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Education for Sustainability: A Case Study of Pre-service Primary Teachers' Knowledge and Efficacy

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Abstract: This study investigated the relationships between knowledge and efficacy for teaching sustainability in a sample of 266 pre-service primary teachers at a large, metropolitan university in Australia. A survey gathered information about the participant's attitudes and self-efficacy for education for sustainability, along with their perceived and actual knowledge of environmental sustainability issues. The participants typically believed they were confident in their abilities to engage with education for sustainability with self-efficacy increasing with increased levels of perceived knowledge. However no relationship was found between perceived knowledge and actual knowledge which suggests that the participants either do not feel constrained by their lack of knowledge, or are perhaps unaware of their actual knowledge of sustainability issues. This lack of relationship may have implications for the development of pedagogical content knowledge with pre-service teachers potentially developing shallow, tokenistic approaches to Education for Sustainability.

Introduction

Education for Sustainability (EfS) develops the knowledge, skills, values and world views necessary for people to act in ways that contribute to more sustainable patterns of living (Australian Curriculum, Assessment and Reporting Authority (ACARA), 2012). Recent years have seen increasing emphasis on sustainability in education with a series of government initiatives, policy statements and whole school programs (e.g., National Action Plan for Education for Sustainability (Department of Sustainability, Environment, Water, Population and Communities, 2009); Australian Sustainable Schools Initiative (AuSSI) (Department of Sustainability, Environment, Water, Population and Communities, 2010); Queensland Environmentally Sustainable Schools Initiative (QESSI) (Department of Education, Training and Employment, n.d.) and Earth Smart Science Schools (ESS) (Department of Education, Training and Employment, n.d.)). Most recently, sustainability has been identified as a cross-curriculum priority in the Australian Curriculum (ACARA, 2011) and as such, is embedded in all learning areas of school education for students from Foundation to Year 10. The inclusion of EfS in the Australian Curriculum aims to develop student knowledge and understanding of the dynamic systems that underpin life on Earth, student views that recognise the dependence of living things on healthy ecosystems, and foster a future oriented mindset whereby sustainability is achieved through informed individual and community action (ACARA, 2011). The Australian Curriculum is currently enacted in the domains of English, mathematics, Science and History. In these domains, it is expected that sustainability will have a "...strong but varying presence depending on (its) relevance...." (ACARA, 2011).

Increased emphasis on sustainability in the Australian Curriculum presents a range of challenges for pre-service teacher training particularly in the closely related areas of efficacy and content knowledge. Efficacy for teaching has been described as "...the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998, p. 233). Teacher efficacy is understood to be both context and subject specific (Ross, Cousins, & Gadalla,

1996; Siwatu, 2011; Tschannen-Moran et al., 1998) and related to subject specific knowledge. It has been found that pre-service teachers feel more competent when they are confident with the subject knowledge they teach (Shallcross, Spink, Stevenson, & Warrick, 2002; Mansfield & Wood-McConney, 2012). Teacher efficacy has an important influence on teacher motivation, behaviour and effectiveness (Mansfield & Wood-McConney, 2012; Pengergast, Garvis, & Keogh, 2011) and it has been suggested that supporting the development of efficacy in the pre-service years is necessary for producing effective, enthusiastic and committed teachers (Tschannen-Moran & Woolfolk Hoy, 2001).

Efficacy beliefs have been described by Bandura (1986, 1997) as being constructed from four main sources of information: mastery experiences, vicarious experiences, social persuasion and emotional arousal. For pre-service teachers, both mastery and vicarious experiences rely on the provision of positive experiences either as part of the pre-service teacher's course work, observations of experienced teachers in action or through mentored teaching experiences (Mulholland & Wallace, 2001). Unfortunately, pre-service teacher preparation for EfS appears to be rather ad hoc in Australia and internationally (Elshof, 2005; Holden & Hicks, 2006; Spiropoulou, Antonakaki, Kontaxaki & Bouras, 2007). While it is understood that effective EfS requires the understanding of a broad range of trans-disciplinary concepts and themes (DEH 2005; Ferreira, Ryan, Davis, Cavanagh & Thomas, 2009), most pre-service teacher courses have limited or no core environmental or sustainability knowledge or pedagogy embedded in them (Bjorneloo & Nyberg, 2007; Ferreira, Ryan & Tilbury, 2007). In addition, EfS has, in the past, often been seen as falling under the broad umbrellas of studies of society and environment (SOSE) or science (Boon, 2011), with the latter being an area in which primary teachers typically have low efficacy (Howitt, 2007; Masters, 2009; Mansfield & Wood-McConney, 2012).

