased progressively with age.

This dip in scores may reflect the nature of the sample with a high proportion of North Asian students (lowest NEP scores) in the 18-24 years group and a high proportion of females (highest scores) in the under 18 group. Another possibility is that it may be symptomatic of a more widespread "early adult dip", akin to the "adolescent dip" found in 14-16 year olds (Olsson and Gericke, 2016). It could represent a "life cycle" or "stage of life" effect (Arnett, 2000) where young adults are emerging into adulthood and navigating great change (Rindfuss, 1991; Wallace, 1995) and possibly less concerned with environmental and social issues. However, cross-national studies have indicated such a life stage is more pronounced in countries with strong individualistic cultures compared to collectivist cultures (Arnett, 2000). Alternatively, the "dip" may reflect the on-going influence of

the DSP on undergraduate education and the development of more pro-anthropocentric views. For tertiary educators, it is potentially a time of great influence as emerging adults undergo changes in their worldviews (Perry, 1999) and they obtain the knowledge and skills for their future careers. Providing targeted and differentiated SE could effectively engage young adults during this formative stage and build their competencies.

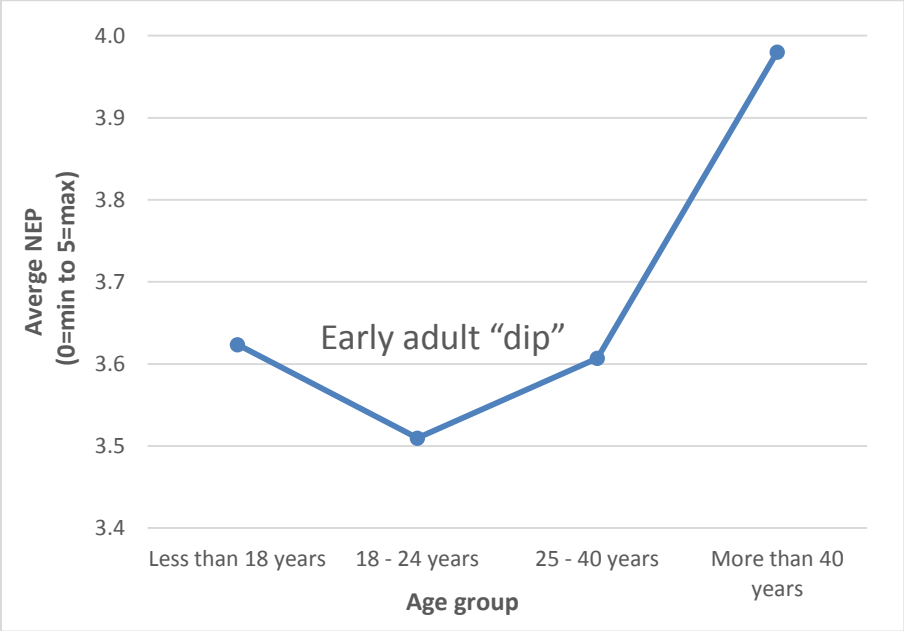

Figure 5. Mean scores of Average NEP in the pre-test sample by age

Home region

Table 5 presents Average NEP scores by home region, which varied significantly: Welch adjusted statistic F(7, 79.43) = 26.822, p = .000. Post-hoc comparisons showed students from Anglo-Saxon countries reported significantly higher scores than all other groups except the EU and Latin America. Respondents from the EU also reported significantly higher scores than those from North Asia, South Asia and the Indian Subcontinent.

Table 5. Descriptive statistics for Average NEP scores in the pre-test sample by home region

Average NEP						
Home region	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**	
					Lower Bound	**Upper Bound**
Africa, Middle East	32	3.3958	.51777	.09153	3.2092	3.5825
Australia, New Zealand, UK, USA, Canada	524	3.7572	.58773	.02568	3.7068	3.8077
European Union	111	3.6512	.32858	.03119	3.5894	3.7130
Latin America	12	3.6778	.43096	.12441	3.4040	3.9516
North Asia	116	3.2460	.34225	.03178	3.1830	3.3089
South Asia	62	3.3624	.42860	.05443	3.2535	3.4712
Subcontinent	69	3.3930	.33972	.04090	3.3114	3.4746
Other	10	3.5200	.39353	.12444	3.2385	3.8015

Total	**936**	**3.6124**	**.53973**	**.01764**	**3.5778**	**3.6470**

Findings confirmed results from the earlier pilot study (Sidiropoulos et al., 2013) and elsewhere (Dunlap, 2016; Inglehart and Welzel, 2010; Schwartz, 2007; Soyez, 2012) and reaffirmed the influence of national context and cultural background in shaping students sustainability perspectives, highlighting the importance of adopting a more nuanced and tailored approach to SE.

Discipline of study

Table 6 presents Average NEP scores by discipline of study, which exerted a significant effect: Welch adjusted statistic F (4, 168.06) = 26.57, p = .000.

