Sustainability awareness, attitudes and actions: A survey of pre-service teachers

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The purpose of this study was to survey the awareness, attitudes and actions of Thai, pre-service, industrial-education teachers (N=390) regarding economic, social and environmental sustainability. Survey items were derived from learning objectives provided by UNESCO in relation to 17 sustainable development goals (SDGs). Research questions focused on overall results as well as analyses to determine differences based on program type and year of study. Results showed an average overall higher percentage in the categories of attitudes (90%) and action (91%) than for awareness (69%). The lowest ranked items in the categories of attitudes and action were related to SDG 5, gender equality. Pre-service teachers in year two of their program reported significantly higher levels of awareness than those in their first, third, fourth or fifth year. There were no significant differences for program type. Implications point to the value for higher education institutes, programs and instructors of identifying sustainability issues most relevant to their context in terms of culture and subject area. Results also pointed to the possibility that higher education institutions may be able to address aspects of sustainability through other initiatives (e.g., mental health awareness days) that are not necessarily branded specifically as sustainability issues.

Introduction

Sustainable development is a moral imperative and an issue "…on a par with human rights, democracy and freedom" (Holden, Linnerud & Banister, 2017, p. 215). Its importance is emphasised by the United Nations General Assembly's conclusion that the survival of societies and of the planet are at risk (UN, 2015). In recognition of this risk, the Assembly put forth 17 *Sustainable Development Goals* (SDGs) to address global problems such as poverty, unemployment, increasing inequalities and disparities related to gender, wealth and power, political and environmental threats. The SDGs focus on three pillars of economic welfare, environmental quality and social coherence (see Böhringer & Jochem, 2007) reaffirming Fisher and McAdams' (2015) argument that sustainability can be conceptualised beyond its environmental dimension. The SDGs form part of the *2030 Agenda for Sustainable Development* (UN, 2015) to ensure that development should not compromise future generations' ability to meet their needs (UN, 1987). Figure 1 shows the UN's (2018) graphic of the SDGs.

Education as a key strategy for sustainable development

The years 2005 to 2014 were declared the UN Decade of *Education for Sustainable Development* (ESD) (see UNESCO, 2014) in recognition of ESD as integral to educational quality and an enabler for sustainable development (UNESCO, 2014b). ESD involves

Figure 1: 17 SDGs (UN, 2018)

preparing "people to cope with, think critically about, and shape social, economic, political and ecological conditions characterised by change, uncertainty, risk and complexity" (Stevenson, Ferreira, Davis & Evans, 2012, p. 3). Education can play a critical role in fostering sustainability (UNESCO, 2006) since it enables the other SDGs (UNESCO, 2017). SDG 4 promotes inclusion, quality and equity in education (UNESCO, 2017). ESD has a potentially important role to play since sustainability continues to represent an elusive target (Jones, Michelfelder & Nair, 2017). However, both starting and continuing ESD presents challenges (OECD, 2007) since there is no one ESD approach or strategy; rather, these vary according to the political and institutional contexts and conditions (Holgaard, Hadgraft, Kolmos & Guerra, 2016).

Sustainability in higher education: A moral responsibility

The *Stockholm Declaration* of 1972 (UNEP, 1972) represents the earliest reference to the role of sustainability in higher education. Since that Declaration, there has been increasing recognition, as Cortese (2003) claimed, of the moral responsibility of higher education to contribute to a sustainable future. Barth and Rieckmann (2016) observed that universities worldwide are demonstrating interest in sustainability in their curricula. This interest from higher education reflects a "substantial rethinking" about what types of competencies and skills are required by graduates if they are to play a role in addressing sustainability-related issues and problems (Ryan, Tilbury, Corcoran, Abe & Nomura, 2010, p. 112).

Holdsworth and Thomas (2015) argued that there was little evidence of implementation of ESD in universities and that, in Australia, it rarely figures in the curriculum. Wolff, Sjöblom, Hofman-Bergholm and Palmberg (2017) remarked that, in higher education, sustainability operates in principle rather than in practice. This lack of attention is due, in

part, to the fact that sustainability crosses many disciplines and subjects which makes it hard to integrate within the structures of higher education (Belkhir, 2015). Also, the specialised education of many academics also limits efforts (Ryan et al., 2010). Furthermore, while the recognition of and a rationale for inclusion of sustainability in higher education have been amply discussed, there is an overall lack of specifications regarding exactly how higher education should act (OECD, 2007). Not surprisingly, higher education research on sustainability remains "at an early stage" (Azeiteiro, Bacelar-Nicolau, Caetano & Caeiro, 2015, p. 2).

Teacher-education programs: A fragmented approach to sustainability

Teacher-education programs have a potentially significant role to play in promoting sustainability, especially given SDG 4. However, in many countries, and for example, in Australia (see Ferreira, Ryan & Davis, 2015), pre-service teachers are not being adequately prepared. This lack of preparation may be because, as Ferreira et al. (2015) observed, the education of pre-service teachers takes place in "complex organisations that are notoriously difficult to change" (p. 194). The lack of preparedness may also be because there is "no core EfS [Education for Sustainability] knowledge" which results in teachers not having the related knowledge to teach sustainability (Stevenson et al., 2012, p. 1). An Australian study found that while university students recognised the importance of sustainability, they were either unaware of or unsatisfied with sustainability in their courses (see Beasy, Peterson, Tomlinson & Tiernan, 2016). Wolff et al. (2017) explained the challenges for sustainability in teacher-education programs in relation to "the interdisciplinary nature of sustainability and the fact that universities are autonomous" (p. 16). The failure of teacher-education programs to prepare teachers for EfS is evidenced by an Australian study of teachers (see Australian Education for Sustainability Alliance, 2017). The study found that while 92% of teachers surveyed regarded sustainability as of value to the curriculum, 80% were either unaware of or did not understand EfS.

