Exploring the relationship between dispositions to think critically and sustainability concern in HESD

Kerry Shephard, Qudsia Kalsoom, Ritika Gupta, Lorenz Probst, Paul Gannon, V. Santhakumar, Ifeanyi Glory Ndukwe and Tim Jowett
(Author affiliations can be found at the end of the article)

Received 16 July 2020
Revised 4 December 2020
26 February 2021
14 March 2021
Accepted 15 March 2021

Abstract

Purpose – Higher education is uncertain which sustainability-related education targets should be sought and monitored. Accepting that something needs to be measurable to be systematically improved, the authors explored how measures relate to potential targets. This paper aims to focus on dispositions to think critically (active open-minded thinking and fair-minded thinking in appraising reasoning) as measures and explored how they related to sustainability concern as an indicative educational target.

Design/methodology/approach – This research included the development and testing of research instruments (scales) that explored dispositions to critical thinking and sustainability concern. Authors researched these instruments within their own correspondence groups and tested them with university students and staff in Pakistan, the USA, Austria, India and New Zealand. The authors also asked a range of contextualising questions.

Findings – Respondents' disposition to aspects of active, open-minded thinking and fair-minded thinking do predict their concern about facets of sustainability but their strength of religious belief was an important factor in these relationships and in their measurement.

Practical implications – This research demonstrates the complexity of monitoring dispositions to think critically and sustainability concern in educational systems, particularly in circumstances where the roles of religious beliefs are of interest; and suggests ways to address this complexity.

Originality/value – This research integrates and expands discourses on ESD and on critical thinking in diverse disciplines and cultures. It investigates measurement approaches and targets that could help higher education institutions to educate for sustainable development and to monitor their progress, in ways that are compatible with their culture and values.

Keywords Evaluation, Monitoring, Educational objectives, Educational targets, Learning gains, Sustainability concern, Targets, Measures, Critical thinking dispositions

Paper type Research paper

Introduction and conceptual underpinning

Higher education is frequently identified as a contributor to the collective developing sustainability of all nations, perhaps, most clearly articulated in Agenda 21 but more

The authors would like to acknowledge the support and contributions of many colleagues and students from multiple institutions. The authors also acknowledge the helpful advice of peer-reviewers.

Author order: All co-authors have made substantial contributions to this article, in diverse ways. The order of authors does not necessarily signify any particular measure of the magnitude of their contribution.

1467-6370
DOI 10.1108/IJSHE-07-2020-0251

recently in relation to the Sustainable Development Goals [United Nations Sustainable Development, 1992; United Nations Educational Scientific and Cultural Organization (UNESCO), 2019]. Numerous accords and commitments have been made by higher education institutions all around the world to educate for sustainability and for sustainable development (HESD) in general and for particular facets of sustainability such as "environmentally responsible citizenship" (Sylvestre *et al.*, 2013). Attempts have been made to agree on a set of learning objectives for HESD, for example, as specific competencies (Wiek *et al.*, 2011), SDG-specific learning objectives [United Nations Educational Scientific and Cultural Organization (UNESCO), 2017] or as generic intellectual independence (Shephard, 2020) but research has struggled to demonstrate clear progress in this regard. Many barriers to progress have been identified and higher education institutions have considered and adopted diverse frameworks while generally avoiding systemic change (Cotton and Alcock, 2012; Ryan and Tilbury, 2013; Schoolman *et al.*, 2016; Lotz-Sisitka *et al.*, 2015; Scott, 2015; Lambrechts *et al.*, 2018; Finnveden *et al.*, 2020). Despite a considerable research presence, the field of HESD has not reached a consensus on what learning higher education should enable, how it should be implemented and how it should be monitoring its progress.

Targets, objectives and measures

The SDGs provide a sustainability-related context to distinguish goals (or targets) from indicators (or measures). Targets (or goals) are generally aspirational and challenging to measure. Measures or indicators, on the contrary, are measurable and measurements of them provide an indication of progress towards targets. In an educational context, a broader framework for learning is developing in higher education that emphasises learning gains, rather than intended outcomes (Hughes and Tight, 2020). Measures or indicators of learning gain need to say something important about the learning journey in the context of sustainability education.

On critical thinking

Those who teach in higher education almost universally appreciate critical thinking as a quality they aim to foster. In many ways, traditional and liberal roles of HE are more aligned to stimulate thinking than to teaching the normative values associated with responsible citizenship or sustainability competencies. Critical thinking is an important educational objective for most university learning programmes worldwide and for many sustainability-related educational programmes and is widely understood as something that guides the behaviours of individuals (Scriven and Paul, 1987; Rieckmann, 2012; Bertschy *et al.*, 2013; Shephard, 2020). Wiek *et al.* (2011) and Lambrechts and Van Petegem (2016) described critical thinking as an essential competence in the context of sustainability education. Most recently, Brundiers *et al.* (2020) integrated critical thinking within academic competency, as a competency that underpins key sustainability competencies. Critical thinking emerges as a central and desirable learning gain across the conceptual diversity that has made empirical progress in HESD so challenging. Aspects of critical thinking could become useful measures of learning gain, particularly if links to indicative or potential HESD targets could be established.

Concern: an indicative target for higher education sustainable development

The SDGs are, of course, high-level targets for HESD, but in many respects, they are too broadly based as guides for higher education, with its focus on the development of individual students. With respect to HESD, "environmentally responsible citizen" or

"social-justice advocate" as examples, make fine aspirational targets for graduates, albeit still at a high level. Because of its link to behavioural change, concern for facets of sustainability has for many years been interpreted in a diverse range of educational paradigms as a worthy educational aspiration (Dunlap, 2008; Clark *et al.*, 2020; Hungerford and Volk, 1990) and it is used in that sense in this research.

Literature review

Authors record here summaries of the literature that underpin this research as it relates to dispositions to think critically, sustainability concern and the impacts of religious beliefs and individual background on these constructs and how they are measured.

On dispositions to think critically

References to critical thinking, as contributions to sustainability learning within educational frameworks in HESD, may not fully appreciate the complexity of enquiry undertaken in the past century on critical thinking as an umbrella term for independent, reflective, deep and similar forms of thinking. Many fields of enquiry may have adopted critical thinking without adequate reference to the diversity of disciplines that have used it or to its interdisciplinary origins. The dangers of underestimating the importance of affective aspects of critical thinking or dispositions to think critically were emphasised in particular by Facione (2000). As emphasised by Facione (2000) and Shephard (2020) no matter what skills learners develop to think critically, if they do not develop the affective dispositions to use these skills as well, it seems unlikely that they will think critically when they most need to or when the consequences of critical thinking are less than positive towards them. Few who work in sustainability education will doubt the challenges involved in thinking critically and independently about sustainability and using the product of such critical thinking to make sound sustainability-aligned judgements. If critical thinking is an important contribution to academic competence, itself underpinning sustainability competencies, perhaps, educational frameworks for sustainability do need to ensure that it is being adequately understood and addressed.

