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Sustainability education at higher education institutions: pedagogies and students' competences

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Abstract

Purpose – This study aims to examine whether the development of students' sustainability competences is dependent on how courses are delivered at higher education institutions (HEIs). It further investigates to what extent such competences can affect students' belief in the new environmental paradigm (NEP) and pro-environmental behaviors (PEBs).

Design/methodology/approach – The data was collected through an online survey conducted in 2021 among the students of an international research university based in The Netherlands. The final sample (N = 262) consisted of all the students who completed the survey and claimed that they had taken at least one course that addressed sustainability. Linear regression models were used to examine the relationship of sustainability education and students' competences, as well as their pro-environmental attitudes and behaviors.

Findings – The findings reveal that the strength of universal, broadly applicable pedagogies is positively related to the development of students' sustainability mindset/framework as well as their sustainability action/communication. The results also reveal that developing students' competences on sustainability mindset/framework is directly related to their belief in the NEP and PEBs.

Originality/value – To develop an integrative pedagogical approach requires understanding how a HEI's engagement in sustainability can impact students' attitudes and behaviors, but little research has actually measured the development of students' competences. This study fills this gap through empirically testing how different pedagogical approaches can affect students' sustainability competences differently. This has important implications for systematically linking pedagogical approaches to teaching practices or concrete learning objectives.

Keywords Competencies, Higher education, Sustainability education, Pedagogies, Educational level, Environmental attitudes

Paper type Research paper

Introduction

The notion of sustainability has gained considerable importance in recent years in public discourses. In turn, development is recognized as sustainable only if it has sufficiently addressed challenges related to economic feasibility, social justice and environmental impacts (Foy, 1990; Tang, 2018). Higher education institutions (HEIs) from different countries have started to embrace the concept and acknowledge the crucial role that they play in the advancement of sustainable development by imparting related values and beliefs among students (DuPuis and Ball, 2013; Lambrechts *et al.*, 2013). In particular, European HEIs have been taking the lead in incorporating sustainability into curricula (Lozano *et al.*, 2019).

In spite of this ongoing trend, students in European HEIs call for a more fundamental transformation of higher education to produce sustainability-oriented competences, as opposed to reactive responses of HEIs to introduce courses on sustainability as a result of bandwagoning (Velazquez *et al.*, 2005; Lambrechts *et al.*, 2013). For example, recently, 986 students from different schools of Erasmus University Rotterdam (EUR) participated in an online poll. When being asked what they thought about courses including classes on sustainability, 51% of students indicated a preference for more availability of sustainability classes at EUR, with the vast majority of them saying that these classes should be offered as part of every study program (Wang *et al.*, 2021). It implies that to develop students' sustainability competences, sustainability education requires the transcendence of the aims and methods of single disciplines (Jones and Iredale, 2010; Lam *et al.*, 2014), as well as the adoption of new educational approaches that move away from traditional knowledge conveyance toward a competency-oriented setting (Evans, 2019; Remington-Doucette *et al.*, 2013; Rieckmann, 2017; Wiek *et al.*, 2011).

Previous literature has demonstrated the impact of academic coursework on students' sustainability competences, such as environmental attitudes and behaviors. For example, students who follow a course in environmental studies are found to be more likely to engage in environmentally responsible behaviors, compared to others who do not take such a course (Smith-Sebasto, 1995). While studying how different majors can change perceptions on the environment among students, scholars found clear evidence that courses can not only increase environmental literacy but also stimulate environmentally responsible behaviors (Ryu and Brody, 2006; Stewart, 2010). Along with these empirical findings, the literature suggests that sustainability education should be an interdisciplinary course of study with an integrative pedagogical approach (Rowe, 2002). It points to an integration of curricula across the full breadth of the campus (Chase and Rowland, 2004), as well as contextualizing current pedagogical approaches through place, self and community (Gruenewald, 2003; Kagawa, 2007; Lundholm, 2005). Accordingly, to develop an integrative pedagogical approach requires understanding how a HEI's engagement in sustainability can impact students' attitudes and behaviors.

However, little research has actually measured the development of students' competences (Cebrián *et al.*, 2020). Lozano *et al.* (2019) are among the first attempts to assess the connections between pedagogical approaches and competences, but their focus draws on teacher perspective, as opposed to measuring students' competences directly. Advancing knowledge in the relationship of different pedagogical approaches and students' sustainability competences not only contributes to the literature of sustainability education but also sheds light on how to develop useful pedagogical tools in purpose of empowering students to address sustainability challenges. Hence, to fill this void, the current study aims to answer to what extent different pedagogical approaches can affect students'

sustainability competences and how these competences in turn impact students' attitudes and behaviors.