The limitations of research on sustainability in HE

In spite of the recognition of sustainable development as a global issue, Barth and Rieckmann (2016) identified a Western dominance in the literature around sustainability and higher education. The authors reviewed more than 500 academic papers related to higher education for sustainable development from more than 300 institutions. They found that 50% of the authors were European and only approximately 8% came from Asia. The authors signalled the need for research from countries previously under-represented in the literature. The authors' arguments were reinforced by Ryan et al. (2010) who noted that the Asia-Pacific region "with 60% of the earth's population" presents serious challenges to sustainability in relation to pollution, rising sea levels, and the social implications of labour migration.

Furthermore, in relation to research on sustainability in education, studies have often tended to limit their focus to the environmental aspects (e.g., Cheong, 2010; Venustea, Oliviera & Valensaas, 2017) as opposed to considering sustainability from the perspective of the three pillars. Research and practice need to go beyond these three pillars to include,

as the OECD (2017) recommended, three elements of awareness (cognitive), attitudes (socio-emotional) and action (behavioural). In relation to education, UNESCO (2017) described these three domains as follows:

> The cognitive domain comprises knowledge and thinking skills necessary to better understand the SDG and the challenges in achieving it. The socio-emotional domain includes social skills that enable learners to collaborate, negotiate and communicate to promote the SDGs as well as self-reflection skills, values, attitudes and motivations that enable learners to develop themselves. The behavioural domain describes action competencies. (p. 11)

UNESCO (2017) developed a set of learning objectives for each of the 17 SDGs and presented five objectives for each of the SDGs for each of awareness, attitudes and action for a total of 255 objectives. The review of the literature conducted for this study did not identify any measures for a context of higher education based on these three dimensions and related to the learning objectives. Michalos, Creech, McDonald and Hatch-Kahlke (2009) created a set of standardised measures related to awareness, attitudes and action, but without a focus on the learning objectives that might be relevant for teacher education programs.

The present study: From sufficiency to sustainability

In response to these gaps in the literature, this purpose of this study is to identify pre-service teachers' overall sustainability awareness, attitudes and actions (SAAA). The study also sought to identify differences in their SAAA for program year and type. Participants in the study were pre-service teachers. They were selected for the study in recognition of the need for education programs to prepare teachers for EfS. The pre-service teachers were studying industrial education. This term is used in Thailand to refer to programs that prepare teachers to teach in secondary or post-secondary vocational schools and colleges, or in the private or public industrial sector as trainers of technicians (e.g., electrical engineers). As UNESCO (2010) reported, many societal problems such as climate change and depletion of natural resources have, to some extent, resulted from developments for which engineers are responsible.

Thailand represents a relevant context in which to conduct such a study not only because it is a developing country and in the Asia-Pacific region, but because of its traditional promotion of sustainability linked to its *Sufficiency Economy Philosophy*. The Sufficiency Economy Philosophy was first promulgated by His Majesty the Late King Bhumibol Adulyadej and subsequently adopted in 2002 as the country's core principle of development (Government of Thailand, 2017). According to a UN national review (see UN, 2017), Thailand is making progress on all 17 SDGs.

The study's research questions were as follows:

In relation to the preservice, industrial-education teachers enrolled in this study:

1. What are the pre-service teachers' overall awareness of, attitudes towards and likelihood of action on sustainability?
2. What is the relationship (if any) between students' year and program, and each of sustainability awareness, attitudes and action?

The study's survey will be of interest and potential value to those interested in pre-service and in-service teacher education or in the training of trades and apprenticeship personnel. In general, results will be of interest to those interested in the role of learning and teaching in promoting sustainability.

Methods

Researching sustainability

Fahy and Rau (2013) posited that research related to sustainability raises questions about what, how and why to measure, and that methodological approaches reflect "broader concerns about the nature of human social life and its investigation" (p. 8). Research related to sustainability using a constructivist lens and epistemology allows for a perspective centred on the social world and on human behaviour. According to that perspective, in response to Fahy and Rau's questions of *what* to measure, this study first considered sustainability from the perspective of the three pillars. This approach is in contrast to a tendency in research and in practice to limit the focus on sustainability to an environmental perspective (e.g., Cutter-McKenzie & Smith, 2003; Kennelly, Taylor, & Mazwell, 2008; Nielsen et al., 2012).

In relation to *why,* the response is that a constructivist epistemology values investigation of how people make sense of the world in general and, in this case, of sustainability in particular. Constructivism assumes agency and actors in a social context. In this study, the focus is on pre-service teachers of telecommunications, electronic or computer engineering. A focus on their awareness, attitudes and action is highly relevant because they are positioned to influence and play a role in future efforts to promote sustainability. The study's focus on a Thai context recognises that sustainability is universally valued and deserves to be investigated in diverse contexts such as Asia. In terms of the questions of *how* to measure, this study adopted online survey methods as opposed to interviews, mindful that "people might be willing to share their true opinion online, but not in a face-to-face interview" (OECD, 2017, p. 1). The choice of approach to data collection also relates to the convenience for researchers in terms of compiling results (Wright, 2005). The use of a survey based on UNESCO's (2017) learning objectives for the 17 SDGs fills a gap in the literature on sustainability-related research instruments for use in educational contexts.

Context

The teacher-education program in which this study was conducted is a five-year Bachelor of Science in Industrial Education (Engineering Education) program. The program consists of 59 courses including two professional teaching practices each lasting one month along with seminars in educational practice. The program focuses on both education courses (e.g., curriculum development), and on general, elective courses and specialised subject-specific and laboratory courses (e.g., fundamentals of electronics; physics of semiconductor devices, etc.). Students do not determine a major until their second year.

At the time when the study was conducted in 2018, the university had some initiatives related to sustainability such as a mention in its mission statement. It also offered some specialised general elective courses about sustainability. Students are required to take a total of 10 general courses during their five-year program. These are organised according to five streams as follows: *Life value* (self-development for good living); *The way of society* (pride in Thai culture); the *Science of thinking* (integrated and creative thinking); *The art of management* (entrepreneurship/ leadership); and (English) *Language and communication*. Courses directly or indirectly related to sustainability include *Sustainable energy* which is focused on systematic thinking for alternative energy sources. One elective course, *Greening the earth: Think earth*, focuses on environmental conservation and natural resources development. Another elective course, *Philosophy of the sufficiency economy*, focuses on awareness and application of the philosophy in daily life in a changing society.