The research described in this article explores affective dispositions to critical thinking as potential educational measures of learning gain associated with sustainability education. It focusses on two dispositions, open-minded thinking and fair-mindedness in appraising reasoning. Both have their roots firmly within longstanding critical thinking discourses (Scriven and Paul, 1987; Facione, 1990, 2000) integral to several disciplines (including economics, psychology, education and business studies) relating to constructs such as reasoning, rational thinking, my-side and confirmation bias and reflective thinking. Open-minded thinking and fair-mindedness, like critical thinking dispositions, were emphasised (as good reasons, depth, breadth and fairness) by Scriven and Paul (1987) as a universal intellectual value that underpins critical thinking. Each was further developed by Facione's expert panel as "open-mindedness regarding divergent world views" and "fair-mindedness in appraising reasoning" (Facione, 1990). Much of the subsequent literature on open-minded thinking and fair-mindedness addresses Baron's construct of actively open-minded thinking (AOMT) rather than facets of thinking that may contribute to it. Baron is to be credited in particular with the development of AOMT in the 1990s as a measurable entity and indeed within this construct many aspects of fair-mindedness are explicitly or implicitly integrated within a current 41 Item AOMT Scale (Baron, 2017 for a description of the early development of AOMT and Baron, 2019 for an analysis of its utility in the evaluation of thinking).

Measurement of open-minded thinking and fair-mindedness in appraising reasoning

Baron (2017, 2019) emphasised that measurements of AOMT might need to account for differences between decisions (or choices) and both short-term beliefs and long-term beliefs and proposed that scales used to measure AOMT might need to include a range of items relevant to these constructs. Svedholm-Häkkinen and Lindeman (2018) proposed that the AOMT is not a unitary construct, but comprises four distinct dimensions, some of which concern attitudes towards knowledge and others concern attitudes towards people. Similarly and most recently, Stanovich and Toplak (2019) reassessed nearly 20 years of research into AOMT to confirm that those with strong religious beliefs interpret some items within scales in ways that make the scales more challenging to interpret and less generalisable than previously thought. Baron also hypothesised that scales might not be generalisable across "domains" such as morality, religion and science (Baron, 2017). Short versions of the AOMT scale may be particularly applicable to measure the nature of good thinking, as in how people should ideally think, but may not adequately address how people actually do think, particularly in these different contexts or domains. Research by Stanovich, West and others (Macpherson and Stanovich, 2007; Sa *et al.*, 1999) found that AOMT was related to reduced susceptibility to belief bias (the inability to decouple prior knowledge from reasoning processes), but the domain sensitivity of such conclusions are not yet clear.

Sustainability concern

The Revised New Ecological Paradigm Scale (NEP, Dunlap and Van Liere, 1978; Dunlap, 2008) was developed initially as a way to explore what was in the 1970s a new and emerging social paradigm, hypothetically summing measures of respondents' views on; our planet's limits to human development, the fragility of nature, the possibility of an ecological crisis, beliefs in human's ability to overcome disasters and whether humans are part of nature or dominant over it. The 15 Item NEP scale initially became the most widely used measure of environmental concern (Hawcroft and Milfont, 2010) and subsequently the reference point for many studies to explore the impacts of education on facets of sustainability concern (collectively identified as ecological worldview) of particular populations or groups in research projects (Reyna *et al.*, 2017; and Brandt *et al.*, 2020). On the way, the NEP scale has endured a great deal of investigation about what it actually measures, its underlying dimensions, its internal reliability and, most relevant to this study, its appropriateness in multicultural contexts. Ntanos *et al.* (2019) and Grúnõová *et al.* (2019) provide extensive summaries of the development and use of the NEP in this regard. Most recently Xiao *et al.* (2019) have demonstrated that the NEP is a powerful predictor of environmental concern and also mediates the effects of socio-demographic variables on environmental concern. Notably, the NEP was developed before the concept of sustainability became dominant in related discourses, but in fact, it does address a range of sustainability-related issues, not only environmental ones.

Although the NEP has been extensively validated for use in many cultures, both Western and non-Western, increasingly research emphasises the complexity of its interpretation in non-western cultures and with respect to strongly held religious beliefs (Hope and Jones, 2014). Overall, it becomes clear that individual NEP items may generate useful data but that in some contexts it may not be reasonable to simply sum facets of the NEP into a single entity that could be meaningfully described as an ecological worldview, pro-environmental attitude or environmental concern. The NEP remains, however, one of the most useful research tools available to explore how cultural features such as religious beliefs interact with facets of sustainability concern and with its measurement.

A conceptual hypothesis for this research

This research builds on the conceptual hypothesis that those who have the skills and dispositions to think critically will be sensitive to the problems that exist in the world around them and, at least, show concern about them and, perhaps, even wish to act in response to them. Those who lack these skills and dispositions to use them may be less inclined to show concern or to act. Authors accept the naivety of this hypothesis in the presence of such uncertainty about concern and individual action as outcomes of education, about the capabilities of those who teach in higher education to achieve these outcomes, about the impacts of culture and individual background on their possible attainment and about how higher educators would know if they did achieve them. Hence, implicit within this approach is the suggestion that in exploring how learning gains associated with sustainability might be measured, a path to identifying what higher education should be teaching and how it should be monitoring its progress might also be found; in line with an accepted tenet of educational development that systematic improvement of something requires it to be measurable (Carnegie Foundation, 2020). Although interests in sustainability education motivated the research described here, concerns about how best to teach and assess critical and independent thinking are widespread in higher education and interact with concerns about the very nature of higher education and its roles in our societies (Biesta, 2019). This research was also informed and directed by the multinational, multicultural makeup of the Authors' team. Cultural Cognition Theory suggests that authors' interests and interpretations will be, to a degree, related to their cultural values (Kahan, 2015) and those cultural considerations must be explicit with the research design and data interpretation (Figure 1).

Bringing all of these factors together, this multinational research focussed on dispositions to think critically (active open-minded thinking and fair-minded thinking in appraising reasoning) as educational measures and explored how they related to sustainability concern as an indicative educational target.

Methods

Constructing the research instrument

This research developed a survey that comprised three scales, each including several items and a number of contextualising questions. Scale development in this project was informed in particular by Robertson (2017) and was initiated by deductively including a number of items, based on the experience and knowledge of the literature of the researchers, in a draft survey for consideration by the research team. Items were initially chosen to best reflect the concepts developed by Scriven and Paul (1987), Facione (1990) and Baron (2017), but modified in number and content during rounds of content, face and construct validity testing. Cognisant of survey fatigue issues, researchers aimed for a survey with 15 items (5 items for each scale), no more than 10 contextualising questions and a small section to allow respondents to enter a code so that they could be resurveyed at a later date while maintaining their anonymity. Researchers initially discussed the content validity of the developing scales to assess whether or not the items included adequately represent the underlying constructs. Researchers also discussed the face validity of the instrument to decide whether or not the scale items are meaningful for individuals with diverse backgrounds and cultures. At this stage some researchers shared the draft instrument with colleagues and postgraduate students in their own institutions, asking for feedback on the scales and contextualising questions and shared these insights with the wider research group. An important aspect of this stage of the research was to explore and refine how each item was constructed and to ascertain how geographically and culturally diverse target