Theoretical framework

In a broad scope, the notion of competences entails the ability to do something which involves four pillars: learning to know, learning to do, learning to be and learning to live together (Delors, 1996). Research has been conducted on how students' competences on sustainability can be developed through pedagogical approaches (Fadeeva *et al.*, 2010). In the context of higher education, competences refer to what the students will be more capable of doing after completing the learning activity (Fadeeva *et al.*, 2010). It is a common way of describing desired educational outcomes, which includes cognitive, functional, ethical and personal dimensions (Segalàs *et al.*, 2010; Sturmberg and Hinchy, 2010). Over the years, several lists of competences for sustainability education have been compiled (for a literature review on the topic Wiek *et al.*, 2011). The list of 12 competences proposed by Lozano *et al.* (2017) stands out as it connects competences to pedagogical approaches. It includes systems thinking; interdisciplinary work; anticipatory thinking; justice, responsibility and ethics; critical thinking and analysis; interpersonal relations and collaboration; empathy and change of perspective; communication and use of media; strategic action; personal involvement; assessment and evaluation; and tolerance for ambiguity and uncertainty. While Lozano *et al.* (2017) draw connections between these competences and pedagogical approaches, previous literature on sustainability competences often failed to systematically link them to teaching practices or concrete learning objectives (Wiek *et al.*, 2015). And yet, establishing such links can carry important implications for sustainability education. Hence, this paper aims to examine whether the development of students' sustainability competences is dependent on how courses are delivered. It further investigates to what extent the competences (i.e. 12 competences developed by Lozano *et al.*, 2019; involving systems thinking, interdisciplinary work, etc.) can affect students' belief in the new environmental paradigm (NEP) and pro-environmental behavior (PEB).

Impact of pedagogies on students' sustainability competences

Sustainability competences need to be developed by integrating different pedagogical approaches, which allow students to benefit from different learning processes (Lozano *et al.*, 2019). In addition to traditional lectures, the value of alternative pedagogical approaches has been addressed in literature (Ceulemans and De Prins, 2010; Lambrechts, 2013), such as a range of student-activating approaches (e.g. jigsaw, problem-oriented education, roleplay and simulations). This paper actively draws on Lozano *et al.*'s (2017) classification of 12 pedagogical approaches into three clusters: First, "universal-broadly applicable pedagogies" that have been used in many disciplines. Second, "community and social justice pedagogies" specifically developed for addressing social justice and community-building. Third, "environmental education pedagogies" emerging from environmental education practices.

The first cluster – universal-broadly applicable pedagogies – involves case studies, interdisciplinary team teaching, lecturing, mind and concept maps, project and/or problem-based learning (PBL) (Lozano *et al.*, 2017). These pedagogies can be applied to academic coursework in various disciplines. Also, it is rather common that several pedagogies in this cluster are adopted for one course as their roles are complementary to each other (Lozano *et al.*, 2017). An integration of these pedagogical approaches can allow students to critically reflect on their conceptions of sustainability and use acquired knowledge to tackle real-life issues. Furthermore, the flexibility of adopting universal-broadly applicable pedagogies in

multiple courses may enable these pedagogies to enhance students' learning experience and outcomes.

The second cluster – community and social justice pedagogies – entails community service learning, jigsaw/interlinked teams and participatory action research (Lozano *et al.*, 2017). These types of pedagogical approaches often involve interactive learning processes and participatory action among the students. For example, students can engage in activities aimed at benefiting other people and the community, develop expertise on specific topics and teach the topics to other students through a cooperative peer-learning method. These pedagogical approaches can not only improve students' responses to uncertainty but also raise their awareness of multidimensionality in identifying and assessing social problems (Batchelder and Root, 1994).

The third cluster – environmental education pedagogies – emphasizes a deep transformation of students' mindset (Bowers, 2002). It involves a variety of pedagogical approaches, such as eco-justice and community, place-based environmental education and supply chain/life cycle analysis (Lozano *et al.*, 2017). These approaches can challenge students to consider sustainability issues through examining specific economic, social and environmental contexts and effects. Students may also become more critical about their responsibility to future generations, as well as environmental racism and class discrimination (Bowers, 2002).