Participants

An invitation to complete the survey was sent by email to all 505 pre-service teachers (283 male, 222 female) enrolled in the faculty during the first semester of 2018. The final response rate was 77% (N=390) (see Table 1). Year 5 students were not all reachable through their university email because, approximately two years before the study was conducted, the university changed its email addressing system.

Instrument

Part 1 of the survey provided participants with information related to ethics, the purpose of the survey, their voluntary participation and, anonymous reporting. Part 2 gathered information pertaining to year of program (1-5) and program type (Telecommunications, Electronics or Computer Engineering). Part three was the survey itself. The survey was completed for this study using UNESCO's (2017) learning objectives for each of the 17 SDGs in relation to awareness, attitudes and action. Use of all 255 objectives in one survey would likely result in fatigue on the part of respondents. For this reason, the survey relied on one item for each domain for each of the 17 SDGs, for a total of 51 items. The survey adapted items to suit the context and, to do so, it also relied on the "suggested topics" for the SDGs. The survey also adapted the original wording to avoid double-barrelled questions and to lessen reading requirements. Survey items are presented in Figures 2 (awareness), 3 (attitudes) and 4 (action).

Table 1: Summary of survey respondents

Year	Major	Total sent	Total responded	%
1	No major declared	105	92	88
2	Telecommunications	40	36	90
	Electronics	34	27	79
	Computer	23	18	78
	Total	97	81	84
3	Telecommunications	32	32	100
	Electronics	34	31	91
	Computer	30	29	97
	Total	96	92	96
4	Telecommunications	35	33	94
	Electronics	34	25	74
	Computer	32	28	88
	Total	101	86	85
5	Telecommunications	39	17	44
	Electronics	38	13	34
	Computer	29	9	31
	Total	106	39	37
	Totals	505	390	77

Instrument scale

For awareness, the survey items begin with "My knowledge of …. is." Likert scale choice options were: very low, low, high, very high. For attitude, items began with "I feel" or "I do not feel." The corresponding items were: very untrue of me, untrue of me, true of me, very true of me. For action, each item was preceded by "I will teach students…" (about or how to). The corresponding scale was: very unlikely, unlikely, likely, very likely.

Podsakoff, MacKenzie, Lee and Podsakoff (2003) described method biases whereby respondents want to appear "consistent and rational," and might, as a result, "search for similarities in the questions asked of them", or attempt to produce socially desirable responses "more as a result of their social acceptability than their true feelings" (pp. 881-882). For these reasons, the survey avoided the use of an agreement scale. This approach avoids the potential problem whereby respondents tend to agree or disagree with items regardless of the content (Podsakoff et al., 2003). For the same reason, with the attitude scale, the survey used negatively worded items (Weijters & Baumgartner, 2012) that negated the statement and required reverse scoring, i.e., "I don't feel" (see Salazar, 2015). Items 1, 5, 6, 8, 11, 12, 14 and 15 were stated negatively, i.e., "I don't feel…." or "I can't empathise…" Negatively-phrased items can result in more diverse responses. This is because they reflect respondents' actual attitudes by doing what Drolet and Morrison (2001, p. 201) referred to as "encouraging respondents to notice differences in items" and avoiding "mindless respondent consistency" (p. 201). To minimise the acquiescence bias, each of the three scales began with its negative value, e.g., very unlikely, very untrue of me, very low. Likewise, the survey followed Garland's (1991) recommendation to eliminate a midpoint (e.g., uncertain or unsure) to minimise social desirability bias or

"respondents' desires to please the interviewer or appear helpful or not be seen to give what they perceive to be a socially unacceptable answer" (p. 70).

Cronbach's alpha

Cronbach's alpha (Cronbach, 1951) as a measure of internal consistency (reliability) was .886 for the 17 awareness items and .937 for the 17 action items, indicating satisfactory discriminating power. A value of .70 or greater would be acceptable (Taber, 2017). Normally, "alpha is maximised when every item in a scale shares common variance with at least some other items in the scale" (Gardner, 1995). For attitude, with the negative items included, the alpha was at .495. With the negative items rephrased as positive, the alpha was .763. The total Cronbach's alpha for all 51 items was 0.903.

Procedures

The survey items were translated into Thai using translation/back translation (Behling & Law, 2000). The survey was administered online using Survey Monkey (http://www.surveymonkey.com). An invitation was sent to students using their university email addresses. The study received ethics approval by the university. Participants were informed of the purpose of the survey and of the fact that their voluntary participation was not required in any way for their university program. They were also informed that survey responses would be reported in aggregated, anonymous format and that their participation and responses would remain confidential. Participants were told that there were "no right or wrong answers". They were provided with a return email address in case they had any questions or concerns.

Data analysis

Analysis was conducted using descriptive statistics in *Excel* (percentages for overall totals) and using univariate analysis of variance (ANOVA) for comparisons between year and program type in relation to awareness, attitudes and actions. Reverse scoring was relied on for the negative attitude items.

Results

Research question 1: What are the pre-service teachers' overall awareness of, attitudes towards and likelihood of action on sustainability?

The results related to this research question are presented in three sections with one figure for each of awareness (Figure 2), attitudes (Figure 3) and actions (Figure 4). Each of the 17 items reflects one SDG-related learning objective. For example, SDG 2 is "Zero hunger". The related survey item is "My knowledge of the consequences of malnutrition is…". The figures present survey items ranked from highest to lowest percentages of positive responses. The figures show, for each of the 17 SDG-related items, the percentages for each of the scale items (e.g., very high, high; low, very low). The figures

also show, for each of the 17 SDG-related items, combined percentages (e.g., very true + true).