Bandura (1997) argued that efficacy is especially sensitive to vicarious experience in circumstances where people are inexperienced or uncertain about their own capabilities. While studies have shown that experienced teachers believe that EfS is important (Bjorneloo & Nyberg, 2007; Huckle & Sterling, 1996), there is concern over the level of understanding of sustainability concepts in the teacher population as a whole (Taylor, Kennedy, Jenkins, & Callingham, 2006) with reports of primary teachers appearing to operate at a level of ecological illiteracy (Cutter-McKenzie & Smith, 2003). It is likely therefore, that most pre-service teachers are not being exposed to positive mastery or vicarious experiences related to EfS during their pre-service classroom observations or mentored teaching.

Social persuasion and emotional arousal were also identified by Bandura (1986, 1997) as being important sources of efficacy. Social persuasion and emotional arousal, typically in the form of encouragement from others and the fostering of positive emotions, can influence efficacy for teaching (Mansfield & Wood-McConney, 2012). Given the potential lack of mastery and opportunities for vicarious experiences of EfS for pre-service teachers, social persuasion and emotional arousal may take on additional importance. This hypothesis is supported by the fact that sustainability is an emotive issue for many; while it is hard to argue that encouraging sustainable practices is inherently bad or unimportant, there is much debate about the a degree of 'urgency of action' in addressing sustainability issues (e.g.: Kollmuss & Agyeman, 2002; Maiteny, 2002; Dillahunt, Becker, Mankoff, & Kraut, 2008). Sustainability issues are often presented using highly emotive language, even by eminent academics and hence attracts critics and criticism (e.g., Bandura, 2002; Plimer, 2011). The construction of efficacy for EfS from social and emotional sources, rather than from mastery and vicarious experiences, may lead to a relationship between knowledge and efficacy for EfS that is different to that found in other subject domains. It has been argued that pre-service teachers feel more competent when they are confident with the subject knowledge they teach (Shallcross et al., 2002), however in this case, the pre-service teachers may be willing to engage with EfS due to emotive reasons, even though their content and pedagogical knowledge are lacking.

The relationship between knowledge and efficacy for teachers is complicated by further factors. Firstly, contemporary pre-service teachers, many of whom could be described as 'digital natives' (Prensky, 2005) or members of the 'Millennial' or 'iGeneration' (Pendergast, 2007) are typically well versed in quickly sourcing information from the internet. Pre-service teachers' ability

to have a vast array of information available at their fingertips may make a lack of background knowledge less of a limitation than it was in the past. Secondly, the psychological literature points to only a modest correlation between one's perception of skill and actual performance levels (e.g., Dunning, 2005; Ehrlinger & Dunning, 2003) with studies revealing the potential for a large gap between perceptions and reality, with unskilled persons typically having overly positive beliefs of their own competence while the highly skilled are typically more conservative about their own knowledge and skills (e.g., Kruger & Dunning, 1999; Ehrlinger, Johnson, Banner, Dunning & Kruger, 2007).

Together, the factors outlined above raise questions about the efficacy that pre-service primary teachers may possess in the area of EfS and the relationship between their knowledge of sustainability issues (both real and perceived) and efficacy for teaching about sustainability. This paper presents the findings of an investigation into the knowledge and efficacy for education for sustainability in a sample of pre-service teachers at a large, metropolitan university in Queensland, Australia. This study was part of a wider project to develop a systems-wide framework for embedding learning and teaching of EfS in teacher education. The wider project, funded by a grant from the Australian and Learning Teaching Council (ALTC), now the Office of Learning and Teaching (OLT), sought to develop a state-wide systems case study and multiple institutional case studies that can serve as a model for other Australian states and higher education institutions. The lead author of this paper is a science educator within the School of Education of this university and was new to the field of education for sustainability. As such, his perspective on environment, sustainability, environmental education and education for sustainability has been shaped by his own background and experiences as a science educator. This explains the focus of the survey on ecological environmental perspectives rather than on a broader definition of sustainability that some in the field might be looking for. At the time of the research, the university in question was actively reviewing its pre-service teacher programs to include a greater emphasis on sustainability, in keeping with the increased presence of sustainability as a cross-curriculum priority in the Australian Curriculum, and the inclusion of a sustainability goal as part of the university's mission statement.

Participants

266 pre-service primary education students participated in this study. The participants were recruited from the Bachelor of Education (Primary) and Bachelor of Education (Early Years) courses at the university. The pre-service teacher courses are four years in duration and students from each year level were invited to participate. Table 1 shows the demographic characteristics of the sample (N = 266). The gender balance of the sample was uneven with 229 (86%) female participants compared to 37 (14%) male participants; however this is in keeping with the wider gender balance within the university's School of Education, and the education sector more generally.