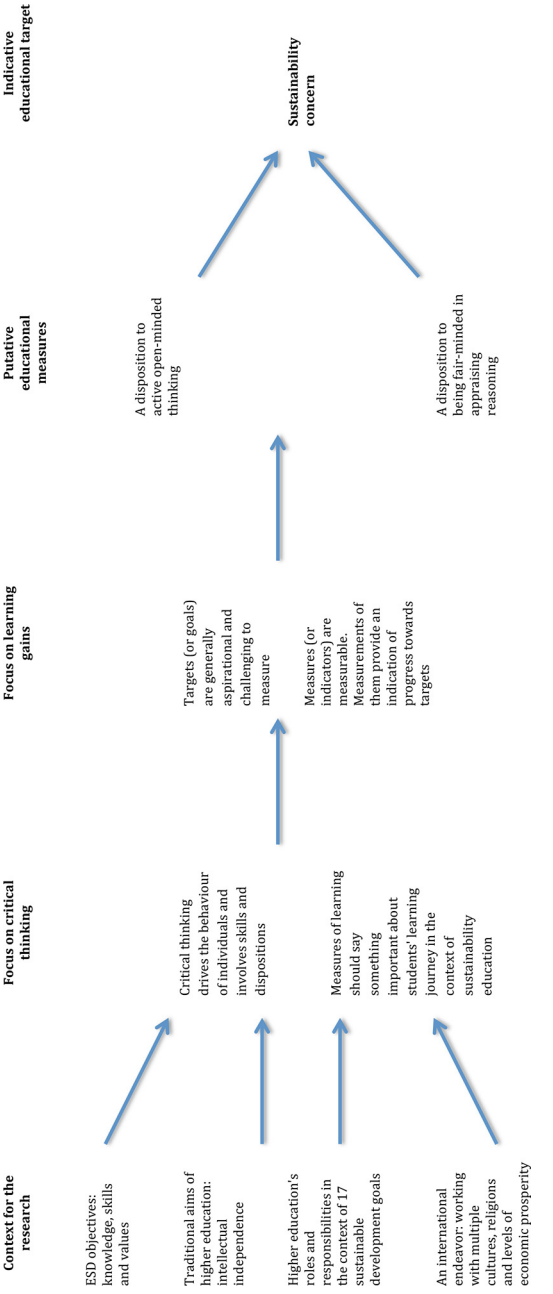


Figure 1.
The conceptual hypothesis and resulting research model

respondents would understand the words and phrases used. The initial survey was considerably modified during these processes. A small pilot project (with 55 anonymous international respondents) was undertaken to continue the process of construct validity testing and to conduct an exploratory factor analysis. It resulted in small changes to the pilot survey and to its constituent items.

The final survey used:

- Five modified items from the NEP. The items chosen (Items 3.1–3.5) were slightly modified versions of those that factored most strongly to the tendencies identified by Shephard *et al.* (2009).
- Five modified items from the AOMT Scale. The items chosen (Items 5.1–5.5) addressed dispositional values such as spending effort on a problem before giving up, considering the opinions of others in forming one's own opinion, weighing new evidence against a favoured belief and being willing to change one's mind if necessary.
- A new five item fair-minded thinking scale (FMT scale) was significantly informed by Facione (1990). The items developed (Items 7.1–7.5) addressed dispositional values such as facing one's own biases and being reasonable in selecting and applying criteria.

All 15 items were included in the survey as 5 point Likert-like choices; with high levels of sustainability concern and thinking dispositions scored in the analysis as 5. Throughout the research phases, some items in each scale were reverse-framed to encourage respondents to engage strongly with the items' meaning. These appear in italics in Table 2. Also included were 10 contextualising questions that were explored and identified as potentially important by the researchers while discussing the content validity of the draft survey and its items. For example, discussions within the authors' group about their own responses to draft items suggested the need for authors to enquire about the strength of religious belief of respondents. Questions addressed respondents': gender; age perception; graduate status and, for graduates, discipline; strength of religious belief; educational background of parents; self-rated critical thinking ability; liberal inclinations (do you think that all people should be provided with the same opportunities in life?); self-rated persistence in solving problems; and confidence in anonymity in the survey. The survey questions are included in the Appendix.

Survey processes

The survey was made available online using Qualtrics software during February and March 2020. Students and academic colleagues in the researchers' institutions were invited to respond by the researchers and by academic colleagues of the researchers and provided with the survey's URL. In all cases, the voluntary nature of responding was emphasised, as was the anonymity of respondents within the system. The research was carried out under a University of Otago Category B Ethics approval for University of Otago staff, students and graduates with equivalent approval in one university in Pakistan. Respondents were also provided with the email address of one of the researchers should they have questions. The nation from within which each survey was completed was calculated from the latitude and longitude of the IP address used to complete the survey online, provided by Qualtrix. The survey was terminated when Covid 19 had a discernable impact on response rates. Survey results were analysed by three researchers using Excel, SPSS, R and two structural-equation modelling (SEM)-programmes (the lavaan package in R and Onyx). Both parametric and

non-parametric significance tests were used, each where appropriate. Non-parametric tests are most appropriate for discrete non-normal data which arises from the individual items measured on Likert-like scales. Parametric statistics are most appropriate for normally distributed data, which arises when individual items are combined into multi-item scales. Adjustments for multiple testing were made where necessary as described below.

Results and analysis

There were 219 responses to the survey. Responses with incomplete entries to the 15 scale items were not included in this analysis, leaving 186 complete responses. Missing values in the contextualising questions were few and were identified in the analysis as variations in n.

All 15 items in the Five Item NEP, AOMT and FMT scales had responses ranging from strongly agree to strongly disagree and resulting in numerical scores of 5 to 1, confirming that the scale items identified constructs that the population surveyed had diverse opinions about. Geographical information provided by Qualtrics confirmed that responses to the survey originated mostly in Pakistan (56%), the USA (13%), Austria (13%), India (5%), New Zealand (4%) and Nigeria (4%), with less than 2% from each of South Africa, Russian Federation, Kuwait, Hungary and France. In total, 71.7% of those who answered confirmed that they were female, 28.3% male (n = 184) (multiple respondents from a woman's university associated with one of the researchers in Pakistan likely contributed to this difference). Age perceptions (4.9% adolescent, 63.2% young adult, 30.8% middle-aged, 1.1% elderly [n = 185]) suggested that most of the respondents were students, with some more senior academic colleagues included. In total, 72.3% of respondents were graduates, 27.7% not yet graduated (n = 184), indicating that researchers had mostly invited highly educated or postgraduate students or that these proved most willing to participate. The self-rated critical thinking ability (18.4% excellent, 57.3% good, 24.3% average, 0% poor or terrible [n = 185]) of the respondents supports the conclusion that respondents were generally highly educated. Similarly, most respondents reported good levels of persistence in solving problems (21.8% excellent, 55.3% good, 21.2% average, 1.8% poor, 0 terrible [n = 170]). Very few respondents disagreed with the assertion that all people should be provided with the same opportunities in life suggesting widely held liberal views (40.3% Strongly Agree, SA, 38.9% Agree, A, 5.9% Unsure, 11.4% Disagree, 3.2% Strongly Disagree [n = 185]). Nearly all of the respondents were confident in their anonymity within the survey (36.1% SA, 49.7% A, 12.6% U, 0.5% D, 1.1% SD [n = 183]). A small majority of respondents reported strongly held religious beliefs (52.2% strongly held; 36.6% not having strongly held religious beliefs, n = 165). A larger majority (66.7%) reported having at least 1 parent who went to university or college (30.1% with neither, n = 185).