Awareness

Figure 2 presents results of participants' self-reported levels of awareness of sustainability. Eighty-four per cent of participants reported either high or very high awareness of the importance of mental health. Similar levels (82%) were reported for the importance of education as a driver of sustainability and 80% reported awareness of the need for waste reduction, recycling and reuse. At the opposite end, 50% reported low or very low awareness of the consequences of malnutrition. Forty-six per cent of respondents reported low or very low for awareness of the health impacts of energy production; 44% reported low or very low awareness of the consequences of lack of water and 40% reported low or very low awareness of the relationship between employment and economic growth. The overall average for the very high and high knowledge categories was 69%.

SDG #	My knowledge of …	Very high	High	Low	Very low
		%		**%**	
3	the importance of mental health.	20	64	14	2
		84		**16**	
4	the importance of education as a driver of sustainability.	23	59	16	2
		82		**18**	
16	the injustice in my country.	36	46	15	3
		82		**18**	
11	the need for waste reduction, recycling and reuse.	24	56	18	2
		80		**20**	
5	the role of education for ensuring the equality of males and females.	21	57	21	1
		78		**22**	
12	how individual lifestyle choices influence environmental development.	17	60	22	1
		77		**23**	
13	which human activities contribute most to climate change.	17	58	24	1
		75		**25**	
14	how renewable energies such as wind turbines can promote sustainability.	13	57	28	2
		70		**30**	
17	the importance of global cooperation to ensure access to technology.	16	53	28	3
		69		**31**	
9	the need for sustainable ICT infrastructure.	20	48	26	6
		68		**32**	
1	the consequences of poverty.	8	58	31	3
		66		**34**	
15	how unsustainable production of technologies can harm the habitats of wildlife.	18	47	33	2
		65		**35**	
10	how inequality is a major cause of societal problems.	12	50	35	3
		62		**38**	
8	the relationship between employment and economic growth.	13	47	35	5
		60		**40**	
6	the consequences of lack of water.	12	44	37	7
		56		**44**	
7	the health impacts of energy production.	6	49	38	7
		55		**45**	
2	the consequences of malnutrition.	6	44	45	5
		50		**50**	

Figure 2: Overall results for awareness

Attitude

Figure 3 presents results related to participants' sustainability-related attitudes. Overall, students' attitudes were positive. The average for attitude in the very true, true category was 90%. Ninety-six per cent reported feeling that education for sustainable development is important and 94% felt that global access to the Internet was important. Ninety-four per cent reported feeling empathy for people who are discriminated against. The least positive attitudes were reported for the SDG 5-related item regarding feeling empathy for people who are different from what is normally expected in the community regarding gender.

SDG #	I feel…	Very true	True	Untrue	Very untrue
		%		%	
4	that education for sustainable development is important.	58	38	2	2
		96		4	
10	empathy for people who are discriminated against.	57	37	5	1
		94		6	
17	that global access to the Internet is important.	53	41	4	2
		94		6	
16	empathy with people suffering from injustice in my country.	52	40	5	3
		92		8	
13	that we need to do something about industry-related greenhouse gases.	36	56	6	2
		92		8	
7	that sustainable energy use is important.	38	54	6	2
		92		8	
3	empathy for people who are suffering from illness.	44	48	6	2
		92		8	
9	that access to basic ICT infrastructure is important.	31	60	7	2
		91		9	
2	empathy for people in the world who are malnourished.	39	52	6	3
		91		9	
15	empathy with non-human life such as wild animals in the forest.	62	26	8	4
		88		12	
6	responsible for my own water use.	33	53	12	2
		86		14	
12	responsible for the environment.	39	45	11	5
		84		16	
1	empathy for people in poor and vulnerable situations such as child labourers.	54	27	14	5
		81		19	
11	responsible for the environmental impacts of my own lifestyle.	36	43	17	4
		79		21	
8	that labour rights for migrant workers are necessary.	22	55	20	3
		77		23	
14	empathy with people whose lives are affected by changing fishing practices.	26	50	20	4
		76		24	
5	empathy with people who are different from what is normally expected in the community regarding gender.	26	47	21	6
		73		27	

Figure 3: Overall results for attitudes

Action

Figure 4 presents results related to participants' perceived likelihood of action related to the SDGs. Overall, across all 17 SDGS, the average was 91% in the category of very likely to likely. Ninety-one to ninety-five per cent of respondents were likely or very likely to teach their students about the majority (11/17) of items. Eighty-five to eighty-six per cent

of respondents were likely or very likely to teach their students about five of the 17 items. By comparison, only 74% were likely or very likely to teach their students about SDG 5. This item is related to their likelihood of teaching students how to identify gender discrimination.

SDG #	I will teach students…	Very likely	Likely	Unlikely	Very unlikely
		%		%	
9	about ICT recycling and disposal.	26	69	4	1
		95		5	
1	about ways to use technology to empower poor people.	24	71	4	1
		95		5	
3	how to use technology to promote their health.	31	64	3	2
		95		5	
4	the basic skills needed for the 21st century.	33	62	4	1
		95		5	
11	about sustainable residential energy use.	25	70	4	1
		95		5	
17	to use technology to create partnerships to promote sustainable development.	29	66	4	1
		95		5	
12	about the environmental impact of technology production.	26	69	4	1
		95		5	
2	about how to change their own lifestyle to fight against hunger.	21	73	5	1
		94		6	
8	about new technologies for sustainable development.	30	64	5	1
		94		6	
7	about renewable energy technologies.	28	64	7	1
		92		8	
13	to use technology to promote knowledge of climate change.	21	70	8	1
		91		9	
14	about sustainable marine energies.	20	68	10	2
		88		12	
16	to use technology to connect with groups that are experiencing injustice.	26	62	11	1
		88		12	
15	about how technology can threaten biodiversity (e.g., habitat loss, deforestation etc.).	21	65	12	2
		86		14	
6	how to use technology to calculate their own water footprint.	22	64	12	2
		86		14	
10	how to use technology to reduce inequality in society.	23	62	13	2
		85		15	
5	how to identify gender discrimination.	20	54	21	5
		74		26	

Figure 4: Overall results for action

Research question 2: What is the relationship (if any) between students' year and program and sustainability awareness, attitudes and action?