	Year of Study			
	1st year	2nd year	3rd year	4th year
N	69	98	68	31
Mean Age (Std Dev) (years)	19.06 (3.77)	21.34 (4.15)	23.02 (6.67)	25.59 (8.64)
Median Age (years)	18	20	20	21
Gender male	10	16	10	1
Gender female	59	82	58	30

Table 1. Pre-service teacher characteristics: specialist areas, gender and age

While it appears that most pre-service teacher courses have limited or no core environmental or sustainability knowledge or pedagogy embedded in them (Bjorneloo & Nyberg, 2007; Ferreira, Ryan & Tilbury, 2007), at this university, the Bachelor of Education (Primary) and Bachelor of Education (Early Years) pre-service teachers all undertake a core, first year science education unit that focuses on the environment and sustainability issues associated with water and water catchments, land use and bush regeneration, plants, weeds and soils. This unit provided the most overt coverage of EfS within the pre-service programs of study and all of the participants in this study had completed this unit.

The Research Instrument

In order to develop a deeper understanding of pre-service teacher's knowledge and efficacy for the teaching of sustainability, the participants in this study were surveyed using an anonymous questionnaire based on the 'Education for Sustainability: Supporting pre-service teachers' survey developed by Boon (2011). The questionnaire included simple demographic questions along with groups of questions exploring the participant's attitude to, and self-efficacy for, EfS as well as their perceived and actual knowledge of environmental sustainability issues. Boon used this instrument to successfully explore the links between pre-service teacher's beliefs and their knowledge of EfS (Boon, 2011); the instrument was published as part of that research. In the case of this study, Boon's instrument was modified by the inclusion of additional demographic questions, minor structural changes and an overall reduction in the number of questions. The modified instrument used in this study is shown in Appendix A.

Boon developed the instrument in light of Ajzen's Theory of Planned Behaviour (Ajzed & Fishbein, 2005) which posits that one's behaviour is influenced by intention, which in turn is influenced by attitude and beliefs. Thus, the first seven questions reflected behaviour (1 and 3), intention (2 and 4) and attitudes (5, 6 and 7). The participants responded to these questions using a five point scale (1 = Strongly Agree, 5 = Strongly Disagree). As part of the validation of the instrument for this research, the first seven items of the questionnaire were subjected to principal components analysis using SPSS version 20. The suitability of the data for factor analysis was assessed prior to the analysis. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was found to be .67, exceeding the recommended value of .6 (Kaiser, 1974). Bartlett's Test of Sphericity (Bartlett, 1954) was found to be significant, which also supported the factorability of the correlation matrix. The principal components analysis revealed a two-component solution which explained a total of 46% of the variance, with component 1 contributing 36% and component 2 contributing 20%. An oblimin rotation was performed and the rotated solution revealed a simple structure, with both components showing a number of strong loadings and all variables loading on only one component (Table 2).

	Component 1	Component 2
Q5. It is important that primary/secondary schools promote education for the environment	.887	-.048
Q7. It is very important to educate school students about our environment from an early age	.871	-.059
Q6. As a teacher I can play an important role in solving environmental problems through teaching	.641	.048
Q3. I have skills and knowledge that would allow me to educate students about the environment	-.056	.820
Q1. I am confident that I can prepare accurate teaching modules about the environment:	-.040	.774
Q4. I am confident and able to include education about our environment in my teaching	.143	.754
Q2. I cannot include education for sustainability in my teaching because it needs to be taught by specially trained teachers	.028	.344

Table 2. Principal components analysis pattern matrix

The interpretation of the two components found that questions 5, 6 and 7 loaded in component 1 and questions 1 to 4 loaded together in component 2. Questions 5, 6 and 7 required the participants to report their perception of how important it is that schools promote EfS and educate students about the environment from an early age. Thus, for the purposes of this study, component 1 was named 'Importance of EfS'. Questions 1 to 4 required the participants to respond to statements related to their confidence for EfS. Note that question 2 was reverse scored. For the purposes of this study, component 2 was named 'Self-efficacy for EfS' and an Aggregated Self-efficacy Score was calculated by summing each participant's responses.

The participants' perceived knowledge of sustainability issues was explored through seven environmental issues (greenhouse gases, nuclear waste, forest clearing, water shortages, climate change, pollution and the extinction of species). The participants were asked to respond to each of these issues using a four point scale (1 = *I have never heard of this issue and would not be able to explain it*, 2 = *I have heard about this but I would not be able to explain what it is really about*, 3 = *I know something about this and could explain the general issue*, 4 = *I am familiar with this and I would be able to explain it well*). Participant scores were summed to form an aggregated score for Perceived Knowledge.