While the three pedagogical clusters emphasize different kinds of knowledge development and learning experiences, they may all contribute to strengthening students' sustainability competences. Lozano *et al.* (2017) argued that no single pedagogical approach alone can develop students' sustainability competences. On the contrary, strengthening students' sustainability competences requires the involvement of multiple pedagogical approaches (Lozano *et al.*, 2017). Accordingly, it is predicted that all three types of pedagogy clusters are positively linked to students' sustainability competences. Hence, the following hypotheses are proposed:

H1a. The strength of universal-broadly applicable pedagogies affects students' sustainability competences positively.

H1b. The strength of community and social justice pedagogies affects students' sustainability competences positively.

H1c. The strength of environmental education pedagogies affects students' sustainability competences positively.

Sustainability competences and perception of new environmental paradigm
The NEP entails a range of facts for an ecological worldview (Dunlap *et al.*, 2000). This concept was first proposed by Dunlap and Van Liere (1978) and later on modified by Dunlap *et al.* (2000) to cover a wider range of pro-environmental orientations. More recently, the emergence of global environmental change has further made the concept relevant for understanding people's environmental concern. Personal attitudes and values reflected in the NEP are argued to constitute a fundamental component of people's belief systems in relation to the environment (Dunlap *et al.*, 2000). These core beliefs may further influence people's attitudes on more specific environmental issues (Stern *et al.*, 1995).

Studies have shown that the NEP is positively related to education, notably because the more educated students are, the more exposed to environmental information and the more receptive to the ecological worldview embedded in the NEP they become (Dunlap *et al.*, 2000, pp. 429–430). Numerous studies have found positive relationships between environmental

courses in higher education and environmental behaviors, values and literacy (Hsu, 2004; McMillan *et al.*, 2004). Little attention has however been paid to the relation between higher education courses in sustainability and students' beliefs in the NEP specifically. Woodworth *et al.*'s (2011) study stands out as an exception and reveals that students were in stronger support of the NEP following their course on environmental issues. In light of previous research, education for sustainable development competences at HEIs is likely to contribute to enhancing students' belief in the NEP, given that students will not only acquire a good understanding of complex systems phenomena including environment-related issues (a competence of systems thinking) but also be able to apply concepts of social and ecological integrity to analyze real-life problems (a competence of justice, responsibility and ethics). In particular, the competences of critical thinking, empathy and change of perspective could be of important value in relation to developing students' belief in the NEP as it allows students to reflect on their own values, perceptions and actions, as well as understand and sympathize for the needs and actions of others. Accordingly, it is predicted that students' sustainability competences can positively affect their belief in the NEP. Therefore, the following hypothesis is proposed:

H2. Students' sustainability competences are positively related to their belief of the NEP.

Sustainability competences and pro-environmental behavior
PEB refers to a variety of low and high environmental impact actions which are summarized into four behavioral domains: domestic energy/water use, waste behavior, transport and eco-friendly shopping (Whitmarsh and O'Neill, 2010). Previous literature has discovered that there are strong correlations across these behavioral domains (Thøgersen and Ölander, 2006), implying that a general pattern of PEB can be observed at the individual level. Some articles explored the diversity of factors that may influence PEB, including environmental values and concern, as well as other motivations and structural factors (Bamberg *et al.*, 2003; Jackson, 2005). These findings suggest that not only environmental concern can trigger PEB but also other specific behavior-oriented attitudes have the potential to predict PEB. Although education has been identified as a crucial variable to explain individuals' strong environmental concern and behavior (Zsóka *et al.*, 2012), the relation between (formal sustainability) education and PEB has not been systematically established.

Studies have pointed to students' sustainability competences being one of the predictors that can determine their PEB. Vicente-Molina *et al.* (2013), for instance, found that PEB is influenced by formal education and knowledge of environmental issues. However, as explained by the authors, the scope and complexity of variables coming into play (e.g. altruistic motivations, gender, actual and perceived knowledge) make it difficult to reliably establish the relationship (Vicente-Molina *et al.*, 2013) and indicate the need for further research on the topic. Indeed, a good understanding of the sustainability framework (i.e. sustainability competence) is of particular importance for students to develop their behavior-oriented attitudes, which will be eventually reflected in PEB. For example, similar to the discussion above, the competence of critical thinking and empathy and change of perspective can enable students to understand and sympathize for the needs and actions of others. As a result, they may critically reflect on the impact of their own actions and engage in PEBs. Correspondingly, it is predicted that students' sustainability competences can positively affect their PEB. Hence, the following hypothesis is proposed:

H3. Students' sustainability competences is positively related to their PEB.