Preliminary analysis

For a preliminary analysis based on three factors, individual responses to items were simply averaged to create Mean Five Item NEP, AOMT and FMT Scores. Mean values of Mean Five Item NEP, Mean Five Item AOMT, Mean Five Item FMT were 3.54, 3.56 and 3.66, respectively, indicating, within the capacity of these putative scales to do so, that on balance the respondents held positive levels of sustainability concern and dispositions to think critically. Pearson correlation coefficient analysis was undertaken to determine the extent to which the 3 scales (Mean Five Item NEP, Mean Five Item AOMT and Mean Five Item FMT) were linearly related. The Mean Five Item NEP scores were significantly correlated with the Mean Five Item AOMT but the effect size was small (r = 0.235, n = 186, p = 0.001). Mean Five Item NEP scores were not significantly correlated with the Mean Five Item FMT. The

correlation between Mean Five Item AOMT and Mean Five Item FMT was significant (r = 0.337, $n = 186$, $p < 0.001$).

The preliminary analysis went on to use multiple regression analysis to explore how the Five Item NEP, AOMT and FMT scale scores might be related to the range of contextualising questions used in the Survey. Multiple regression analysis of each scale factor with the contextualising questions (gender; age perception; educational qualifications; religious belief; educational background of parents; self-rated critical thinking; liberal inclinations; self-rated persistence in solving problems; and confidence in anonymity in the survey) produced the data recorded in Table 1. The data suggest that although gender, educational background and persistence in solving problems do significantly predict Mean Five Item NEP and AOMT, the strength of respondents' religious beliefs had by far the largest contribution to these correlations. In this analysis, Mean Five Item NEP and Mean Five Item AOMT scores were negatively predicted by the strength of religious belief.

To explore the possible relationship between respondents' self-reported strength of religious belief and their responses to all items in the NEP, AOMT and FMT Scales, in detail, statistical tests were conducted to compare the mean responses, to each of 15 Items, of individuals with strong religious beliefs ($n = 97$) with individuals without strong religious beliefs ($n = 68$), as described in Table 2. Mean responses were significantly different for 12 of the 15 Items, for one item by more than 1 Likert unit and in most cases by more than 0.3 Likert units. For the majority of items, those with strong religious beliefs had significantly lower scores of NEP, AOMT and FMT, but for particular items in the AOMT and FMT scales, namely, items 5.1, 7.1 and 7.4, those with strong religious beliefs had significantly higher scores than those without strong religious beliefs.

To explore one example of this occurrence in more depth, Pearson Correlation Coefficient analysis was undertaken to determine the extent to which the mean responses to Items 5.1 and 5.3, and mean responses to Items 5.2, 5.4 and 5.5, for all 186 respondents, were linearly related to Mean Five Item NEP. As anticipated, mean responses to Items 5.2, 5.4 and 5.5, for all 186 Respondents, were significantly and positively correlated to Mean Five Item NEP ($r = 0.336$, $p < 0.001$). Mean responses to Items 5.1 and 5.3, however,

Scale	Significant correlation?	Effect size of all predictors in the model (%)	Significant predictors	Coefficient B and standardised B	Significance of each predictor
Mean five item *NEP*	Yes $p < 0.001$	28.7	Religious belief Gender Educational background of parents	−0.619, −0.479 −0.214, −0.150 −0.111, −0.152	<0.001 0.044 <0.040
Mean five item *AOMT*	Yes $p < 0.001$	14.5	Gender Religious belief Persistence	−0.248, −0.224 −0.366, −0.365 +0.112, +0.101	0.005 <0.001 0.038
Mean five-item FMT	No $p = 0.37$				

Notes: The data suggest that although gender, parental educational background and self-reported persistence in solving problems do significantly predict Mean Five Item *NEP* and *AOMT*, the strength of respondents' religious beliefs had by far the largest contribution to these correlations. In this analysis, Mean Five Item *NEP* and Mean Five Item *AOMT* scores were negatively predicted by the strength of religious belief

Table 1. Significant predictors of the Mean Five Item *NEP*, *AOMT* and *FMT* scales revealed by multiple regression analysis

Item #	Item	RB	*n*	Mean	*p*	Adj.*p*	Sig?
3_1	*Human skills will ensure that we can continue to live on the earth indefinitely*	1 0	97 68	2.45 2.85	0.004	0.025	Y
3_2	Humans are severely abusing the environment	1 0	97 68	4.32 4.62	<0.001	<0.001	Y
3_3	*The natural world is strong enough to cope with the impacts of modern industrial nations*	1 0	97 68	3.37 3.76	<0.001	<0.001	Y
3_4	The earth is like a spaceship with very limited room and resources	1 0	97 68	3.40 3.85	<0.001	<0.001	Y
3_5	*Humans were meant to rule over the rest of nature*	1 0	97 68	3.06 4.21	0.753	1	N
5_1	Actively seeking all opposing arguments is a sign of good character	1 0	97 68	3.48 2.96	0.0071	0.0354	Y
5_2	*People should not revise their beliefs in response to new information or evidence*	1 0	97 68	3.49 4.43	<0.001	<0.001	Y
5_3	People should actively seek out evidence that goes against their beliefs	1 0	97 68	3.65 3.74	<0.001	<0.001	Y
5_4	*Intuition is the best guide in making decisions*	1 0	97 68	2.57 3.13	1	1	N
5_5	*Changing your mind is a sign of weakness*	1 0	97 68	3.94 4.50	0.0071	0.0354	Y
7_1	Logical thinking is more important to me than emotions or feelings	1 0	97 68	3.60 3.19	<0.001	0.0022	Y
7_2	*People should mostly consider the interests of their friends and relatives in reaching decisions*	1 0	97 68	3.01 3.66	<0.001	<0.001	Y
7_3	I make an effort to become conscious of my prejudices	1 0	97 68	3.95 4.04	0.0272	0.0819	N
7_4	I deliberately interact with people with different points of view from my own	1 0	97 68	3.94 3.60	<0.001	<0.001	Y
7_5	*It is a waste of effort to look for alternative ways to be fair*	1 0	97 68	3.61 4.13	0.0012	0.0084	Y

Notes: *n* is the number of respondents in each group. Mood's Median Test (Mood, 1950, a non-parametric test that is not dependent on equal variance and normality assumptions) was used with *p*-value adjustment for multiple comparisons (Holm, 1979) to calculate the significance levels of the differences in item means between groups. In total, 12 from 15 items had significantly different means (only 3_5, 5_4, 7_3 was not significantly different). Those with strong religious beliefs score more highly than those without on items 5.1, 7.1 and 7.4

Table 2.
The 15 items used in Version 4 of the survey (items in italics were those reversed phrased with respect to the scales) and mean responses to all 15 Items of those with strong religious beliefs (RB = 1) and those without (RB = 0)

for all 186 respondents, were significantly and negatively correlated to Mean Five Item NEP ($r = -0.163$, $p < 0.026$). The impact of holding strong religious beliefs on this data set is not simple and appears to differ between items; suggesting that not only is the population of 186 respondents non-homogeneous in this regard but also that a simple analysis based on single-factor scale means will not adequately describe the data in this research.