The participants' knowledge of sustainability issues was explored using a series of ten multiple-choice items. The items were included in the instrument as a means of gathering a quick 'snap-shot' of the pre-service teacher's knowledge of a range of sustainability issues. The questions used in this study represent a subset of the questions originally formulated by Boon for inclusion in her 2011 study. Boon's multiple-choice questions were based on subject matter classified under three domains of sustainability education as described by the OECD (2009) (p.20). While Boon's original instrument included 21 questions, she found the length of the survey to be problematic and influenced the return rate of the instrument. For this study, the number of multiple-choice items was reduced to 10. These questions were chosen based on the piloting of the original instrument with a group of pre-service secondary science teachers (N = 16). Questions were rejected on the basis ambiguity, emotiveness, repetition and negative wording. The ten questions reflected a cross-section of environmental sustainability issues such as climate change, water pollution, species extinction, nuclear waste and carbon emissions. In addition, while some of Boon's multiple-choice knowledge questions provided five possible answers, all of the multiple-choice knowledge questions used in this study used a uniform number of four possible answers. These questions were

used to gauge participants' actual knowledge of sustainability issues, with the number of correct answers tallied to give a Measured Knowledge Score.

The internal reliability of the Importance of EfS, Self-efficacy for EfS and Percieved Knowledge scales were checked using Cronbach's alpha (Table 3). Ideally, the alpha scores would be above .7 (DeVellis, 2003) and the scores calculated for the scales in this study were very close to this figure, or exceeded it. It has been noted however, that Cronbach alpha scores are quite sensitive to the number of items in the scale and it has been suggested by Briggs and Cheek (1986) that for scales with a small number of items, it may be more appropriate to report the mean inter-item correlation for the items. Briggs and Cheek (1986) recommend an optimal range of .2 to .4 for the inter-item correlation. The inter-item means are shown in Table 3.

	Alpha	Inter-item mean
Importance of EfS (3 items)	.73	.48
Self-efficacy for EfS (4 items)	.71	.43
Perceived knowledge (7 items)	.85	.45

Table 3. Scale reliability analysis (Cronbach's alpha)

Procedure

Ethical clearance for this study was obtained from the university's Ethical Review Committee in accordance with the National Health and Medical Research Council's Statement on Ethical Conduct in Human Research (2007). The recruitment of participants for this project began with the principal researcher making a short presentation to the four pre-service primary teacher education student cohorts (first to fourth year) at the end of a scheduled lecture. The goals of the study and the nature of the research were explained and the students were invited to participate. The students were also given the opportunity to ask clarifying questions. An information letter and questionnaire was distributed to those who expressed interest in participating. The information letter made it clear that participation was voluntary. Those who wished to participate completed the questionnaire and returned it to a box at the door of the lecture theatre as they departed. To maintain participant anonymity, the principal researcher was not present when students deposited their questionnaire into the box.

The aggregated scores for Self-efficacy, Perceived Knowledge and Knowledge were calculated and the distribution of the scores examined. Data were grouped by the participant's year level. This approach allowed for one-way between-groups analysis of variance (ANOVA) to be conducted to explore the differences between the cohorts of students enrolled in the pre-service teacher courses. The relationships between self-efficacy, perceived knowledge and knowledge were explored by calculating the Pearson correlation coefficients for the aggregated scores.

Results

This section will present the results of the participant's responses to the survey in four parts: the importance of EfS, self-efficacy for teaching sustainability, perceived knowledge and measured knowledge. The relationships between Self-efficacy, Perceived Knowledge and Measured Knowledge will then be presented.

Importance of EfS

The participants were asked to report their perception of how important it is that schools promote EfS and educate students about the environment from an early age. It was found that the majority of participants agreed or strongly agreed that EfS was important (Table 4).