Educational level and sustainability competences
As discussed thus far, studies have shown the relation between education and sustainability competences. However, there is no clarity yet as to which competences are developed in students by sustainability programs. This relates back to the fact that sustainability competences are not systematically linked to learning outcomes or pedagogical approaches (for an exception see, for example, Lozano *et al.*, 2017). Not being able to measure which competences sustainability programs develop is harmful to the recognition of such courses within and outside of universities (Brundiers *et al.*, 2021). In an attempt to remedy such gaps, some scholars have proposed to create a hierarchy among competences. However, little consensus has emerged from such endeavors, which also revealed different aspects coming into play when ranking competences and connecting them to students' increasing knowledge and positive attitudes toward sustainability.

First, the reductive assumption that sustainability primarily and mostly relates to environmental sustainability needs to be deconstructed. Studies indeed hint at the importance of giving more attention to social sustainability as a means of developing students' overall sustainability competence (Pappas *et al.*, 2013). This echoes findings indicating the importance of values-thinking competence as well as intrapersonal and implementation competences (Brundiers *et al.*, 2021). That is, a holistic, socially-oriented and value-focused approach to sustainability might bear more impact on developing sustainability competences. Second, context has been shown to be of importance. Sustainability competences are deeply linked to geopolitical realities, which has sometimes been overlooked by Eurocentric studies. Discussing which competences should be prioritized therefore needs to be done in light of contextual aspects that include different worldviews (Zidny *et al.*, 2020).

Studies that have endeavored to rank sustainability competences have typically identified systems thinking as one of the main competences (Demssie *et al.*, 2019; Rieckmann, 2012). Other studies have attempted to connect established sustainability competences to levels of Bloom's taxonomy (which ranks learning objectives from less to more complex) as well as to levels of higher education (e.g. BA, MA and Ph.D.), thereby connecting competences to gradual learning objectives (Brundiers *et al.*, 2021; Pappas *et al.*, 2013). Results have suggested students' increasing ability to rely on holistic approaches to sustainability as courses progress (Pappas *et al.*, 2013). Thus, in light of these findings, the following hypothesis is proposed:

H4. Higher educational levels will correspond to stronger sustainability competence among students, compared to others with a lower educational level.

The theoretical predictions are summarized in the conceptual model shown in Figure 1.

Method
Sample
To test the theoretical predictions, an online survey was conducted. This method allows the researchers to access individuals and measure their perceptions efficiently (Wright, 2005). Hence, it is well-suited to the purpose of the current research to examine whether the development of students' sustainability competences is dependent on how courses are delivered at HEIs, and to what extent these competences can affect students' belief in the NEP and PEBs.

The data was collected in April–May 2021 among the students of EUR, an international research university based in the Netherlands. The survey was published in various online portals, including the university website and social media, SIN-Online and student
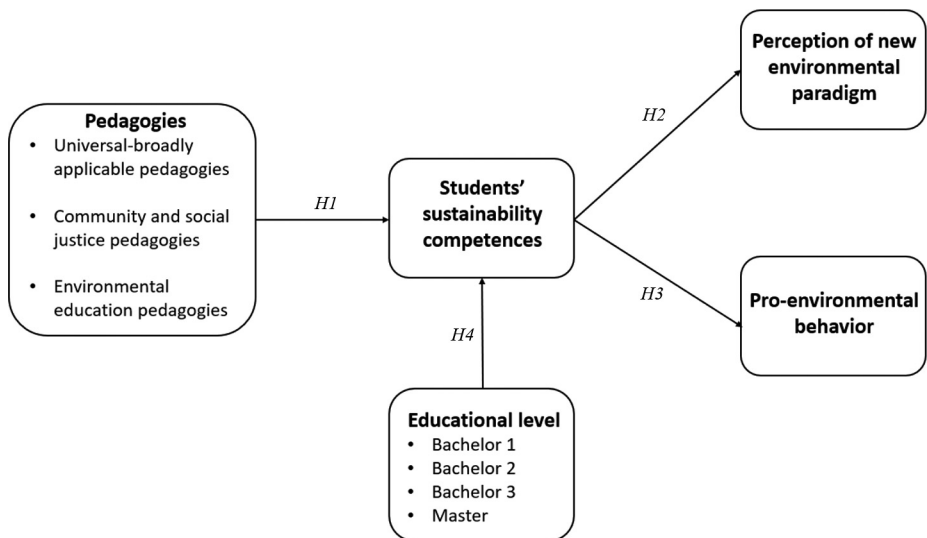
Figure 1.
Conceptual model

association platforms. Students at different educational levels were all invited to fill out the questionnaire. In total 821 students participated in the survey, among whom 420 (51.16%) students claimed that they have taken at least one course that addressed sustainability at EUR.