Analysis using structural equation modelling

The preliminary analysis assumed that each scale can be explained by a single factor and that all items contribute equally to each factor so that factor scores can be estimated by the mean of all contributory items. SEM is not limited by these assumptions and seeks best-fit models with the greatest explanatory power. SEM analysis started with the complete data set of 15 items. Even though there was a high correlation between all three latent variables (*NEP*, *FMT* and *AOMT*), analysis confirmed that more complex models were required to explain this data. The analysis proceeded to explore each scale individually, applying SEM for two purposes: to assess whether single factor models provide good fits for the scale data or whether two-factor models may be better; and to obtain estimates of the parameters of best fit models, including factor loadings for each item and standardised factor scores. The analysis is described in Figure 2.

Factor scores obtained for the SEM scale models for the Five Item *NEP* and Two Factor *AOMT* and *FMT* scales allow a recalculation of the correlation between *NEP*, *AOMT* and *FMT*. Pearson Correlation Coefficient analysis was undertaken to determine the extent to which the five scales (Five Item *NEP*, *AOMT* Factor One, *AOMT* Factor Two, *FMT* Factor One and *FMT* Factor Two) were linearly related. All correlations were significant. [*AOMT* Factor One and Five Item *NEP* ($r = 0.327$, $n = 186$, $p < 0.001$); *AOMT* Factor Two and Five Item *NEP* ($r = -0.253$, $n = 186$, $p = 0.001$; *FMT* Factor One and Five Item *NEP* ($r = 0.360$, $n = 186$, $p < 0.001$); *FMT* Factor Two and Five Item *NEP* ($r = -0.379$, $n = 186$, $p < 0.001$)].

Factor scores obtained for the SEM scale models for the Five Item *NEP* and Two Factor *AOMT* and *FMT* scales also allow a recalculation of the predictive relationships between *NEP*, *AOMT*, *FMT* scales and responses to the contextualising questions. Multiple regression analysis of each scale factor with the contextualising questions (Gender; Age perception; Educational qualifications; Religious belief; Educational background of parents; Self-rated critical thinking; Liberal inclinations; Self-rated persistence in solving problems and confidence in anonymity in the survey) produced the data recorded in Table 3. The data suggest that although gender does significantly predict *AOMT* Factor One, the strength of respondents' religious beliefs had by far the largest effect sizes predicting Five Item *NEP*, *AOMT* Factors One and Two and *FMT* Factor Two.

Discussion

The research described in this article suggests that significant positive relationships between elements of both *AOMT* and *FMT* and facets of sustainability concern exist and can be measured, so that thinking dispositions may be useful measures or indicators of learning gains towards indicative HESD learning targets such as sustainability concern. More particularly, however, a range of measurement and interpretive concerns do need to be stressed in this multicultural exploration. The population of respondents largely self-identified as liberal-minded, critical thinkers who persist in solving problems and who felt anonymous in the survey; surely a reasonable group of people and reasonable circumstances with whom and within which to research these matters. Detailed analysis of responses within the three scales, however, confirms that individual items within them received significantly different levels of agreement from those with and without strong religious beliefs and that some elements of both *AOMT* and *FMT* do not positively predict sustainability concern. More complex scale models than simple Five Item Means were needed to accommodate these significant differences.

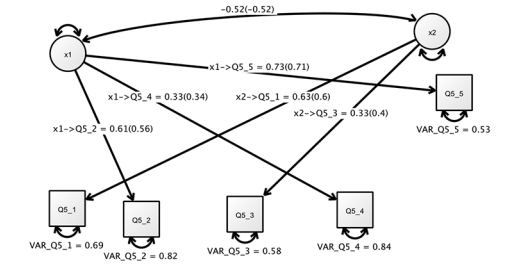
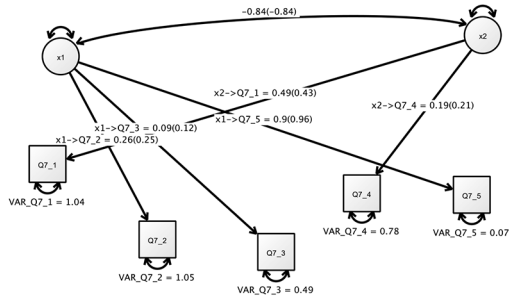
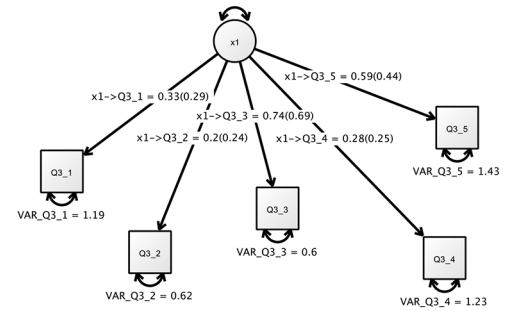
	SEM of the AOMT data confirmed that a two factor model provided the best fit with all items loading positively to one of two factors: Items 5.2 (0.56), 5.4 (0.34) and 5.5 (0,71) load to Factor One; Items 5.1 (0.60) and 5.3 (0.40) load to Factor Two. Negative correlation between the two factors was confirmed (-.52). Goodness of fit measures for the model were Chi Sq 4.32, DF 4 (Chi Sq/DF<5), RMSEA <0.001, SMRA 0.031 and CFI 1.011 confirming a very good fit.
	SEM of FMT data produced a satisfactory two factor model but with one item dominating one factor and low factor loadings on the other factor. The model had reasonable goodness of fit measures, substantially better than any single factor model. Items 7.2 (0.25), 7.3 (0.12) and 7.5 (0,96) load to FMT Factor One. Items 7.1 (0.43) and 7.4 (0.21) load to FMT Factor Two. Negative correlation between the two factors was confirmed (-.84). Goodness of fit measures for the model were Chi Sq 7.074, DF 4 (Chi Sq/DF<5), RMSEA =0.047, SMRA 0.05 and CFI 0.947 indicating a satisfactory fit.
	SEM of the NEP data produced a satisfactory model with all items loading positively to one factor (Five Item NEP) with reasonable goodness of fit measures. Two factor models were no better fitting and were not supported by our preliminary analysis of data. Item loadings were 3.1 (0.29), 3.2 (0.24), 3.3 (0.69), 3.4 (0.25) and 3.5 (0.44). Goodness of fit measures for the model were Chi Sq 16.3, DF 5 (Chi Sq/DF=5), RMSEA 1.111, SMRA 0.67 and CFI 0.075 indicating a barely satisfactory fit.

Figure 2.
SEM of the individual *AOMT*, *FMT* and *NEP* scales

Thinking dispositions and their measurement

The data suggest that although gender, educational background and persistence in solving problems do significantly predict Mean Five Item *AOMT*, the strength of respondents' religious beliefs had by far the largest contribution to these correlations. The *AOMT* and *FMT* data were explained best by allocating items in each scale to two factors based on levels of agreement expressed by those with strong religious beliefs and those without. SEM allowed for the calculation of individual scale scores of all participants and multiple regression analysis using these factor scores confirmed the importance of religious belief as a predictor of how individual respondents responded to items in the *AOMT* and *FMT*

Scale	Is the correlation significant?	Effect size of all predictors in the model (%)	Significant predictors	Coefficient B and standardised B	Significance of each predictor (p)
Five item NEP	Yes $p < 0.001$	17.2	Religious belief	−0.625, −0.395	<0.001
AOMT factor one	Yes $p < 0.000$	15.3	Gender	+0.277, +0.157	0.047
			Religious belief	−0.650, −0.406	<0.001
AOMT factor two	Yes $p = 0.014$	7.4	Religious belief	+0.344, +0.244	0.006
FMT factor one	No $p = 0.060$	4.7	Religious belief	−0.530, −0.262	0.004
FMT factor two	Yes $p = 0.043$	5.4	Religious belief	+0.485, +0.278	0.002

Notes: The data suggest that although gender does significantly predict *AOMT* factor one, the strength of respondents' religious beliefs had by far the largest effect sizes predicting Five Item *NEP*, *AOMT* factor one and two and *FMT* factor two

Table 3.
Significant predictors of the *NEP*, *AOMT* and *FMT* scale factors were revealed by multiple regression analysis using factor scores

scales. It is important to stress that this data does not support any suggestion that those with strong religious beliefs are somehow deficient in their dispositions to actively open-minded thinking and fair-mindedness in appraising reasoning. Indeed, those with strong religious beliefs, on the basis of some items in both scales, show higher levels of these dispositions than do those without strong religious beliefs. In effect, how each group responds to the scales depends entirely on what proportion of different types of items are incorporated within the scales.