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Q5. It is important that primary/secondary schools promote education for the environment	117 (44%)	129 (48%)	20 (8%)	0 (0%)	0
Q6. As a teacher I can play an important role in solving environmental problems through teaching	44 (17%)	150 (56%)	65 (24%)	6 (2%)	1 (1%)
Q7. It is very important to educate school students about our environment from an early age	118 (44%)	130 (49%)	16 (6%)	2 (1%)	0

Table 4. Frequency distribution of responses for the importance of EfS

Self-efficacy for teaching sustainability

The participant's self-efficacy for teaching sustainability was explored using four items. The frequency distributions of the participant's responses to these items are shown in Table 5.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Q1. I am confident that I can prepare accurate teaching modules about the environment:	14 (5%)	161 (61%)	82 (31%)	9 (3%)	0
Q2. I cannot include education for sustainability in my teaching because it needs to be taught by specially trained teachers	0	11 (4%)	59 (22%)	155 (58%)	41 (15%)
Q3. I have skills and knowledge that would allow me to educate students about the environment	15 (6%)	177 (67%)	66 (25%)	8 (3%)	0
Q4. I am confident and able to include education about our environment in my teaching	24 (9%)	189 (70%)	50 (19%)	3 (1%)	0

Table 5. Frequency distribution of responses to self-efficacy items

The majority of participants indicated that they were in agreement with the statement (note reverse wording for item 2. An Aggregated Self-efficacy Score was calculated by summing each participant's responses for the four items and subtracting the result from 20, the maximum numerical score. Low Aggregated Self-efficacy Scores represent a low self-efficacy and high scores represent a high self-efficacy.

The distribution of the Aggregated Self-efficacy Scores was approximately symmetric (Figure 1). Half of the participants returned a Self-efficacy score of 11 or more out of 20 (mean = 11.15, sd = 1.65).

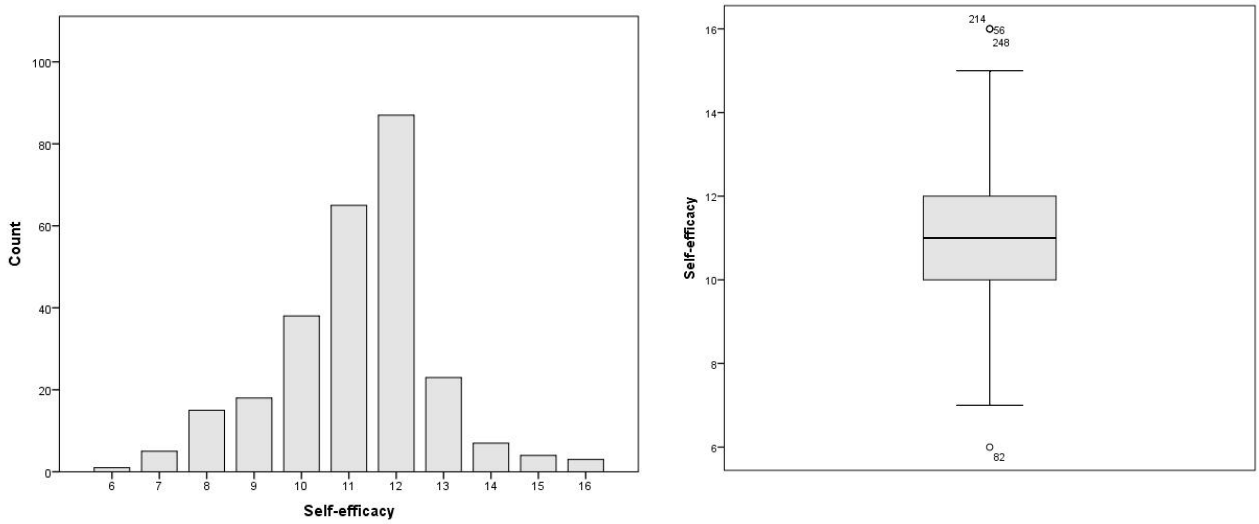

Figure 1. Distribution of Aggregated Self-efficacy scores

A one-way between-groups analysis of variance was conducted to explore the potential differences in Aggregated Self-efficacy Scores between students at different stages of their four year pre-service program. No statistically significant differences in confidence were found.

Perceived Knowledge

The participant's perceived knowledge of sustainability issues was explored using seven environmental issues. The frequency distribution for the participant responses to these items are shown in Table 6.

	I have never heard of this issue and would not be able to explain it	I have heard about this but I would not be able to explain what it is really about	I know something about this and could explain the general issue	I am familiar with this and I would be able to explain it well
Greenhouse gases	4 (1.5%)	98 (36.8%)	139 (52.3%)	25 (9.4%)
Nuclear waste	4 (1.5%)	142 (53.4%)	96 (36.1%)	24 (9.0%)
Forest clearing	3 (1.1%)	48 (18.0%)	159 (59.8%)	56 (21.1%)
Water shortages	5 (1.9%)	33 (12.4%)	155 (58.3%)	73 (27.4%)
Climate change	1 (.4%)	53 (19.9)	153 (57.5%)	59 (22.2%)
Pollution	1 (.4%)	16 (6.0%)	158 (59.4%)	91 (34.2%)
Extinction of species	1 (.4%)	32 (12.0%)	158 (59.4%)	75 (28.2%)

Table 6. Frequency distribution for perceived knowledge items

For most items, more than half of the participants indicated that they 'know something about the topic and could explain the general issue'. Participants' perceived knowledge of nuclear waste

was an exception to this pattern, with approximately half indicating that they 'had heard of this issue, but would not be able to explain what it is really about'.