Table 6. Descriptive statistics for Average NEP scores in the pre-test sample by discipline of study

Average NEP						
Discipline of study	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**	
					Lower Bound	**Upper Bound**
Accounting, Business Mgmt. & IT	416	3.4196	.50823	.02492	3.3706	3.4685
Architecture & Engineering	192	3.5909	.39486	.02850	3.5347	3.6472
Education	36	3.7463	.37807	.06301	3.6184	3.8742
Science	214	3.8370	.57431	.03926	3.7596	3.9144
Arts	57	3.8515	.50866	.06737	3.7165	3.9864
Total	**915**	**3.5929**	**.52988**	**.01752**	**3.5585**	**3.6273**

Students in Arts, Science and Education disciplines recorded significantly higher scores than those in Accounting, Business Management & IT or Architecture & Engineering. These findings confirmed previous research of lower scores for Business students (Lang, 2011) and Engineering students (Kuo and Jackson, 2014) compared to other majors. To investigate further, the cross-sectional sample was analysed by individual discipline to investigate any differences in average scores for NEP, ECO and HUMAN orientation. Results showed remarkable consistency within certain disciplines (Education and Arts) reflecting greater homogeneity despite differences in gender and age. Conversely, respondents in Business, in Science and in Architecture & Engineering held more divergent views within their disciplines, with scores influenced by demographic factors of age, gender and home region.

Several explanations can be offered for these observed differences. The course content could be shaping student perceptions over time, or it may indicate a pre-existing bias towards technological solutions and the moral right of humans to manipulate their environment (Teisl et al., 2011). Beliefs are reinforced by the epistemological and ontological assumptions of particular disciplines and lead to divergent conceptualisations of "sustainability" (Christie et al., 2014; Fisher and McAdams, 2015; Sylvestre et al., 2013; Wiek et al., 2011). Indeed, "epistemological silos" have at times, obfuscated the role of values and cognitive aims of knowledge production, whether intentionally or not (Miller et al., 2008). Alternatively, different scores for Average NEP by discipline may simply have reflected students' personality (Lang, 2011) where choice of discipline resonated with students personal values. However, there are limits to the assertion that personal preferences are revealed in free choice, as this is largely a characteristic of liberal democracies and not as prevalent in traditional collectivist societies, where students are more influenced by family priorities (Bomhoff and Gu, 2012). This consideration may have influenced many international students in the sample. Also, longitudinal studies showed that personality accounted for a small part of differences in environmental worldviews or changes in views after SE (Boeve-de Pauw et al., 2011), so discipline and other "cultural" factors remained significant influences. In summary, the relative influence of personality, culture and discipline and their contemporaneous effects remain largely unknown.

Level of study

Table 7 presents Average NEP scores by level of study, which had a significant effect between groups: Welch adjusted static F(3, 41.66) = 8.30, p = .000. Post-hoc comparisons show scores for undergraduate students were significantly higher (p = .00) than postgraduate students. However, the apparent decline in Average NEP scores with increasing levels of study should be interpreted with caution, given the skewness in the data sample. No significant differences were found within any discipline, suggesting these differences could reflect other factors.

Table 7. Descriptive statistics for Average NEP scores in the pre-test sample by level of study

Average NEP						
Level of Study	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**	
					Lower Bound	**Upper Bound**
Tertiary Preparation (TP)	15	3.6844	.82210	.21227	3.2292	4.1397
Undergraduate (UG)	746	3.6453	.55068	.02016	3.6057	3.6849
Postgraduate (PG)	171	3.4513	.43359	.03316	3.3858	3.5167
PhD	19	3.5527	.23686	.05434	3.4385	3.6669
Total	**951**	**3.6092**	**.53679**	**.01741**	**3.5750**	**3.6433**

Treatment group

There were significant differences in Average NEP scores between treatment groups: Welch adjusted static F(1, 963.6) = 30.61, p = .000. Students in the "Intervention" group reported significantly higher scores (M = 3.69, SD = 0.562) than their counterparts in "Control" (M = 3.51, SD = 0.487). This was somewhat surprising because in most disciplines, students in intervention and control groups were enrolled in the same programme of study. Moreover, most Intervention units in Business and in Engineering & Architecture were compulsory units and not always freely chosen by students. To investigate further, a full range of ANOVA one-way tests were conducted for each individual discipline by Group. As expected, there was no difference in Average NEP scores between cohorts in Architecture & Engineering. However, differences were observed between groups in Business and in Science. Within Science, the strongest influence on scores in the Intervention group was the higher mean scores for respondents in "Sustainability-focussed" units (particularly Average ECO Orientation) compared to other science students. Within the Business discipline, scores in the Control cohort were consistently lower across gender, age, and home region except for students from South Asia, Latin America and the Indian Subcontinent whose scores were higher than the Intervention group. This finding supported the contention that scores for the two cohorts did not always represent students with inherently different environment views/attitudes.

The significance of such variability in sustainability perspectives in the pre-test sample indicated the importance of the personal, situational and educational context in any given learning setting. The importance of context is explored further in Section 5.2, which reports the comparative effects of regular tertiary education and SE.