The final sample ($N = 262$) consisted of all the students who completed the survey. Among them, 187 (71.37%) students were female; 72 (27.48%) students were male; and 3 (1.15%) students preferred not to mention their gender. Most students ($n = 255$, 97.33%) were between 18 and 28 years old. The students came from 42 countries based in five continents. Over half of them were from Europe ($n = 196$, 74.81%), followed by students with a multi-nationality ($n = 44$, 16.78%). Ten (3.82%) students came from Asia, five (1.91%) from South America, four (1.53%) from Africa and three (1.15%) from North America. The majority of the students ($n = 109$, 41.6%) were studying a master's program. Sixty one (23.28%) students were in the first year of their bachelor's program, 35 (13.36%) in the second year and 44 (16.79%) in the third year. Only 13 (4.96%) students were doing a pre-master's.

Survey design and measures. The online survey was developed in Qualtrics. The procedure started by introducing the study and asking the participants' consent for collecting their personal data for research purposes. Then, students were asked whether they have taken any course that addressed sustainability at EUR. Students who answered "no" to this question were directed to the end of the survey. After this question, a few variables were measured, including *students' conception of sustainability*, *strength of pedagogical approaches*, *sustainability competences*, *perception of NEP* and *PEB*. The survey ends with a few demographic questions. Students who completed the survey participated in a lottery and the winner received a book voucher of 50 euros. A pretest was conducted among a group of students before the distribution of the survey, and the formulation of some questions was adjusted based on their feedback.

Validated scales were used to measure the variables in the current study (see Table 1). In total, five variables were measured through multi-item scales, including four main variables,

Scale	Items	Cronbach's alpha
New environmental paradigm Dunlap *et al.* (2000) (Five-point Likert scale)	We are approaching the limit of the number of people the Earth can support (1) Humans have the right to modify the natural environment to suit their needs (2) When humans interfere with nature it often produces disastrous consequences (3) Human ingenuity will insure that we do not make the Earth unlivable (4) Humans are seriously abusing the environment (5) The Earth has plenty of natural resources if we just learn how to develop them (6) Plants and animals have as much right as humans to exist (7) The balance of nature is strong enough to cope with the impacts of modern industrial nations (8) Despite our special abilities, humans are still subject to the laws of nature (9) The so-called "ecological crisis" facing humankind has been greatly exaggerated (10) The Earth is like a spaceship with very limited room and resources (11) Humans were meant to rule over the rest of nature (12) The balance of nature is very delicate and easily upset (13) Humans will eventually learn enough about how nature works to be able to control it (14) If things continue on their present course, we will soon experience a major ecological catastrophe (15)	0.735
Pro-environmental behavior Barbaro and Pickett's (2016) (Four-point Likert scale)	Turn off lights you're not using (1) Walk, cycle or take public transport for short journeys (i.e. trips of less than 5 km) (2) Use an alternative to travelling (e.g. shopping online) (3) Share a car journey with someone else (4) Cut down on the amount you fly (5) Buy environmentally friendly products (6) Eat food which is organic, locally-grown or in season (7) Avoid eating meat (8) Buy products with less packaging (9) Recycle (10) Reuse or repair items instead of throwing them away (11) Compost your kitchen waste (12) Save water by taking shorter showers (13) Turn off the tap while you brush your teeth (14) Write to your member of parliament about an environmental issue (15) Take part in a protest about an environmental issue (16)	0.758
Strength of pedagogical approaches Lozano *et al.* (2019) (Five-point Likert scale)	Case studies (1) Interdisciplinary team teaching (2) Lecturing (3) Mind and concept maps (4) Project and/or problem-based learning (5) Community service learning (students engage in activities intended to directly benefit other people) (6)	0.845
	(continued)	

Table 1.
Scale reliability
($N = 262$)