Comparisons between program years
Table 2 shows a significant difference between years for awareness. Year 2 students reported higher levels of awareness than those in years 1, 3, 4 and 5.

Table 2: ANOVA results for awareness for years 1-5

Years	N	Mean	SD.	F
1	92	2.7976	.40111	4.064**
2	81	2.9246	.34625	
3	92	2.8750	.35689	
4	86	2.7041	.45451	
5	39	2.8795	.36358	
Total	390	2.8298	.39558	

** The mean difference is significant at the .01 level.

Table 3 shows there was no significant difference between years 1-5 for attitudes.

Table 3: ANOVA results for attitudes for years 1-5

Years	N	Mean	SD.	F
1	92	3.2376	.38554	.133
2	81	3.2624	.34366	
3	92	3.2617	.31150	
4	86	3.2469	.42757	
5	39	3.2841	.42022	
Total	390	3.2552	.37303	

Table 4 shows there was no significant difference between years 1-5 for actions.

Table 4: ANOVA results for actions for years 1-5

Years	N	Mean	SD.	F
1	92	3.1751	.34430	2.066
2	81	3.1745	.37223	
3	92	3.1567	.35223	
4	86	3.0412	.44825	
5	39	3.2035	.42562	
Total	390	3.1440	.38730	

Comparisons for program type
Table 5 shows there was no significant difference between program types for awareness.

Table 5: ANOVA results for awareness for program type

Program	N	Mean	SD.	F
No major declared	92	2.7976	.40111	2.534
Telecommunications	118	2.9021	.39120	
Electronics	96	2.7612	.41745	
Computer	84	2.8420	.35727	
Total	390	2.8298	.39558	

Table 6 shows there was no significant difference between program types for attitudes.

Table 6: ANOVA results for attitudes for program type

Program	N	Mean	SD.	F
No major declared	92	3.2376	.38554	.806
Telecommunications	118	3.2996	.37190	
Electronics	96	3.2318	.37475	
Computer	84	3.2386	.35976	
Total	390	3.2552	.37303	

Table 7 shows there was no significant difference between program types for actions.

Table 7: ANOVA of actions for program type

Program	N	Mean	SD.	F
No major declared	92	3.1751	.34430	
Telecommunications	118	3.2067	.40502	2.596
Electronics	96	3.0949	.41498	
Computer	84	3.0777	.36166	
Total	390	3.1440	.38730	

Discussion

This study conceptualised sustainability not only as an environmental imperative but also an economic and social one. This conceptualisation is consistent with the UN's 17 SDGs that reflect environmental, economic and social imperatives. The study focused on pre-service teachers' cognitive awareness of, emotional attitudes towards and likelihood of related action on sustainability. The study's 51 survey items were based on learning objectives for the 17 SDGS for each of these three categories. The research questions focused on overall results as well as tests of significance to determine differences based on program type and year of study.

Results for research question 1 showed an average higher percentage in the categories of attitudes (90% very true of me + true of me) and action (91% very likely + likely) than for awareness (69% very high + high). The comparatively lower levels of awareness (only 50% for consequences of malnutrition) suggest that the pre-service teachers may not have the sustainability knowledge that they normally should impart to their future students. Results for awareness are congruent with those of a survey of engineering students world-wide by Azapagic, Perdan and Shallcross (2007), who found significant gaps in knowledge and generally unsatisfactory levels of understanding of sustainable development. Similarly, an Australian study of pre-service teachers (Ferreira, Ryan & Davis, 2015) found that 80% were unaware or did not understand EfS.

Results showed relatively lower levels of awareness related to lack of water, the impacts of energy production and the relationship between employment and economic growth. For

those charged with teaching future engineering technicians, a low level of awareness in these areas is a concern. As Rahimifard and Clegg (2008) posited, engineers have a critical role to play with regards to sustainable development. The awareness item related to the consequences of malnutrition was ranked low. This relative lack of awareness points to cultural differences and factors that may influence sustainability awareness in higher education students. It also points to the value of taking into account specific cultural needs when addressing EfS, keeping in mind that, depending on the country, certain SDGs may be less relevant or important than others. In the case of Thailand, various government strategies reduced the percentage of underweight preschool children from 51% in 1980 to less than 10% in 2006 (Chavasit, Kasemsup & Tontisirin, 2013) suggesting that malnutrition is not a major problem in this country.

What may be surprising in the results is the difference between the percentages for awareness versus those of attitude and action. In this regard, awareness would normally be considered a necessary precursor to action and, perhaps even attitude. For participants in this study, lower self-reported awareness did not appear to negatively affect attitudes. This result is congruent with those of other studies. Kagawa (2007) found that students at a UK university thought positively about sustainability but that this positive attitude did not correlate with their familiarity of sustainability and sustainable development as concepts. Similarly, Azapagic, Perdan and Shallcross (2007) found that, while students felt that sustainable development was important, they demonstrated low levels of knowledge about it. As Michalos et al. (2009) found, "sustainable development favourable attitudes are much more important than sustainable development knowledge for explaining sustainable development favourable behaviours" (p. 10).

Michalos et al. (2009) argued that "*having attitudes favourable* to sustainable development is relatively more influential than age, levels of education and knowledge *for engaging in behaviours favourable* to sustainable development" (p. vi). Attitudes were lowest for 'I don't feel empathy with people who are different from what is normally expected in the community regarding gender'. This item was also the one for which respondents indicated the lowest level of action ('I will teach students how to identify gender discrimination'). This is in spite of Thailand's 2015 adoption of a Gender Equality Act which includes gender-responsive budgeting and opportunities for inclusive participation (see United Nations Women, n.d.). A surprising result in relation to attitudes (Figure 3) is that 21% (untrue of me + very untrue of me) indicated not feeling responsible for the environmental impacts of their own lifestyle. The highest ranked item for attitudes was that education for sustainable development is important. This result is consistent with Michalos et al. (2009). In their study, this item also ranked highest (98%).