2. *Personal self-reported behaviours*

The list of personal self-reported actions for sustainability and the environment is summarised in Table 8.

Table 8. Personal self-reported actions for sustainability and the environment

Activity	**Description**
Waste separation	Separate waste and place recyclables (paper, plastics, glass, aluminium, etc.) into recycling bin
Save energy	Save energy by turning off lights and electronic equipment
Grow food	Grow some of your own food
Compost	Compost garden waste and kitchen scraps
Save water	Take shorter showers and/or conserve water by other means

Collect water	Collect and use rainwater
Public transport	Ride your bike or public transport instead of using a car
Nature	Participate in bushwalking or other nature-based outdoor activities
Donate	Donate to social or environmental groups
Volunteer	Volunteer for social or environmental benefit

Figure 6 shows the frequency of 10 individual items of self-reported actions. Participants engaged frequently in low commitment actions such as separating waste (recycling), saving energy and water while high commitment actions such as collecting and reusing water, growing food and composting were undertaken less frequently.

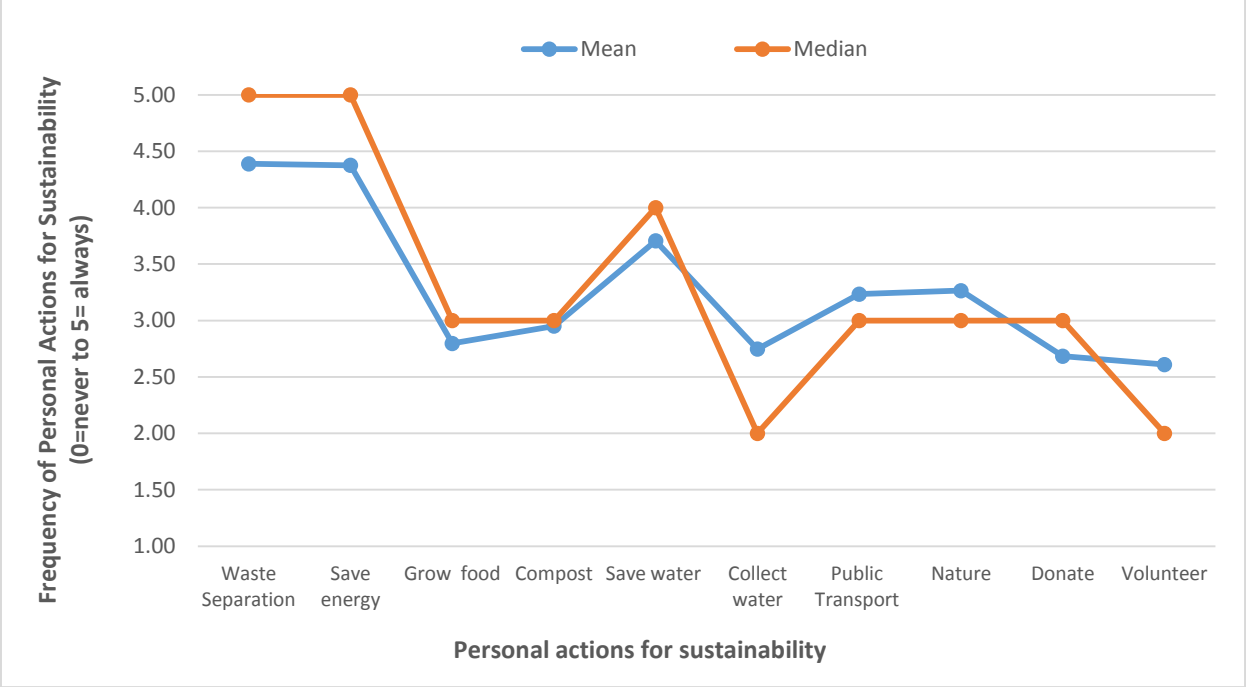

Figure 6. Frequency of self-reported personal actions for sustainability in the pre-test sample

Self-reported sustainability behaviour was analysed by each of the 10 personal actions for sustainability and by the sum of all personal actions for sustainability. The influence of demographic and academic factors was also investigated. Whilst both gender and treatment group exerted significant effects on respondents' attitudes and worldviews, neither translated into significant differences in overall behaviour.

Significant effects on overall self-reported sustainability behaviour scores were as follows:

- demographic factors of **age** (n=946, F=11.047, df=3, p=0.000, eta2=0.034) and **home region** (n=934, F=11.214, df=7, p=0.000, eta2=0.078) shown in Figure 7;
- situational factors of **country of study** (n=991, F=22.457, df=2, p=0.000, eta2=0.047) and **years in the country of study** (n=932, F=7.534, df=3, p=0.000, eta2=0.024); and
- educational factor of **discipline of study** (n=940, F=9.301, df=7, p=0.000, eta2=0.038) shown in Figure 8.