An Aggregated Perceived Knowledge Score was calculated by summing each participant's responses for the seven items. The distribution of Aggregated Perceived Knowledge Scores was approximately symmetric (Figure 2), with half of the participants returning a Perceived Knowledge Score of 21 or more out of 28 (mean = 20.67, sd = 3.68) and typical scores falling between 19 (Q1) and 23 (Q2).

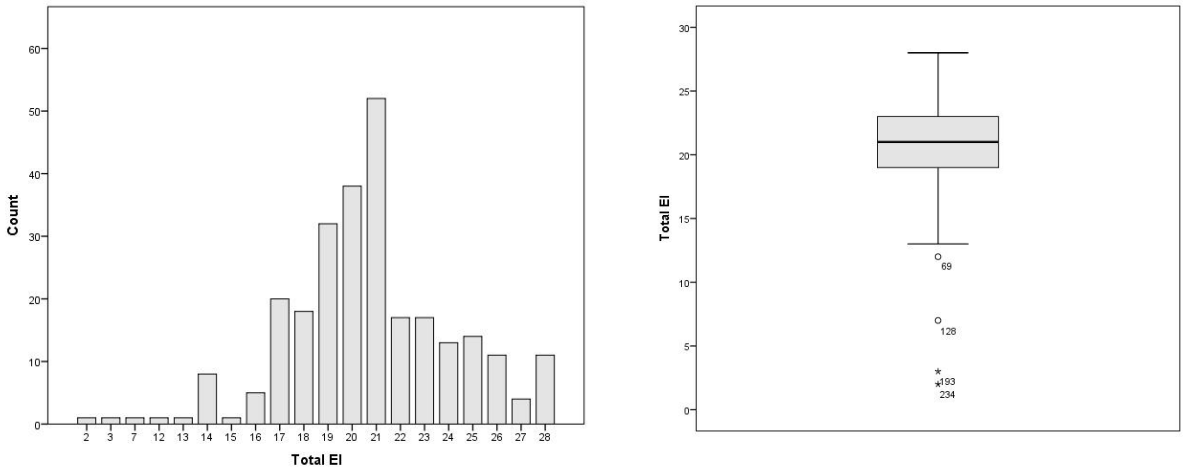

Figure 2. Distribution of Aggregated Perceived Knowledge Scores

A one-way between-groups analysis of variance revealed no statistically significant differences in Aggregated Perceived Knowledge Scores between students at different stages of their four year pre-service program.

Measured Knowledge

Participants' knowledge of sustainability issues was explored using ten multi-choice items (see Appendix). An aggregated Knowledge Score was calculated by summing the number of correct responses. The distribution of Knowledge Scores was approximately symmetrical (mean = 6.03, sd = 1.87), with half of the participants providing 6 or more correct answers (out of 10). Typical scores were between 5 (Q1) and 7 (Q2). A one-way between-groups analysis of variance found a statistically significant difference in Knowledge between the year groups ($F(3,262) = 3.278$, $p = .022$). Bonferroni corrected post hoc tests revealed a significant difference between the first and third years (mean difference = .948, $p = .017$) with the third years having a higher mean than the first years.

Relationships between Efficacy, Perceived Knowledge and Measured Knowledge.

The relationships between participants' efficacy for teaching sustainability, their perceived knowledge of sustainability issues and their actual knowledge was explored by calculating the Pearson correlation coefficients (Table 7) for these measures.

	Efficacy	Perceived Knowledge	Measured Knowledge
Efficacy	1	.217 (p = .000)	.114 (p = .064)
Perceived Knowledge		1	.110 (p = .074)
Measured Knowledge			1

Table 7. Pearson correlation coefficients for aggregated scores

A statistically significant correlation was found (r = .217 p =.000) with Efficacy for teaching sustainability increasing with higher levels of Perceived Knowledge. The correlations between Efficacy and Perceived Knowledge and between Perceived knowledge and Knowledge were found to be not statistically significant.