Scale	Items	Cronbach's alpha
	Jigsaw/interlinked teams (a cooperative peer-learning method) (7)	
	Participatory action research (students conduct research that involves participants and has concrete outcomes) (8)	
	Eco-justice and community (9)	
	Place-based environmental education (students apply theories to concrete geographical locations) (10)	
	Supply chain/life-cycle analysis (method that follows the path of a specific product or commodity) (11)	
	Traditional ecological knowledge (long-term knowledge of complex local ecosystems) (12)	
Sustainability competences Lozano *et al.* (2019) (Five-point Likert scale)	Systems thinking (1) Interdisciplinary work (2) Anticipatory thinking (3) Justice, responsibility, and ethics (4) Critical thinking and analysis (5) Interpersonal relations and collaboration (6) Empathy and change of perspective (7) Communication and use of media (8) Strategic action (9) Personal involvement (10) Assessment and evaluation (11) Tolerance for ambiguity and uncertainty (12)	0.907
Conceptions of sustainability Fisher and McAdams (2015) (Four-point Likert scale)	Preserving resources for future generations (1) Protecting ecosystems and biodiversity (2) Reusing waste to create new goods (3) Energy efficiency (4) Recycling and reducing waste (5) Long-term human well-being (6) Democratic participation (7) Local community (8) Social equity and justice (9) Technology and innovation (10) Assessing risk to human systems (11) Renewable energy (12) Change to political/economic systems (13)	0.802

Table 1.

which are *perception of NEP*, *PEB*, *strength of pedagogical approaches* and *sustainability competences*, as well as one control variable, *conceptions of sustainability*.

New environmental paradigm. This scale measures individuals' primitive beliefs about their relationship to the natural world (Dunlap *et al.*, 2000). These beliefs comprise one's worldview and are believed to affect specific attitudes and beliefs about environmental issues. The scale contains 15 self-report items measured on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Examples include "We are approaching the limit of the number of people the Earth can support" and "When humans interfere with nature it often produces disastrous consequences." The anti-NEP items were reverse coded. A Cronbach's alpha (α) test was conducted to ensure the reliability of each scale. If Cronbach's alpha is between 0.60 and 0.80, the scale is considered to be moderately reliable

and is accepted (Pallant, 2010). This variable thus demonstrated sufficient reliability (Cronbach's α = 0.735). A principle component factor analysis suggested that this variable is composed of four dimensions. However, Dunlap *et al*. (2000) argue that when measuring *the NEP*, a high internal consistency (0.7 or higher) provides "a reasonable rationale for combining a set of items into a single measure rather than creating *ad hoc* dimensions that emerge from various factoring techniques" (p. 431). Therefore, one mean-scale was created for measuring *the NEP*.

Pro-environmental behavior. This variable was measured using the scale developed by Whitmarsh and O'Neill (2010). The original scale contains 24 items. However, similar to the approaches adopted in Barbaro and Pickett's (2016), the first seven questions were excluded given that these questions may not be applicable to undergraduate students. Hence, the scale in the current study consists of 16 items measured on a four-point Likert scale, ranging from 1 (never) to 4 (always). Examples include "recycle" and "buy environmentally friendly products." A high internal consistency was observed for this variable (Cronbach's α = 0.758). Hence, similar to the NEP variable, a mean-scale was computed for measuring *PEB*.

Strength of pedagogical approaches. This variable was measured through the scale developed by Lozano *et al*. (2019). The scale contains 12 items measured on a five-point Likert scale, ranging from 1 (never/not applicable) to 5 (all of the time). Example items include "Case studies" and "Lecturing." This variable demonstrated a high reliability (Cronbach's α = 0.845). Following Lozano *et al*. (2019), the scale was divided into three dimensions: *universal-broadly applicable pedagogies* (items 1–5), *community and social justice pedagogies* (items 6–8) and *environmental education pedagogies* (items 9–12). Mean-scales were created for each dimension.

Sustainability competences. This variable was measured using a scale developed by Lozano *et al*. (2019). The scale contains 12 items measured on a five-point Likert scale, ranging from 1 (definitely not/not applicable) to 5 (definitely yes). Example items are "systems thinking" and "interdisciplinary work." This scale demonstrated sufficient reliability (Cronbach's α = 0.907). However, a principal component analysis resulted in two dimensions. Items such as "justice, responsibility, and ethics"; "critical thinking and analysis"; "interdisciplinary work"; and "anticipatory thinking" were mainly loaded on the first dimension. Other items such as "strategic action," "communication and use of media" and "personal involvement" were loaded on the second dimension. As a clear distinction can be made between these two dimensions, the first dimension was labeled as "sustainability mindset/framework" and the second dimension as "sustainability action/communication." Both dimensions were saved to measure students' competences for the data analysis.

Conceptions of sustainability. Students' conceptions of sustainability were measured using the scale developed by Fisher and McAdams (2015). The scale contains 13 items and is measured on a four-point Likert scale, ranging from 1 (not at all important) to 4 (extremely important). Example items are "recycling and reducing waste" and "reserving resources for future generations." This scale demonstrated sufficient reliability (Cronbach's α = 0.802) and consists of four dimensions: *ecosystems and nature* (items 1–2), *eco-efficiency* (items 3–5), *community and well-being* (items 6–9) and *systemic change and innovation* (items 10–13). Mean-scales were created for each dimension.