Respondents' age influenced their scores for overall self-reported behaviour and most sustainability actions. Only the group aged over 40 years (M = 36.14, SD = 6.681) was significantly different from other age groups: less than 18 years (M = 32.02, SD = 5.615), 18-24 (M = 31.86, SD = 7.132) and 25-40 (M = 32.58, SD = 7.089).

Home region was the most influential factor on overall sustainability behaviour, as reflected in the highest eta2 value of 0.078. Significant differences were found across all individual self-reported actions and were consistent with cultural patterns observed in previous research (Cotton et al., 2016; Vicente-Molina et al., 2013).

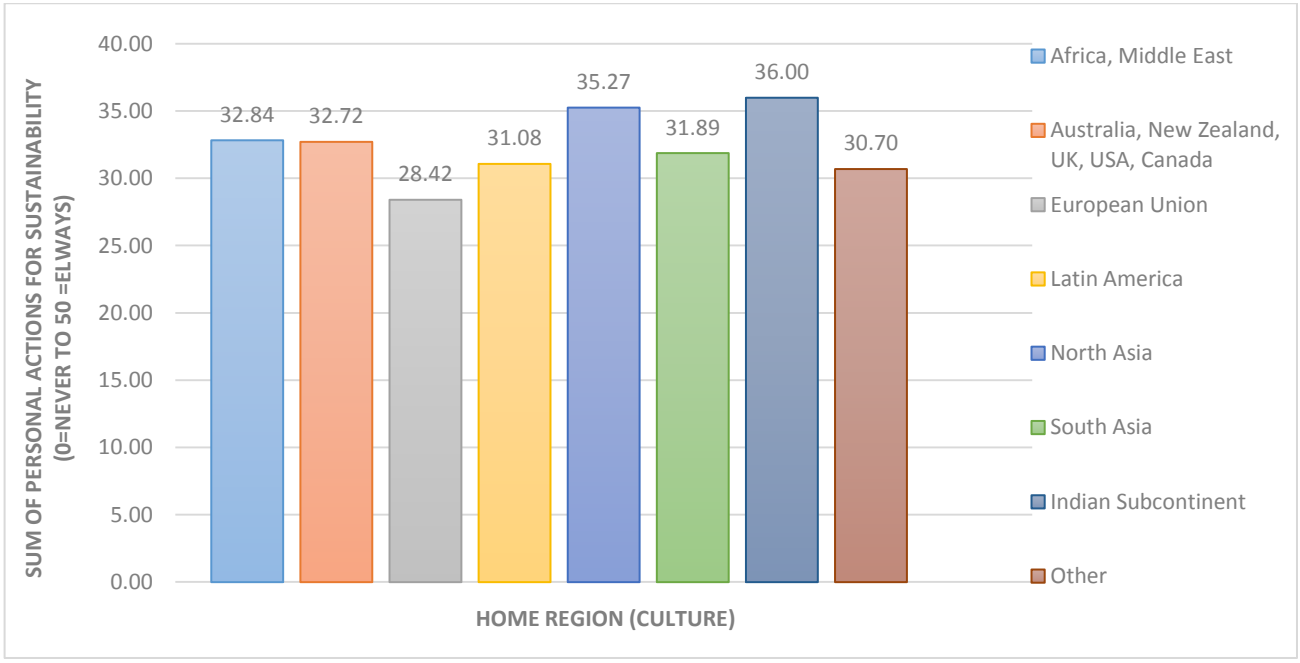

Figure 7. Overall self-reported sustainability behaviour scores in the pre-test sample by home region

Country of study significantly affected scores for overall self-reported behaviour and for most individual items. Post-hoc comparisons indicated respondents in Italy (M = 28.24, SD = 5.634) scored significantly lower than Australia (M = 33.19, SD = 7.005) and Malaysia (M = 32.22, SD = 7.559). This confirmed the pattern for home region and highlights the potential influence of social norms on personal behaviour. Low commitment actions may not be linked to environmental perspectives at all: waste separation and recycling are social norms in Australia according to Roy Morgan Research (2016), while saving water and electricity provide financial benefits.

Discipline of study was found to be significant for overall self-reported behaviour but only between three groups: Architecture & Engineering (M = 29.95, SD = 6.538) was significantly lower than Accounting, Business Management and IT (M = 33.55, SD = 7.284) and Science (M = 32.83, SD = 6.836) groups. The high score for the Accounting, Business Management & IT group could be considered an anomaly given their comparatively low scores for NEP, HWN and importance of sustainability. The apparent disconnection between perspectives and actions towards the environment may reflect moral obligations (Chen, 2016) or possibly a 'social desirability bias' (Milfont, 2009), particularly for the large proportion of North Asian students in the sample (see Figure 8).