Results related to awareness and the second research question revealed no significant program differences but there were differences between years. Year two students reported higher levels of awareness than did respondents for years 1, 3, 4 and 5. It might be expected that those with more experience and education (i.e., year 5 students) would be those with more awareness. For example, Pascarella and Terenzini (2005) found, at least for moral reasoning, that it increased as students progressed in years of study. It was beyond the scope of the study to investigate why year 2 students had higher levels than

year 5 students. It is possible that their program did not provide them with knowledge of sustainability issues. If the program had done so, then one would expect to see higher levels for each year with the highest in year 5. The other hypothesis is that, as a relatively younger generation of students, year 2 students may have been exposed, either in their program or elsewhere (e.g., social media) to sustainability issues more than their peers in later years. In terms of likelihood of action, results revealed no significant differences for program type or year. The fact that there is no difference between years is surprising. It might be expected that those in their final year would be significantly more inclined towards action.

Conclusions

This study has contributed to the literature on pre-service teachers' sustainability awareness, attitude and action. In particular, this study contributes to the literature related to an Asian context where research on sustainability and higher education has tended to be under-represented. The study also focused attention on the relevance of conceptualising sustainability beyond its environmental dimension to encompass social and economic aspects. Most importantly, the survey has illustrated how these three dimensions of sustainability can be investigated from the perspective of awareness, attitudes and action using the learning objectives provided by UNESCO (2017). Results revealed that students can hold positive attitudes about sustainability and even be likely to act on those attitudes in spite of a perceived lack of knowledge on the topic. Results also highlighted that, while students can hold very positive attitudes and likelihood of action in one area of sustainability, they may hold negative ones in other areas. In this case of this study, gender equality and discrimination emerged as problematic. The highest levels of awareness were related to topics to which the pre-service teachers may have had exposure to and learned about outside of their studies. These topics include mental health and the need for waste reduction, recycling and reuse. This result suggests that some of the targets for sustainability may be satisfied through initiatives that are not necessarily branded as sustainability-related. Universities may offer initiatives (e.g., mental health awareness days) to support mental health awareness although these may not necessarily be promoted under the banner of sustainability (see Australian Medical Students' Association, 2013).

Results showed that 50% of participants reported low or very low levels of awareness regarding malnutrition. This result confirms Holden et al.'s (2017) argument that sustainability priorities can vary, meaning that "some countries may satisfy the imperatives of respecting environmental limits and satisfying human needs, but not the imperative of ensuring social equity" (p. 224). Holden et al. proposed a policy focus on six sustainability themes such as those related to poverty, equity and climate change. Researchers such as Quinlan (2011) interested in educating 'the whole student' have advocated specific foci on particular issues through development of, for example, social responsibility, and not separating the cognitive from the affective. Quinlan noted that approaches to this holistic form of development may need to vary depending on the context but might include problem-based learning or specialised curricula. In general, higher education institutes may

need to rethink overall priorities to avoid what Barnett and Coats (2005) referred to as a tendency to focus more on economic goals and on preparing students for the workplace.

In terms of practice to improve sustainability awareness, attitudes and actions (SAAA), Kalsoom and Khanam (2017) argued that sustainability education requires transformative practices that lead to changes in and questioning of assumptions, cognition and values. Kalsoom and Khanam listed drama and inquiry-based learning as practices that can support transformation. Computers in general and virtual games specifically, may play a role in these practices. Fabricatore and Lopez (2012) identified the value of digital games for sustainability because of their entertainment value but more importantly because of how they can engage learners in meaningful and collaborative ill-structured problem solving. However, Fabricatore and Lopez also identified limitations of such approaches in that existing games tend to narrow the focus to environmental aspects of sustainability. They also noted that games typically tend to be designed for younger learners as opposed to for those in higher education.

In this study, for both attitudes and actions, SDG 5 (gender) items ranked the lowest. Subsequent studies could probe this particular SDG more deeply using additional objectives from the 251 created by UNESCO (2017). For example, for SDG 5, as for the other SDGs, there are five objectives for each of the cognitive, socio-emotional and behavioural categories for a total of 15. In addition, there are suggested topics, examples of learning approaches and methods. The value of the 251 learning objectives is that they operationalise the SDGs and therefore offer a focus for researchers' in-depth inquiry into particular SDGs. In general, this study's survey offers a tool for use by researchers interested in investigating individuals' SAAA using a perspective that considers the construct in terms of three pillars.

Limitations

Results should be interpreted in relation to the limitations of the study. One of these limitations is that the survey identified participants' levels of SAAA without identifying why they had these levels. Future studies might include, following analysis of survey results, interviews or focus groups to gain insights into factors that influence students' SAAA. It was beyond the scope of this study to ascertain participants' SAAA prior to beginning their program. Future studies might benefit from baseline measures of students' SAAA as well as longitudinal measures. A further limitation of the study is that it was not possible to identify those non-university related factors (e.g., exposure to sustainability issues through social media) that might have influenced participants' SAAA. This study was also limited to self-report measures. As noted previously, participants may have provided responses that reflect a social-desirability bias, i.e., they want to 'look good'. The study was conducted in one university only and in one country. It is up to the readers to generalise the results to their context.

References

Azapagic, A., Perdan, S. & Shallcross, D. (2007). How much do engineering students know about sustainable development? The findings of an international survey and possible implications for the engineering curriculum. *European Journal of Engineering Education,* 30(1), 1-19. https://doi.org/10.1080/03043790512331313804

Australian Education for Sustainability Alliance (2017). *Education for sustainability and the Australian Curriculum Project: Final report for research Phases 1 to 3.* http://www.aaee.org.au/wp-content/uploads/2017/08/AAEE-Education-for-Sustainability-and-the-Australian-Curriculum-Project-Final-Report-2015.pdf

Australian Medical Students' Association (2013). *Australian university student mental health: A snapshot: Summary of findings.* http://www.amsa.org.au/wp-content/uploads/2013/09/AMSA-SMHW-University-Student-Mental-Health-Summary-Report.pdf

Azapagic, A., Perdan, S. & Shallcross, D. (2007). How much do engineering students know about sustainable development? The findings of an international survey and possible implications for the engineering curriculum. *European Journal of Engineering Education, 30*(1), 1-19. https://doi.org/10.1080/03043790512331313804

Azeiteiro, U. M., Bacelar-Nicolau, P., Caetano, F. J. P. & Caeiro, S. (2015). Education for sustainable development through e-learning in higher education: Experiences from Portugal. *Journal of Cleaner Production,* 106, 308-319. https://doi.org/10.1016/j.jclepro.2014.11.056

Barnett, R. & Coates, K. (2005). *Engaging the curriculum in higher education.* Maidenhead: Society for Research into Higher Education (SRHE) and Open University Press.