The correlation matrix of the variables measured by validated scales is shown in Table 2. As presented in the table, sustainability mindset/framework is detected to be positively correlated with all three pedagogical approaches, though the correlation with the community and social justice pedagogies ($r_{s\ mindset/framework\ -\ C/SD\ pedagogies}$ = 0.142, $p < 0.05$) is relatively lower than the other two ($r_{s\ mindset/framework\ -\ U\ pedagogies}$ = 0.483, $p < 0.001$, $r_{s\ mindset/framework\ -\ Eedu\ pedagogies}$ = 0.326, $p < 0.001$). In parallel, *sustainability*

	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. NEP	3.88	0.464	–	–	–	–	–	–	–	–	–	–
2. PEB	2.64	0.38	0.368**	–	–	–	–	–	–	–	–	–
3. U pedagogies	3.97	0.892	0.102	0.166**	–	–	–	–	–	–	–	–
4. C&SJ pedagogies	1.68	0.842	–0.041	0.054	0.468**	–	–	–	–	–	–	–
5. Eedu pedagogies	2.04	0.893	0.062	0.109	0.532***	0.471**	–	–	–	–	–	–
6. S mindset/framework	–	–	0.254**	0.201**	0.483***	0.142*	0.326**	–	–	–	–	–
7. S action/communication	–	–	–0.015	0.114	0.373***	0.355**	0.263**	0.000	–	–	–	–
8. CSI E&N	3.62	0.487	0.400**	0.281**	0.131*	–0.002	0.006	0.198**	0.021	–	–	–
9. CSI Eco	3.41	0.497	0.237**	0.270**	0.098	0.003	0.040	0.127*	0.001	0.514**	–	–
10. CSI C&W	3.19	0.603	0.259**	0.359**	0.129*	0.118	0.142*	0.123*	0.206**	0.259**	0.345**	–
11. CSI S&I	3.27	0.446	0.235**	0.251**	0.170**	0.062	0.132*	0.266**	0.180**	0.329**	0.458**	0.488**

Notes: $N = 262$. NEP: new environmental paradigm; PEB: pro-environmental behavior; U pedagogies: universal pedagogies; C&SJ pedagogies: community and social justice pedagogies; Eedu pedagogies: environmental education pedagogies; S mindset/framework: sustainability mindset/framework (This variable is a saved component of the factor analysis.); S action/communication: sustainability action/communication (This variable is a saved component of the factor analysis.); CSI E&N: conceptions of sustainability index ecosystems and nature; CSI Eco: conceptions of sustainability index eco-efficiency; CSI C&W: conceptions of sustainability index community and wellbeing; CSI S&I: conceptions of sustainability index systems change and innovation; SD: standard deviation. *$p < 0.05$, **$p < 0.01$

Table 2.
Descriptive statistics and correlation matrix

action/communication is also positively correlated with all three pedagogical approaches ($r_{s\ action/communication\ -\ U\ pedagogies} = 0.373, p < 0.001$; $r_{s\ action/communication\ -\ C/SD\ pedagogies} = 0.355, p < 0.001$; and $r_{s\ action/communication\ -\ Edu\ pedagogies} = 0.263, p < 0.001$). In addition, both *NEP* and *PEB* are found to be positively correlated with *sustainability mindset/ framework* ($r_{NEP\ -\ s\ mindset/framework} = 0.254, p < 0.001$, $r_{PEB\ -\ s\ mindset/framework} = 0.201$, $p < 0.001$) but not with *sustainability action/communication*. Further, all four dimensions of the concepts of sustainability are found to be positively correlated with *sustainability mindset/framework*. However, only two dimensions – *community and well-being* and *systemic change and innovation* – are detected to be positively correlated with *sustainability action/communication* ($r_{CSI\ C\&W\ -\ s\ action/communication} = 0.206, p < 0.001, r_{CSI\ S\&I\ -\ s\ action/communication} = 0.180, p < 0.001$).