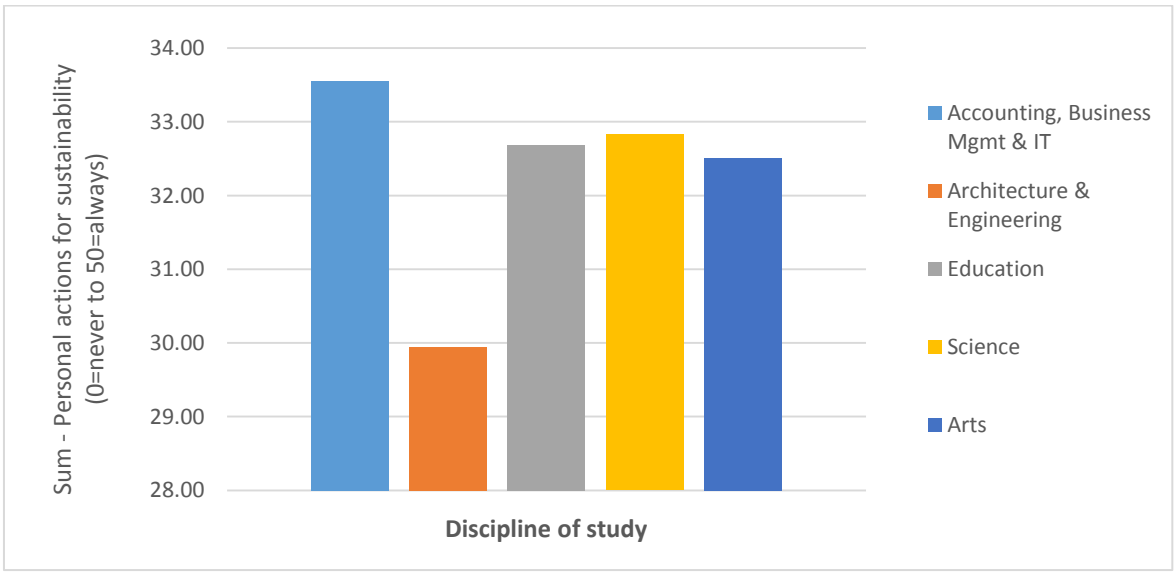

Figure 8. Overall self-reported sustainability behaviour scores in the pre-test sample by discipline of study

3. *Relationship between attitudes and self-reported behaviour*

The relationship between worldviews, attitudes and behaviours was explored using the non-parametric Spearman rho (rank) correlation (Pallant, 2016). Significant correlations were found between attitudes and behaviours as shown in Table 9. The most significant correlations for Overall self-reported behaviour were INS score (9% of total variation), Average Ecocentric orientation (4%) and to a lesser extent, NEP-Limits to Growth. Both INS and Average Ecocentric scores were strongly correlated with high commitment rather than low commitment self-reported actions. No significant correlation was detected between Overall self-reported behaviour and Average NEP, which in turn was weakly correlated with "low commitment" actions.

Table 9. Correlations between sustainability worldviews/attitudes and personal behaviours in pre-test sample

Spearman rho correlations											
	Waste separation	**Save energy**	**Grow food**	**Compost**	**Save water**	**Collect water**	**Public transport**	**Nature**	**Donate**	**Volunteer**	**Overall behaviour**
INS	.156**	.183**	.170**	.173**	.179**		.143**	.236**	.213**	.231**	**.297****
HWN					.082*			.072*	.095**	.084*	.092**
Average NEP	.092**				.120**		-.125**				
Limits to Growth	.070*		.084**	.108**	.131**	.119**		.101**	.135**	.102**	**.144****
Dominance	.087**	.069*		-.082*			-.093**				
Balance of Nature					.092**						
Constraints					.066*		-.191**		-.117**	-.085**	
Eco-crisis	.109**				.085**		-.071*				
Average Ecocentric[1] orientation	.109**	.098**	.112**	.130**	.168**	.110**		.170**	.157**	.125**	.206**
Average Human[2] orientation				-.102**	.066*		-.193**		-.088**	-.064*	
1. Average Ecocentric orientation = mean of odd numbered NEP items 2. Average Human orientation = mean of even-numbered NEP items											
**Correlation is significant at the 0.01 level (2-tailed). *2 Correlation is significant at the 0.05 level (2-tailed).											

These findings confirmed previous research and may reflect a lack of coherence in the development of students' sustainability orientations across their views/attitudes and self-reported behaviours (Kollmuss and Agyeman, 2010; Lozano, 2008; Sammalisto et al., 2016). Another explanation could be the role of contextual norms and norm-activation, as specified in the VBN model used in this study. Subjective norms are influenced in turn by social norms (Ajzen and Fishbein, 2005) and these may have accounted for some of the differences observed between respondents in different social "cultures" as well as different disciplinary "cultures".

5.2 Longitudinal analysis of matched data

5.2.1 Description of overall sample

The longitudinal sample (N=429) was collected from seven institutions in Australia (89%), Italy (9%) and Malaysia (2%). It was similar to the cross-sectional sample in terms of disciplinary composition and distribution, level of study and mode of study, although students in Malaysia were all in intervention courses. Table 10 shows the distribution across discipline groups by treatment group and Table 11 presents demographic characteristics.