There is much within the discourses of psychology and sociology to help us understand how religious beliefs may interact not only with the underlying constructs being considered but also with the means of measurement involved. With respect to the published *AOMT* scale, itself incorporating aspects of *FMT*, Baron (2017) categorised decisions, short-term beliefs and long-term beliefs and considered the need to create a scale with balanced inputs. Arguably, Items 5.1, 5.3 and 7.4, all clearly separate from most other items in a statistical sense, represent manifestations of long-term belief, rather than choices or decisions to make as a result of reasoning. In addition, how people interpret scale items relates strongly to their individual, social and cultural circumstances (Pennycook *et al.*, 2014; Piazza and Landy, 2014; Bronstein *et al.*, 2019; Stanovich and Toplak, 2019). There are also strong links between these observations and Kahan's "science-of-science-communication measurement problem" (Kahan, 2015, p. 36) emphasising, for example, identity-protective cognition as a concept that limits understanding of a phenomenon and its measurement and the importance of cultural cognition theory within this discourse.

Sustainability concern and its measurement

Broadly positive *NEP* scores (Mean = 3.54) within the sample encourages us to be positive not only about levels of sustainability concern expressed but also about using the *NEP* as a means to say something about sustainability concern as a viable educational target. Notably, those with strong religious beliefs do generate lower overall mean *NEP* scores than those without, as also described by Hope and Jones (2014) and others. Taken from the perspective of the *NEP's* design and origins, low overall *NEP* scores do indicate low levels of sustainability concern, but with the benefit of contextualising information such as additional survey questions, low and varied *NEP* scores may say as much about the conceptual underpinning of the *NEP*, as they do about the values of its respondents. Much research has explored, for example, complex relationships between concern, the *NEP* and variables such as age, gender, education and political ideology (recently summarised by Xiao *et al.*, 2019).

The relationship between sustainability concern and thinking dispositions

The data suggest that there are strong predictive relationships between facets of *AOMT* and *FMT* and the *NEP*, but that these relationships are far from straightforward. It appears that conclusions drawn from how people respond to the *AOMT*, *FMT* and *NEP* scales must be contextualised with respect to the validity of the scales in multicultural contexts, with a particular focus on how extensive strong religious beliefs are in each culture. Each of the items provides valuable information, but in multicultural situations, it cannot be assumed that each fits neatly into a self-contained factor or facet of the original construction or that each facet can be simply and sensibly numerically combined. Contextualising information will always be required. With contextualising information, these scales may yet prove to be powerful research tools as aids to understanding what and how people think about facets of sustainability. With respect to this enquiry, it is clear that aspects of *AOMT* and of *FMT* do indeed significantly predict aspects of sustainability concern, but this result does need to be

interpreted with caution. It may be the case, for example, that only by challenging their own long-term beliefs will learners be able to develop high levels of concern for all facets of sustainability concern identified within the *NEP*, but the extent to which this challenge could or should reasonably be addressed by higher education is far from clear (Ives and Kidwell, 2019, for a focus on religiosity). In stressing the nuanced nature of this relationship, this analysis may have produced a far more valuable outcome than simply confirming our initial hypothesis.

Bridging the gap between theory and practice

HESD internationally is struggling to agree on what learning should be achieved and monitored. The conceptual hypothesis builds on the near-universal appreciation for critical thinking to suggest that those who have the skills and dispositions to think critically will be sensitive to the problems that exist in the world around them and, at least, show concern about them. The research has explored how to describe and measure dispositions to think critically and facets of sustainability concern and highlighted how individuals' strength of religious belief is an important factor in these relationships and in their measurement. Future developments of these scales will need to consider the possibilities of; incorporating a more diverse range of items (reflecting decisions or beliefs or both); items that are contextual or domain, independent; and items that span the diverse disciplinary landscape of critical, rational and reflective thinking. It is also notable that, in the context of sustainability, items within the *AOMT* and *FMT* scales essentially ask respondents to think in social and economic contexts, rather than in environmental contexts. This may need to be addressed in future developments of scales.

It may simply be irrational to consider the possibility of one scale that addresses the critical thinking dispositions of those with strong religious beliefs and those without. If, in an educational sense, we seek improvements in some aspects of dispositions for open and fair-mindedness, rather than necessarily in all aspects, insights from this analysis suggest that different scales might be developed for different regions or cultures and so help educational institutions to monitor improvements of something valuable to them. Educational quests for critical thinking are by their very nature focussed on the skills and dispositions of critical thinking rather than the products of this critical thinking. Future developments of the scales researched here will also need to consider the relative advantages of maintaining separate scales for *AOMT* and *FMT* or amalgamating them, as their behaviour within this research had many commonalities.

Limitations

This is in essence an exploratory study. Respondents were limited in number and unbalanced with respect to sex and geographical background. Although these data emphasise the substantially different levels of agreement with some items exhibited by people with different levels of religious beliefs, authors do not know precisely what respondents had on their minds when responding to these items or the extent to which different degrees of cognitive dissonance may have been involved. The 5 item scales were purposefully designed to be manageable by unpaid voluntary respondents but were undoubtedly too small to provide high levels of internal reliability, particularly with SEM. From a statistical point of view, even though on balance respondents with and without strong religious beliefs tend to agree with all items, the extent to which they agree differs so much that any scale that incorporates these different types of items is bound to suffer from poor internal reliability.

Conclusions

The research demonstrates the complexity of monitoring dispositions to think critically and sustainability concern in educational systems in circumstances where the roles of religious beliefs are of interest. The research model used in this research was that critical thinking dispositions could become useful measures of ESD learning gain if links to indicative or potential HESD targets such as sustainability concern, could be established. Accordingly, the research investigated measurement approaches and educational targets that could help higher education institutions to educate for sustainable development and to monitor their progress, in ways that are compatible with their culture and values. The research suggests that dispositions to critical thinking may have a significant positive bearing on facets of sustainability concern, so that thinking dispositions may make useful measures or indicators of learning gains in HESD that are relevant to HESD educational targets. Detailed analysis of responses, however, confirms that those with and without strong religious beliefs contribute significantly different responses to scale items within these measures. The research demonstrates the complexity of monitoring dispositions to think critically and sustainability concerns in educational systems in a circumstance where the roles of religious beliefs are of interest. The strength of an individual's religious beliefs may need to be routinely considered, as researchers in the future interpret and apply data pertaining to ESD targets and measures. This research also emphasises the advantages of multinational and multicultural collaboration in researching the complexity of sustainability targets and measures and in identifying suitable targets and measures for HESD in international contexts.