Barth, M. & Rieckmann, M. (2016). State of the art in research on higher education for sustainable development. In M. Barth, G. Michelsen, M. Rieckmann & I. Thomas (Eds.), *Routledge handbook of higher education for sustainable development,* pp. 100-113. London: Routledge. https://www.taylorfrancis.com/books/e/9781317918110/chapters/10.4324%2F9781315852249-18

Beasy, K., Peterson, C., Tomlinson, A. & Tiernan, B. (2016). Curriculum for the future: Sustainability is a must! In *Teaching Matters 2016 Conference Programme,* 7 December 2016, Hobart, Tasmania, pp. 8. http://ecite.utas.edu.au/120530

Behling, O. & Law, K. (2000). *Translating questionnaires and other research instruments: Problems and solutions.* SAGE university papers series on quantitative applications in the social sciences no. 07-131. Thousand Oaks, CA: SAGE.

Belkhir, L. (2015). Embedding sustainability in education through experiential learning using innovation and entrepreneurship. *Higher Education Studies,* 5(1), 73-80. https://doi.org/10.5539/hes.v5n1p73

Böhringer, C. & Jochem, P. E. P. (2007). Measuring the immeasurable - a survey of sustainability indices. *Ecological Economics,* 63(1), 1-8. https://doi.org/10.1016/j.ecolecon.2007.03.008

Chavasit, V., Kasemsup, V. & Tontisirin, K. (2013). Thailand conquered under-nutrition very successfully but has not slowed obesity. *Obesity Reviews,* 14(2), 96-105. https://onlinelibrary.wiley.com/doi/pdf/10.1111/obr.12091

Cheong, I. P.-A. (2010). Educating pre-service teachers for a sustainable environment. *Asia-Pacific Journal of Teacher Education,* 33(1), 97-110. https://doi.org/10.1080/1359866052000341151

Cortese, A. D. (2003). The critical role of higher education in creating a sustainable future. *Planning for Higher Education,* 31(3), 15-22. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.739.3611&rep=rep1&type=pdf

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika,* 16(3), 297-334. https://doi.org/10.1007/bf02310555

Cutter-Mackenzie, A. & Smith, R. (2003). Ecological literacy: The 'missing paradigm' in environment education (part one*). Environmental Education Research,* 9(4), 497-524. https://doi.org/10.1080/1350462032000126131

Drolet, A. L. & Morrison, D. G. (2001). Do we really need multiple-item measures in service research? *Journal of Service Research,* 3(3), 196-204. https://doi.org/10.1177/109467050133001

Fabricatore, C. & Lopez, X. (2012). Sustainability learning through gaming: An exploratory study. *Electronic Journal of e-Learning,* 10(2), 209-222. https://files.eric.ed.gov/fulltext/EJ985423.pdf

Fahy, F. & Rau, H. (2013). *Methods of sustainability research in the social sciences.* Thousand Oaks, CA: SAGE Publications.

Ferreira, J.-A., Ryan, L. & Davis, J. (2015). Developing knowledge and leadership in pre-service teacher education systems. *Australian Journal of Environmental Education,* 31(2), 194-207. https://doi.org/10.1017/aee.2015.24

Fisher, P. & McAdams, E. (2015). Gaps in sustainability education. *International Journal of Sustainability in Higher Education,* 16(4), 407-423. https://doi.org/10.1108/IJSHE-08-2013-0106

Gardner, P. (1995). Measuring attitudes to science: Unidimensionality and internal consistency revisited. *Research in Science Education,* 25(3), 283-289. https://doi.org/10.1007/bf02357402

Garland, R. (1991). The mid-point on a rating scale: Is it desirable? *Marketing Bulletin,* 2, 66-70. http://marketing-bulletin.massey.ac.nz/V2/MB_V2_N3_Garland.pdf

Government of Thailand (2017). *Thailand's voluntary national review on the implementation of the 2030 agenda for sustainable development.* Ministry of Foreign Affairs of the Kingdom of Thailand. http://www.mfa.go.th/sep4sdgs/contents/filemanager/images/sep/VNR%20English.pdf

Holden, E., Linnerud, K. & Banister, D. (2017). The imperatives of sustainable development. *Sustainable Development,* 25(3), 213-226. https://doi.org/10.1002/sd.1647

Holdsworth, S. & Thomas, I. (2015). Framework for introducing education for sustainable development into university curriculum. *Journal of Education for Sustainable Development,* 9(2), 137-159. https://doi.org/10.1177/0973408215588246

Holgaard, J. E., Hadgraft, R., Kolmos, A. & Guerra, A. (2016). Strategies for education for sustainable development – Danish and Australian perspectives. *Journal of Cleaner Production,* 112(4), 3479-3491. https://doi.org/10.1016/j.jclepro.2015.09.063

Jones, S. A., Michelfelder, D. & Nair, I. (2017). Engineering managers and sustainable systems: The need for and challenges of using an ethical framework for transformative leadership. *Journal of Cleaner Production,* 140(1), 205-212. https://doi.org/10.1016/j.jclepro.2015.02.009

Kagawa, F. (2007). Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. *International Journal of Sustainability in Higher Education,* 8(3), 317-338. https://doi.org/10.1108/14676370710817174

Kalsoom, Q. & Khanam, A. (2017). Inquiry into sustainability issues by preservice teachers: A pedagogy to enhance sustainability consciousness. *Journal of Cleaner Production,* 164, 1301-1311. https://doi.org/10.1016/j.jclepro.2017.07.047