Table 10. Discipline of study profile of survey participants in the matched longitudinal sample by group

	Type of group		
	Control	**Intervention**	**Total**
Discipline of Study			
Accounting, Business Mgmt. & IT	105	71	176 (43%)
Science	77	47	124 (30%)

Architecture & Engineering	24	42	66 (16%)
Arts	0	25	25 (6%)
Education	17	2	19 (5%)
Total	**223**	**187**	**410**

Table 11. Demographic profile of survey participants in the matched longitudinal sample by group

	Type of group		
	Control	**Intervention**	**Total**
Age group			
Less than 18 years	12	4	16 (4%)
18-24 years	75	76	151 (40%)
25 - 40 years	91	69	160 (42%)
More than 40 years	16	37	53 (14%)
Total	**194**	**186**	380
Gender			
Male	63	63	126 (31%)
Female	148	133	281 (69%)
Total	**211**	**196**	407
Home Region - main country of residence			
Australia, NZ, UK, USA, Canada	104	129	233 (62%)
European Union	26	16	42 (11%)
North Asia	27	13	40 (11%)
Subcontinent	16	5	21 (6%)
South Asia	7	14	21 (6%)
Africa, Middle East	5	5	10 (3%)
Latin America	5	2	7 (2%)
Other	1	1	2 (1%)
Total	**191**	**185**	**376**

5.2.2 Findings of longitudinal analysis

Changes in respondents' pre-post scores were investigated by key factors. Statistical tests consisted of parametric tests to compare means including paired-sample and one-way ANOVA t tests (normal data), Welch, Brown-Forsythe (heteroskedastic data), as well as non-parametric tests.

1. Overall sample

Table 12 presents a comparison of respondents' pre-test and post-test mean scores for key measures of environmental worldviews and attitudes in the intervention and control cohorts. Results were consistent with cross-sectional analyses with higher initial scores in the intervention cohort. While margins persisted at the end of term, some shifts in direction were also recorded. Scores for AA-Dominance converged lower and the gap in HWN scores narrowed, while those for both AE-constraints and INS widened suggesting some weakening of views in the Control group in the absence of SE. The increase in Cronbach's alpha scores for both cohorts suggested a greater coherence and strengthening of students' worldviews during the term. Overall, student worldviews firmed towards human dominance and exemptions from nature as well as an increased sensitivity to environmental fragility and damage, which confirmed earlier studies (Sidiropoulos et al., 2013; Teisl et al., 2011). A significant and differential rise in the INS score was also observed for the intervention cohort that suggested a greater connectedness to nature after exposure to SE.

Table 12. Comparative mean scores for respondents' pre and post environmental worldviews, by group

Group	Cronbach's Alpha (Total NEP)	Average NEP	LTG limits	AA dominance	BN balance	AE constraints	Eco-Crisis	INS	HWN
		mean[1] (std deviation)	mean[1] (std deviation)	mean[1] (std deviation) (p value)[2]	mean[1] (std deviation) (p value)[2]	mean[1] (std deviation) (p value)[2]	mean[1] (std deviation) (p value)[2]	mean[1] (std deviation) (p value)[2]	mean[1] (std deviation) (p value)[2]
Pre-test Control	0.766	3.56 (0.519)	3.14 (0.719)	3.72 (0.901)	3.78 (0.668)	3.46 (0.704)	3.69 (0.779)	4.57 (1.446)	2.21 (0.781)
Pre-test Intervention	0.798	3.76**[a] (0.546) (p< .0005)	3.44**[a] (0.854) (p< .0005)	3.91*[a] (0.809) (p = .033)	3.97**[a] (0.705) (p = .007)	3.53 (0.742)	3.97**[a] (0.753) (p< .0005)	**4.71** (1.530)	2.31 (0.744)
Post-test Control	0.784	3.54 (0.539)	3.11 (0.741)	3.70 (0.857)	3.76 (0.682)	3.40 (0.726)	3.72 (0.771)	4.47 (1.475)	2.24 (0.796)
Post-test Intervention	0.806	3.78**[b] (0.551) (p< .0005)	3.51**[b] (0.763) (p< .0005)	3.86 (0.846)	3.97**[b] (0.638) (p= .002)	3.57*[b] (0.718) (p= .020)	3.99**[b] (0.749) (p= .001)	**4.93****[b] (1.488) p= .003)	2.28 (0.761)
Control		***No significant changes in any pre & post-test NEP score***							
Intervention		***No significant changes in any pre & post-test NEP, only for INS***							

1. Scale from 1=Anthropocentric view to 5=Ecocentric view
2.*Significant difference between groups at the *0.05 level, **at the 0.01 level, in (Pre)[a] (Post)[b]
Legend: NEP: New Ecological Paradigm, LTG: Limits to Growth, AA: Anti-Anthropocentrism, BN: Balance of Nature, AE: Anti Exemptionalism, CRISIS: Ecocrisis, and INS: Interconnectedness with Nature Scale.