Discussion

This study investigated the relationships between knowledge and efficacy for EfS in a sample of pre-service teachers at a large, metropolitan university in Australia. In summary, the participants typically considered EfS to be important and believed they were confident in their abilities to engage with EfS. The majority of participants indicated that they knew about the issues identified in the survey instrument and could explain these in general terms. The relationship between the participant's efficacy and perceived knowledge was statistically significant, with efficacy increasing with increased levels of perceived knowledge. These positive findings may be related to the fact that all of the participants had completed a unit of study that focused on environmental sustainability issues as part of their program of studies. This unit was undertaken in the first semester of their first year of study. However, it was not possible to determine the impact that this unit has had on the pre-service teacher's knowledge and efficacy for EfS for this sample group. Other studies (e.g., Taylor et al., 2006) suggest that the inclusion of a unit which focuses on sustainability issues in a pre-service teacher program has a positive impact on the student's knowledge and may go some way to addressing the concerns raised by Cutter-Mackenzie and Smith (2003) about 'ecological illiteracy' amongst primary school teachers. Similar studies undertaken in other universities (and with different course structures) may shed further light on the impact of pre-service units that focus on sustainability.

Despite the inclusion of a unit specifically focused on sustainability, this study found that there appeared to be no relationship between perceived knowledge and measured knowledge or between measured knowledge and efficacy for EfS in this sample group of pre-service teachers. This lack of a relationship may indicate that the questions used to assess the participant's knowledge of sustainability issues were, in fact, an inaccurate measure – a flaw in the survey design rather than related to the students. This possibility could be explored, and perhaps eliminated, through the use of semi-structured interviews in which participants demonstrate their understandings of sustainability issues without the need for the precise answer that a multiple choice question requires. This is a future research aim for the authors.

The lack of relationship between measured knowledge and efficacy may, however, indicate that the pre-service teachers who participated in this study either do not feel constrained by their lack of knowledge, or are perhaps unaware of their actual knowledge of sustainability issues; as Kruger and Dunning (1999) point out, maybe these students have an inflated perception of their own abilities. Self-confidence should not be confused with competence. If the 'content' regarding sustainability is not well known, then it logically follows that a dearth in the pedagogical content

knowledge (PCK) for sustainability also exists. This is of particular concern if pre-service teachers are not exposed to mastery in EfS in both their university experience or when on field placement in schools and classrooms.

The lack of a relationship between measured knowledge and efficacy also raises the question of how much knowledge is actually necessary to support positive efficacy for EfS. While it seems counter intuitive, there is a suggestion that a strong knowledge base does not necessarily play a key role in improving confidence to teach subjects such as science, though this is far from clear. For example, Appleton (1995) found that some pre-service teachers felt that a small amount of teacher knowledge was sufficient, provided they approached the topic as co-learners with the children which provided opportunities for teachers to improve their knowledge as they taught, rather than as prerequisite to teaching. While some knowledge was considered necessary to help student learning, it was not deemed necessary for the teacher to have all the knowledge provided knowledge could be 'constructed' and adequate information could be obtained from other sources. Given the increasing presence of ICT's in many primary classrooms and the virtually ubiquitous access to the internet via portable devices favoured by many in our society, it is possible that contemporary pre-service teachers feel more comfortable with a lower level of personal knowledge of specialist topics as they are used to operating in a 'digitally extended and enhanced' world (Prensky, 2009).

A possible danger arising from the combination of factors outlined above is the potential for pre-service teachers to develop shallow, tokenistic approaches to EfS. These are approaches that, while recognising that EfS is important (with social and emotional triggers contributing to a degree of 'urgency for action'), as teachers, their lack of knowledge and PCK may mean that their efforts in working with students promote inappropriate or superficial responses. Such responses may include, for example, too much focus on acquiring knowledge *about* environmental and sustainability issues and not enough recognition of the complex, transdisciplinary nature of such issues or of the collaborative, action-oriented approaches to education for sustainability that have been argued for within the EfS community for the past two decades at least (Tilbury, 1995: Sterling, 2001).

Given that sustainability is a cross-curriculum priority in the Australian Curriculum and is embedded in all learning areas, it follows that the knowledge and pedagogical skills to teach sustainability will need to be embedded in all areas of pre-service teacher training. For the university in which this study was undertaken, this implies an expansion of EfS beyond a single core unit with an environmental science focus to wider and more structured approach across the whole course. This is in keeping with the university's mission statement; however, meaningful implementation of such an approach will require in-service opportunities for academics teaching in these units to ensure the inclusion of appropriate EfS knowledge and PCK. This will also require overall co-ordination of EfS related offerings within the pre-service teaching programs to ensure the skills, attitudes and behaviours related to sustainability are given sufficient depth and breadth of coverage. For the pre-service teachers, opportunities need to be developed where they can fine-tune their knowledge of sustainability issues and gain an understanding of how primary school students may learn about these issues. Such opportunities are likely to require new kinds of university-school partnerships, particularly with schools that are seen as leaders in EfS. A key part of these partnerships would be that the pre-service teachers experience effective EfS in schools and begin to develop a deeper understanding of the required PCK. Because such programs and partnerships take time to develop, let us hope that not too much more time passes before all pre-service teachers have worthwhile opportunities to engage in EfS during their preparation for life in the classroom.