Kennelly, J., Taylor, N. & Maxwell, T. W. (2008). Addressing the challenge of preparing Australian pre-service primary teachers in environmental education: An evaluation of a dedicated unit. *Journal of Education for Sustainable Development,* 2(2), 141-156. https://doi.org/10.1177/097340820800200211

Michalos, A. C., Creech, H., McDonald, C. & Hatch Kahlke, P. M. (2009). *Measuring knowledge, attitudes and behaviours towards sustainable development: Two exploratory studies.* Winnipeg, Canada: International Institute for Sustainable Development. https://www.iisd.org/pdf/2009/measuring_knowledge_sd.pdf

Nielsen, W., Anderson, P., Hurley, A., Sabljak, V., Petereit, A., Hoskin, V. & Hoban, G. (2012). Preparing action competent environmental educators: How hard can it be? *Australian Journal of Environmental Education,* 28(2), 97-107. https://ro.uow.edu.au/sspapers/130/

OECD (2007). *Higher education for sustainable development.* Final report of international action research project. https://tinyurl.com/y4y4eos6

OECD (2017). *Understanding public attitudes to sustainable development: Overview of international surveys.* https://www.oecd.org/dev/pgd/Overview_of_International_Surveys_on_Sustainable_Development_DevCom_%20Nov2017.pdf

Pascarella, E. & Terenzini, P. (2005). *How college affects students, Volume 2: A third decade of research.* San Francisco, CA: Jossey-Bass.

Podsakoff, P., MacKenzie, S., Lee, J. & Podsakoff, N. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology,* 88(5), 879-903. https://doi.org/10.1037/0021-9010.88.5.879

Quinlan, K. M. (2011). *Developing the whole student: Leading higher education initiatives that integrate mind and heart.* London, UK: Leadership Foundation for Higher Education. http://www.learning.ox.ac.uk/media/global/wwwadminoxacuk/localsites/oxfordlearninginstitute/documents/overview/research/publications/Quinlan_Developing_2011.pdf

Rahimifard, S. & Clegg, A. J. (2008). The role of the engineering community in sustainable development. *International Journal of Sustainable Engineering,* 1(1), 1-2. https://doi.org/10.1080/19397030802237485

Ryan, A., Tilbury, D., Corcoran, P., Abe, O. & Nomura, K. (2010). Sustainability in higher education in the Asia-Pacific: Developments, challenges, and prospects. *International Journal of Sustainability in Higher Education,* 11(2), 106-119. https://doi.org/10.1108/14676371011031838

Salazar, M. (2015). The dilemma of combining positive and negative items in scales. *Psicothema,* 27(2), 192-200. https://doi.org/10.7334/psicothema2014.266

Stevenson, R., Ferreira, J-A., Davis, J. & Evans, N. (2012). *Embedding EfS in teacher education: An introductory guide to using the systems change model.* Sydney, Australia: Office for Teaching and Learning. https://eprints.qut.edu.au/67598/1/ID11-1900_Embedding_EfS_Guide_2014.pdf

Taber, K. S. (2017). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education,* 48(6), 1-24. https://doi.org/10.1007/s11165-016-9602-2

United Nations (1987). *Report of the world commission on environment and development: Our common future.* Oslo, Norway: United Nations General Assembly, Development and International Co-operation. http://www.un-documents.net/our-common-future.pdf

United Nations (2015). *Transforming our world: The 2030 Agenda for Sustainable Development.* Resolution adopted by the General Assembly on 25 September 2015. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

United Nations (2017). *Sustainable development knowledge platform: Voluntary national Review 2017, Thailand.* https://sustainabledevelopment.un.org/memberstates/thailand

United Nations (2018). Sustainable development goals: Communication materials. https://www.un.org/sustainabledevelopment/news/communications-material/

United Nations Women (n.d.). *Thailand promises education to cultivate acceptance of gender equality, data to monitor progress, training to promote gender-responsive budgeting.* http://www.unwomen.org/en/get-involved/step-it-up/commitments/thailand

UNEP (1972). *Declaration of the United Nations Conference on the Human Environment.* UNEP. http://www.un-documents.net/unchedec.htm

UNESCO (2006). *Orienting technical and vocational education and training for sustainable development.* UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training. https://unevoc.unesco.org/fileadmin/user_upload/pubs/SD_DiscussionPaper_e.pdf

UNESCO (2010). *Engineering: Issues, challenges and opportunities for development.* Paris, France: UNESCO. http://unesdoc.unesco.org/images/0018/001897/189753e.pdf

UNESCO (2014). *Shaping the future we want - UN Decade of Education for Sustainable Development (Final report).* Paris, France: UNESCO publishing. https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=1682&menu=35

UNESCO (2014b). *UNESCO roadmap for implementing the global action programme on education for sustainable development.* Paris, France: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000230514

UNESCO (2017). *Education for sustainable development goals: Learning objectives.* UNESCO Education 2030. Paris, France: UNESCO. https://unesdoc.unesco.org/images/0024/002474/247444e.pdf

Venuste, N., Olivier, H. & Valens, N. (2017). Knowledge, attitudes and awareness of pre-service teachers on biodiversity conservation in Rwanda. *International Journal of Environmental and Science Education*, 12(4), 643-652. https://files.eric.ed.gov/fulltext/EJ1144760.pdf

Weijters, B., Geuens, M. & Schillewaert, N. (2009). The proximity effect: The role of inter-item distance on reverse-item bias. *International Journal of Research in Marketing,* 26(1), 2-12. https://doi.org/10.1016/j.ijresmar.2008.09.003

Wolff, L-A., Sjöblom, P., Hofman-Bergholm, M. & Palmberg, I. (2017). High performance education fails in sustainability? - A reflection on Finnish primary teacher education. *Education Sciences,* 7(32). https://doi.org/10.3390/educsci7010032

Wright, K. B. (2005). Researching Internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of Computer-Mediated Communication*, 10(3). https://doi.org/10.1111/j.1083-6101.2005.tb00259.x

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