2. *Intervention and Control cohorts*

Key influences on changes in respondents' pre-post mean scores across a range of measures are presented in Table 13, where a tick indicates significant differences between groups.

Table 13. Significant mean differences in respondents' changes in worldviews, attitudes and behaviour for the overall matched sample, by factor

CHANGE IN SCORES	Group (EfS, Control)	Gender	Age	Home region	Level of Study	Discipline	Country of study	Years in study country
Δ Average NEP								√*
Δ INS								√**
Δ HWN								√*
Δ NEP- Limits					√**			
Δ NEP- Dominance								√*
Δ NEP- Balance								
Δ NEP- Constraints								
Δ NEP- Ecocrisis								
Δ Average ECO								
Δ Average HUMAN								
ΔImp-sus- /programme								
Δ Imp-sus-profession						√*		

Δ Imp-sus-life								
Δ Behaviour - total			√*					
Δ Attitude/perception	√**			√*		√**		
*Significant at 0.05 level, **Significant at 0.01 level								

No significant changes were found within the Control and Intervention cohorts. Also, no significant differences were found between changes in the two cohorts for any *single* measure of worldview, attitude or overall behaviour, with one exception. Exposure to SE significantly increased the incidence of a self-reported "Change in perceptions/attitudes to sustainability" compared to respondents in the Control cohort (Mann-Whitney U=16053, z=-3.77, p=0.000 (two-tailed). This cognitive shift was significantly correlated with two additional factors: the importance of sustainability in their everyday life, which suggested an effect of personal motivation/receptivity and the frequency of mentioning sustainability in the course (Fb=2.601, df=4, t=0.037), which suggested an education/pedagogy effect. Thus, SE *did* stimulate cognitive shifts in students' perspectives, albeit not reflected in ANOVA tests for standard quantitative measures/scales.

Outcomes in educational and social research are rarely the result of single causes and there is often confounding and extraneous variation that is not possible to control directly (Tolmie et al., 2011). Given the quasi-experimental nature of the study and the large initial differences between treatment groups (Intervention and Control), a one-way between-groups analysis of covariance (ANCOVA) was conducted using the pre-test score as a covariate to 'control' for the pre-existing differences (Tolmie et al., 2011). Preliminary checks were conducted to ensure that assumptions were not violated regarding normality, linearity, homogeneity of variances, homogeneity of regression slopes and reliable measurement of the covariate (Pallant, 2016). Where assumptions were met, ANCOVA tests were conducted on key NEP measures and overall self-reported behaviour to test for differences between treatment groups. Results are reported in Table 14.

Post-test measure	Pre-test measure	F value	P value	Partial Eta squared	Group	F value	P value	Partial Eta squared
Average NEP	√**	F(1,354) = 547.985	<.0005	.61	√*	F(1,354) = 5.417	.021	.015
NEP- Limits	√**	F(1,356) = 208.558	<.0005	.371	√**	F(1,356) = 10.13,	.002	.028
NEP- Dominance	√**	F(1,356) = 400.702	<.0005	.532	X	F(1,354) = 1.186	.277	.003
NEP-Constraints	√**	F(1,355) = 248.530	<.0005	.414	√*	F(1,355) = 4.938	.027	.014
NEP-Ecocrisis	√**	F(1,355) = 241.086	<.0005	.406	X	F(1,355) = 2.151	.143	.006
Total Behaviour	√**	F(1,365) = 500.691	<.0005	.580	X	F(1,365) = 1.840	.176	.005

Table 14. ANCOVA one-way results of differences between groups using pre-test scores as covariates

The influence of gender, age, home region and discipline on students' sustainability perspectives is well established in the literature and recent research has confirmed their importance as mediating factors on the effectiveness of SE. Accordingly, a series of two-way between-groups analysis of covariance (ANCOVA) were conducted for selected NEP measures. A 2 by 2 between-group (Intervention and Control) ANCOVA was conducted for each dependent variable with each factor: gender, age, home region, discipline and level of study. In each test, the dependent variable was the post-test NEP measure with the pre-test NEP score used as a covariate to control for individual differences.

Significant interaction effects were found for several post-NEP scores between Groups (Intervention and Cohort) and gender, discipline and home region. Specifically, males and females responded differently in Intervention and Control cohorts for Constraints, F(1,355) = 4.917, p = .027, eta2= 0.014, and for Average NEP, F(1,354) = 6.104, p=.014, eta2=.017. The only significant interaction effect between Group and Home region was for the Dominance score, indicating students from different cultures responded differently in the two groups, F(7,352) = 3.036, p = .004, eta2=.060. Students from different disciplines also responded differently between Intervention and Control cohorts for Limits, F(3,340) = 4.296, p = .005, eta2=.038. These differential effects between disciplines confirmed previous studies (Felgendreher and Löfgren, 2017; Fisher and McAdams, 2015; Kuo and Jackson, 2014; Warburton, 2003) and showed that student conceptions of and learning for sustainability were strongly influenced by their exposure to particular messages within academic disciplines.