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Appendix A

Education for Sustainability: Supporting Pre-Service Teachers

Adapted from:

Boon, H. (2011). Beliefs and education for sustainability in rural and regional Australia. *Education in Rural Australia, 21*(2), p 52-54.

Educating for sustainability is a relatively new field of education but one that is receiving increasing attention from governments and policy makers. Much has yet to be learnt about how best to support existing and future teachers in the implementation of education of sustainability. The answers that you give in this survey will be used to improve the way the topics related education for sustainability are embedded in pre-service teaching programs.

This is an anonymous survey and your answers will remain confidential.
Your contribution to this research is greatly valued. Thank you.

Age in years: _____ Gender: M ❑ F ❑

Pre-service teaching training course: Early childhood ❑ Primary ❑

Current progression through course:

First year ❑ Second year ❑ Third year ❑ Fourth year ❑

Highest level of science education:

None ❑ Year 8-10 ❑ Year 11-12 ❑ Undergraduate degree ❑ Postgraduate degree ❑

Please indicate your opinion about the following questions by circling one of the boxes.

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	I am confident that I can prepare accurate teaching modules about our environment	SA	A	N	D	SD
2	I cannot include education for the environment in my teaching because it needs to be taught by specially trained teachers	SA	A	N	D	SD
3	I have skills and knowledge that would allow me to educate students about the environment	SA	A	N	D	SD
4	I am confident and able to include education about our environment in my teaching	SA	A	N	D	SD
5	It is important that primary/secondary schools promote education for the environment	SA	A	N	D	SD
6	As a teacher I can play an important role in solving environmental problems through teaching	SA	A	N	D	SD
7	It is very important to educate school students about our environment from an early age	SA	A	N	D	SD

How much do you know about the following environmental issues? Please tick (✓) only one box in each row.

	I have never heard of this and would not be able to explain it	I have heard about this but I would not be able to explain what it is really about	I know something about this and could explain the general issue	I am familiar with this and I would be able to explain it well
Greenhouse gases				
Nuclear waste				
Forest clearing				
Water shortages				
Climate change				
Pollution				
Extinction of species				

Please circle the answer you think is the best in each of the following questions:

1. Sustainable development means:
   a) development we can sustain without damaging the economy
   b) development which meets the needs of people today without compromising the ability of future generations to meet their needs
   c) development which sustains people above the poverty line
   d) development which preserves adequate reserves for endangered species

2. The biodiversity crisis refers to a decrease in:
   a) the total number of plants and animals
   b) the number of plant species
   c) the number of different plants and animals
   d) the number of animal species

3. The main cause of climate change over the past few decades is hypothesised to be:
   a) a hole in the earth's atmosphere
   b) increased deforestation
   c) increased cloud cover
   d) increased carbon emissions

4. The main cause of water pollution in oceans and rivers is:
   a) run-off from farmland and populated areas
   b) waste from factories
   c) pollution left on beaches
   d) oil spills from tankers

5. The most common reason for animal species becoming extinct is:
   a) they are killed by pesticides
   b) their habitats are destroyed by humans
   c) there is too much hunting
   d) there are climate changes that affect them

6. Tropical rain forests are important because they:
   a) cause heavy rainfall in otherwise dry areas
   b) contain valuable timber which can be logged easily without damage to the ecosystem
   c) host many different species of plants and animals
   d) have especially fertile soils

7. Which one of the following, when used in power plants from electricity generation, is highly efficient but results in nuclear waste?
   a) uranium
   b) coal
   c) petrol
   d) natural gas

8. The major source of human induced carbon emissions comes from:
   a) burning carbon containing fossil fuels
   b) deforestation
   c) increased run-off of nutrients from farmland
   d) increased populations of animals and humans breathing out carbon dioxide and producing methane gas

9. The biggest environmental threat to Australian farmland as a result of climate change is considered to be:
   a) soil salinity
   b) land clearing
   c) drought
   d) pesticides

10. The ozone layer has been mainly depleted by:
    a) burning of fossil fuels
    b) pollution from garbage tips
    c) the release of CFC's into the atmosphere
    d) the increasing temperature of the sun