References

Baron, J. (2017), "Assessment-of-actively-open-minded-thinking", available at: www.semanticscholar.org/paper/Assessment-of-actively-open-minded-thinking/1e5346efc9dc963e43a7ef469147067f0e3cf469

Baron, J. (2019), "Actively open-minded thinking in politics", *Cognition*, Vol. 188, pp. 8-18.

Bertschy, F., Künzli, C. and Lehman, M. (2013), "Teachers' competencies for the imple- mentation of educational offers in the field of education for sustainable development", *Sustainability 5067e5080*, Vol. 5 No. 12.

Biesta, G. (2019), "Should teaching be re(dis)covered? Introduction to a symposium", *Studies in Philosophy and Education*, Vol. 38 No. 5, pp. 549-553.

Brandt, J.O., Barth, M., Merritt, E. and Hale, A. (2020), "A matter of connection: the 4 Cs of learning in pre-service teacher education for sustainability", *Journal of Cleaner Production*, Vol. 279, p. 123749.

Bronstein, M.V., Pennycook, G., Bear, A., Rand, D.G. and Cannon, T.D. (2019), "Belief in fake news is associated with delusionality, dogmatism, religious fundamentalism, and reduced analytic thinking", *Journal of Applied Research in Memory and Cognition*, Vol. 8 No. 1, pp. 108-117.

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harré, N., Jarchow, M., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P. and Zint, M. (2020), "Key competencies in sustainability in higher education – toward an agreed-upon reference framework", *Sustainability Science*, doi: 10.1007/s11625-020-00838-2.

Carnegie Foundation (2020), "The six core principles of improvement", available at: www.carnegiefoundation.org/our-ideas/six-core-principles-improvement/

Clark, C.R., Heimlich, J.E., Ardoin, N.M. and Braus, J. (2020), "Using a delphi study to clarify the landscape and core outcomes in environmental education", *Environmental Education Research*, Vol. 26 No. 3, pp. 381-399.

Cotton, D.R.E. and Alcock, I. (2012), "Commitment to environmental sustainability in the UK student population", *Studies in Higher Education*, Vol. 38 No. 10, pp. 1-15.

Dunlap, R.E. (2008), "The NEP scale: from marginality to worldwide use", *The Journal of Environmental Education*, Vol. 40 No. 1, pp. 3-18.

Dunlap, R.E. and Van Liere, K.D. (1978), "The new environmental paradigm", *The Journal of Environmental Education*, Vol. 9 No. 4, pp. 10-19.

Facione, P.A. (1990), *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction*, The CA Academic Press.

Facione, P.A. (2000), "The disposition toward critical thinking: its character, measurement, and relation to critical thinking skill", *Informal Logic*, Vol. 20 No. 1, pp. 61-84.

Finnveden, G., Friman, E., Mogren, A., Palmer, H., Sund, P., Carstedt, G., Lundberg, S., Robertsson, B., Rodhe, H. and Svärd, L. (2020), "Evaluation of integration of sustainable development in higher education in Sweden", *International Journal of Sustainability in Higher Education*, Vol. 21 No. 4, doi: 10.1108/IJSHE-09-2019-0287.

Grúnõová, M., Sané, M., Cincera, J., Kroufek, R. and Hejcmanová, P. (2019), "Reliability of the new environmental paradigm for analysing the environmental attitudes of senegalese pupils in the context of conservation education projects", *Environmental Education Research*, Vol. 25 No. 2, pp. 211-221.

Hawcroft, L.J. and Milfont, T. (2010), "The use (and abuse) of the new environmental paradigm scale over the last 30 years: a meta-analysis", *Journal of Environmental Psychology*, Vol. 30 No. 2, pp. 143-158.

Holm, S. (1979), "A simple sequentially rejective multiple test procedure", *Scandinavian Journal of Statistics*, Vol. 6 No. 2, pp. 65-70.

Hope, A.L.B. and Jones, C.R. (2014), "The impact of religious faith on attitudes to environmental issues and carbon capture and storage (CCS) technologies: a mixed methods study", *Technology in Society*, Vol. 38, pp. 48-59, doi: 10.1016/j.techsoc.2014.02.00.

Hughes, C. and Tight, M. (Eds) (2020), *Learning Gains in Higher Education*, Emerald

Hungerford, H.R. and Volk, T.L. (1990), "Changing learner behavior through environmental education", *The Journal of Environmental Education*, Vol. 21 No. 3, pp. 8-21.

Ives, C.D. and Kidwell, J. (2019), "Religion and social values for sustainability", *Sustainability Science*, Vol. 14 No. 5, pp. 1355-1362.

Kahan, D.M. (2015), "Climate-Science communication and the measurement problem", *Political Psychology*, Vol. 36 No. 1.

Lambrechts, W. and Van Petegem, P. (2016), "The interrelations between competences for sustainable development and research competences", *International Journal of Sustainability in Higher Education*, Vol. 17 No. 6, pp. 776-795.

Lambrechts, W., Van Liedekerke, L. and Van Petegem, P. (2018), "Higher education for sustainable development in flanders: balancing between normative and transformative approaches", *Environmental Education Research*, Vol. 24 No. 9, pp. 1284-1300.

Lotz-Sisitka, H., Wals, A.E., Kronlid, D. and McGarry, D. (2015), "Transformative, transgressive social learning: rethinking higher education pedagogy in times of systemic global dysfunction", *Current Opinion in Environmental Sustainability*, Vol. 16, pp. 73-80.

Macpherson, R. and Stanovich, K.E. (2007), "Cognitive ability, thinking dispositions, and instructional set as predictors of critical thinking", *Learning and Individual Differences*, Vol. 17 No. 2, pp. 115-127, doi: 10.1016/j.lindif.2007.05.003.

Mood, A.M.F. (1950), *Introduction to the Theory of Statistics*, McGraw-hill.

Ntanos, S., Kyriakopoulos, G., Skordoulis, M., Chalikias, M. and Arabatzis, G. (2019), "An application of the new environmental paradigm (NEP) scale in a greek context", *Energies*, Vol. 12 No. 2, p. 239.

Pennycook, G., Cheyne, J.A., Barr, N., Koehler, D.J. and Fugelsang, J.A. (2014), "Cognitive style and religiosity: the role of conflict detection", *Memory and Cognition*, Vol. 42 No. 1, pp. 1-10.

Piazza, J. and Landy, J.F. (2014), "Morality founded on divine authority scale [data set]", *American Psychological Association*, doi: 10.1037/t28311-000.

Reyna, C., Bressán, E., Mola, D., Belaus, A. and Ortiz, M.V. (2017), "Validez estructural de la escala del nuevo paradigma ecológico en ciudadanos argentinos utilizando diferentes abordajes", *Pensamiento Psicológico*, Vol. 16 No. 1, pp. 107-118.

Rieckmann, M. (2012), "Future-oriented higher education: which key competencies should be fostered through university teaching and learning?", *Futures*, Vol. 44 No. 2, pp. 127-135.