6 Conclusion and Recommendations

Thirty years after publication of the Brundtland report espousing Sustainable Development and three years after the end of the DESD, it is pertinent to ask how tertiary education is currently contributing to student learning for sustainability. This paper reported the results of a multi-university study, where a series of "snapshots" were taken of student sustainability views, attitudes and self-reported behaviours at the beginning and end of term, during 2013-2015. The purpose was to better understand students' existing sustainability orientations and to evaluate the influence of regular education and sustainability education on students learning for sustainability. The sample was drawn from students enrolled in various disciplines, levels of study and locations in Australia, Italy and Malaysia and was typical of the ad hoc approach to sustainability education in many institutions.

Results from cross sectional analyses showed students initial perceptions/attitudes were characterised by jointly strong ecocentric and anthropocentric orientations that represented "anthropocentric environmentalist" or "utilitarian" views towards sustainability. Significant differences were found between students based on their gender, age, home region ("culture"), discipline and level of study. These differences may pose challenges to tertiary educators in the form of gaps in their understanding and/or receptivity to more holistic and integrative conceptions of sustainability and SD. The study also found signs of an "early adult dip" where students aged 18-25 years held the strongest anthropocentric views. This could present both a hindrance and an opportunity to create a lasting impact on student learning. Tertiary educators are advised to be cognisant of such variability and accurately gauge their students' perspectives before tailoring suitable pedagogy and learning activities.

The study found student views were not consistently expressed in self-reported actions for sustainability, which were dominated by low commitment actions. Higher commitment actions varied by demographic, educational and situational factors and were linked most strongly to their ecocentric orientation and connection to nature.

Results from longitudinal analyses showed that following tertiary education overall, student perspectives converged towards a more moderate or tempered stance between ecocentric and anthropocentric extremes. Exposure to SE, even during one term, often led to minor shifts in students' sustainability perspectives but the incidence and type of change was mixed. Changes were generally expressed as a closer connection to nature, a heightened awareness and concern about human damage to the environment and constraints/limits to growth but also a stronger belief in human ingenuity to solve problems and to overcome these constraints. Thus, SE reinforced an instrumental view of human-nature relations that may lead to incremental improvements and a gradual reform approach towards pro-sustainability values, behaviours and systems but not a transformation. As expected, students' self-reported behaviour was also generally not affected by exposure to SE in one term.

The outcome of SE was found to be an amalgam of the student's personal context (gender and culture) and their learning situation (discipline and level of study). This represented the complex, multi-layered nature of learning for sustainability in tertiary education that made the learning outcome quite uncertain. Students from different disciplinary and cultural traditions may have been exposed to widely different conceptions of SD and possibly lacked an integrated understanding of how to achieve more holistic sustainable outcomes. Students need to appreciate the role of their discipline and profession in contributing to a transition towards a more sustainable future. Educators can effectively build student knowledge and skills by encouraging students to reflect and discuss their own views compared to others and by adopting educational practices that critically review multiple

perspectives and approaches to SD. This study also strongly supports the introduction of generic SD units that complement specific disciplinary approaches and acknowledge and value divergent epistemological perspectives on knowledge and problem solving to build a more holistic and integrative view of SD.

Given the importance of HEIs in shaping and shifting graduate views and capabilities to address and solve sustainability challenges, the results are cause for some concern. Integrating ESD in an ad hoc and largely voluntary manner has produced weak results. Graduates from ad hoc approaches to ESD may lack the values and skills necessary to address acute sustainability challenges or to contribute to significantly more sustainable outcomes, either personally or professionally. This poses a major challenge and necessitates a rethinking from the current ad hoc approach towards a more coherent educational strategy. It is recommended that sustainability education be embedded into every programme (at least ten percent of content and assessment) with the pedagogy tailored to suit the receptivity of students. A structured educational strategy is suggested with repeated exposure to sustainability throughout the programme of study. Sustainability should be woven into each programme to encourage a more critical and creative view of human-nature relations and gradually build student capacity to envisage and create pathways of transition towards transformational change.

This study was subject to several limitations related to the lack of representativeness across intervention and control groups, disciplines and levels of study as well as geographical locations, which limited the generalisability of results. The influence of low response rates, missing values, self-selection bias and small samples sizes also limited the ability to make strong inferences about the impact of SE across a multitude of settings. While it was not possible to generalise results from this study to all HEIs, it did reveal some potentially interesting insights.

The study could be replicated elsewhere to confirm the results and explore generalisability of findings. This type of research could also be extended to other universities ensuring an equivalence of disciplines, levels and modes of study to provide a larger, more balanced sample and allow greater generalisability of results. The apparent "early adult dip" could be investigated further. A complementary line of inquiry into teachers' pedagogies would also provide useful insights to design more effective learning experiences, particularly for young adults and for mixed cohorts of students. Lastly, a mixed/merged research methods approach could provide greater insights into how students experience their learning for sustainability when they report cognitive changes in their views and perspectives resulting from sustainability education, and the main influences on their learning experience.

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