Robertson (2017), "Developing valid and reliable survey scales", available at: www.i2ifacility.org

Ryan, A. and Tilbury, D. (2013), "Uncharted waters: voyages for education for sustainable development in the higher education curriculum", *The Curriculum Journal*, Vol. 24 No. 2, pp. 272-294.

Sa, W.C., West, R.F. and Stanovich, K.E. (1999), "The domain specificity and generality of belief bias: searching for a generalizable critical thinking skill", *Journal of Educational Psychology*, Vol. 91 No. 3, pp. 497-510.

Schoolman, E.D., Shriberg, M., Schwimmer, S. and Tysman, M. (2016), "Green cities and ivory towers: How do higher education sustainability initiatives shape millennials' consumption practices?", *Journal of Environmental Studies and Sciences*, Vol. 6 No. 3, pp. 490-502, doi: 10.1007/s13412-014-0190-z.

Scott, W. (2015), "Exploring a transformative orientation to sustainability in universities: a question of loose and tight framings", *Environmental Education Research*, Vol. 21 No. 6, pp. 943-953.

Scriven, M. and Paul, R. (1987), "Cited by the foundation for critical thinking, defining critical thinking", available at: www.criticalthinking.org/pages/defining-critical-thinking/766

Shephard, K. (2020), *Higher Education for Sustainability: Seeking Intellectual Independence in Aotearoa New Zealand*, Springer, Singapore.

Shephard, K., Mann, S., Smith, N. and Deaker, L. (2009), "Benchmarking the environmental values and attitudes of students in New Zealand's post-compulsory education", *Environmental Education Research*, Vol. 15 No. 5, pp. 571-587.

Stanovich, K.E. and Toplak, M.E. (2019), "The need for intellectual diversity in psychological science: our own studies of actively open-minded thinking as a case study", *Cognition*, Vol. 187, pp. 156-166.

Svedholm-Häkkinen, A.M. and Lindeman, M. (2018), "Actively open-minded thinking: development of a shortened scale and disentangling attitudes towards knowledge and people", *Thinking and Reasoning*, Vol. 24 No. 1, pp. 21-40.

Sylvestre, P., McNeil, R. and Wright, T. (2013), "From talloires to turin: a critical discourse analysis of declarations for sustainability in higher education", *Sustainability*, Vol. 5 No. 4, pp. 1356-1371, available at: www.mdpi.com/2071-1050/5/4/1356

United Nations Sustainable Development (1992), "Agenda 21. Rio declaration on environment and development", available at: https://sustainabledevelopment.un.org/outcomedocuments/agenda21

United Nations Educational Scientific and Cultural Organization (UNESCO) (2017), "Education for sustainable development goals. Learning objectives", UNESCO, Paris, available at: http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

United Nations Educational Scientific and Cultural Organization (UNESCO) (2019), "Sustainable development goals", available at: https://en.unesco.org/sustainabledevelopmentgoals

Wiek, A., Withycombe, L. and Redman, C.L. (2011), "Key competencies in sustainability: a reference framework for academic program development", *Sustainability Science*, Vol. 6 No. 2, pp. 203-218, doi: 10.1007/s11625-011-0132.

Xiao, C., Dunlap, R.E. and Hong, D. (2019), "Ecological worldview as the central component of environmental concern: clarifying the role of the NEP", *Society and Natural Resources*, Vol. 32 No. 1, pp. 53-72.

Appendix: Survey questions

(Indicate the extent to which you agree ... 5 point Likert-like scale)

Human skills will ensure that we can continue to live on the earth indefinitely
Humans are severely abusing the environment
The natural world is strong enough to cope with the impacts of modern industrial nations
The earth is like a spaceship with very limited room and resources
Humans were meant to rule over the rest of nature

Actively seeking all opposing arguments is a sign of good character
People should not revise their beliefs in response to new information or evidence
People should actively seek out evidence that goes against their beliefs
Intuition is the best guide in making decisions
Changing your mind is a sign of weakness

Logical thinking is more important to me than emotions or feelings
People should mostly consider the interests of their friends and relatives in reaching decisions.
I make an effort to become conscious of my prejudices
I deliberately interact with people with different points of view from my own
It is a waste of effort to look for alternative ways to be fair

Do you think that all people should be provided with the same opportunities in life?
I am fully confident that this survey guarantees my anonymity.

Sex (Male, Female, Other, rather not say)
Perception of age (Adolescent, Young adult, Middle - aged, Elderly)
Do you have strongly held religious beliefs? (Yes, No, Rather not say)
Did either of your parents go to university or college? (Yes, No, Rather not say)
Are you a graduate (Yes, No; if yes, which discipline of subject area?)
How persistent are you in solving problems? (Excellent, Good, Average, Poor Terrible)
How would you rate yourself as a critical thinker? (Excellent, Good, Average, Poor, Terrible)

Author affiliations

Kerry Shephard, Higher Education Development Centre, University of Otago, Dunedin, New Zealand

Qudsia Kalsoom, Beaconhouse National University, Lahore, Pakistan

Ritika Gupta, School of Education, Azim Premji University, Bangalore, India

Lorenz Probst, Institute for Development Research, University of Natural Resources and Life Sciences Vienna, Wien, Austria

Paul Gannon, Department of Chemical and Biological Engineering, Montana State University Bozeman, Bozeman, Montana, USA

V. Santhakumar, Azim Premji University, Bengaluru, School of Development, India

Ifeanyi Glory Ndukwe, Higher Education Development Centre, University of Otago, Dunedin, New Zealand

Tim Jowett, Department of Mathematics and Statistics, University of Otago, Dunedin, New Zealand

About the authors

Kerry Shephard is Professor of higher education development at the University of Otago's Higher Education Development Centre, Dunedin, New Zealand. Kerry's research studies higher education policy and practice, academic and educational development and the impacts that higher education has on the values of learners, particularly in the context of sustainability. Kerry Shephard is the corresponding author and can be contacted at: kerry.shephard@otago.ac.nz

Qudsia Kalsoom is an Assistant Professor at Beaconhouse National University, Pakistan. She studies research problems related to education for sustainable development; pedagogies of sustainability in higher education; critical action research; and social justice education.

Ritika Gupta is a Lecturer in the Department of Education at Azim Premji University, India. She is a psychologist and arts-based therapist primarily interested in working on preventive and promotive initiatives for mental wellness, especially in schools. Her interest areas are contemplative pedagogy, integrating socio-emotional learning in schools and the impact of education on personality dispositions.

Lorenz Probst is Deputy Head of the Institute for Development Research at the University of Natural Resources and Life Sciences, Vienna, Austria. His passion is designing, facilitating and analysing learning processes for sustainability. His research focusses on transformative learning and communicative action in sustainability transitions.

Paul Gannon is Professor of Chemical and Biological Engineering and Associate Director of the Montana Engineering Education Research Centre at Montana State University, USA. Paul has been increasingly engaged in engineering education research focussed on interconnected issues of diversity, ethics and sustainability.

V. Santhakumar is a Professor at Azim Premji University, Bangalore, India. He is currently researching issues of education and development. He has an interdisciplinary education in social sciences with a focus on economics.

Ifeanyi Glory Ndukwe was a research assistant on this project and has recently completed a PhD.

Tim Jowett is a Research Fellow and Statistical Consultant for the Science Division at the University of Otago, New Zealand. His main area of interest is applied statistics where he works with researchers from a wide range of science-related subjects.