Results

To test the theoretical predictions, data analysis was conducted in SPSS (version 26). *H1* predicted a positive impact of the strength of pedagogical approaches on students' sustainability competences. Two linear regression analyses were conducted with *sustainability mindset/framework* (Model 1) and *sustainability action/communication* (Model 2) as the dependent variables, respectively. The predictors were the three types of pedagogical approaches. Conceptions of sustainability, age, gender and educational level were controlled in the regression models. Assumptions of the regression analysis were tested, and no violation was detected. Model 1 (see Table 3) was found to be significant $F(10, 251) = 10.851, p < 0.001$. The value of R^2 revealed that the model explained 30.2% of the total variance. The positive impact of the strength of *universal-broadly applicable pedagogies* on *sustainability mindset/framework* was found to be highly significant ($\beta = 0.482, t = 6.421$, $p < 0.001$). In contrast, the regression analysis revealed a significant negative impact of *community and social justice pedagogies* on *sustainability mindset/framework* ($\beta = -0.149$, $t = -1.978, p < 0.05$). Further, the positive impact of the strength of the *environmental education pedagogies* was found to be significant ($\beta = -0.158, t = 2.128, p < 0.05$).

When testing the impact of the pedagogical approaches on *sustainability action/ communication*, Model 2 (see Table 3) was found to be significant $F(10, 251) = 8.097, p < 0.001$.

Unstandardized coefficient	Model 1 β (SE)	Model 2 β (SE)
Constant	-2.871*** (0.660)	-1.779** (0.686)
Universal-broadly applicable pedagogies	0.482*** (0.075)	0.254*** (0.078)
Community and social justice pedagogies	-0.149* (0.076)	0.236** (0.079)
Environmental education pedagogies	0.158* (0.074)	0.019 (0.077)
Conceptions of sustainability_ecosystems and nature	0.241 (0.129)	-0.038 (0.134)
Conceptions of sustainability_community and wellbeing	-0.112 (0.134)	-0.244 (0.139)
Conceptions of sustainability_eco-efficiency	-0.057 (0.105)	0.220* (0.109)
Conceptions of sustainability_systemic change and innovation	0.414** (0.147)	0.278 (0.153)
Age	-0.020 (0.022)	-0.022 (0.023)
Gender	0.064 (0.116)	0.026 (0.120)
Educational level	0.011 (0.040)	0.117** (0.042)
R^2	0.302	0.244
F value	10.851***	8.097***

Notes: *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$

Table 3.
Impact of the strength of pedagogical approaches on sustainability mindset/framework (model 1) and action/ communication (model 2)

The value of R^2 revealed that the model explained 24.4% of the total variance. Similar to Model 1, the positive impact of the strength of *universal-broadly applicable pedagogies* on *sustainability action/communication* was found to be highly significant ($\beta = 0.254$, $t = 3.260$, $p < 0.001$). However, the significant impact of *community and social justice pedagogies* was also found to be positive ($\beta = 0.236$, $t = 3.004$, $p < 0.01$). In addition, we could not find any significant impact of the strength of *environmental education pedagogies* on *sustainability action/communication* ($\beta = 0.019$, $t = 0.241$, $p = 0.810$).

Combining the results of Models 1 and 2, we could confirm the prediction in *H1a* that the strength of *universal-broadly applicable pedagogies* is positively related to the development of *students' sustainability mindset/framework* as well as their *sustainability action/ communication*. However, *H1b* and *H1c* are only partially confirmed given that the *strength of community* and *social justice pedagogies* is only uncovered to affect *students' sustainability action/communication* positively, and the *strength of environmental education pedagogies* is only found to be significantly associated with *students' sustainability mindset/framework*.

H2 predicted that students' sustainability competence is positively related to their belief in NEP. One linear regression analysis was conducted with *NEP* as the dependent variable (Model 3). The predictors were the two types of sustainability competences. Conceptions of sustainability, age, gender and educational level were controlled in the regression models. Assumptions of the regression analysis were tested, and no violation was detected. Model 3 (see Table 4) was found to be significant $F(9, 252) = 10.520$, $p < 0.001$. The value of R^2 revealed that the model explained 27.3% of the total variance. When comparing the predicting power of the two types of sustainability competences, a positive impact was only discovered for *sustainability mindset/framework* on students' belief in the NEP ($\beta = 0.071$, $t = 2.712$, $p < 0.01$). In contrast, no such effect was found for *sustainability action/ communication* ($\beta = -0.036$, $t = -1.375$, $p = 0.170$).

Parallel to Model 3, Model 4 (see Table 4) tested *H3* which predicted that students' sustainability competences are positively related to their PEB. The model was found to be significant $F(9, 252) = 7.139$, $p < 0.001$. The value of R^2 revealed that the model explained 20.3% of the total variance. With respect to the influence of the two types of sustainability competences, a positive impact was only discovered for *sustainability mindset/framework* on

Unstandardized coefficient	Model 3 β (SE)	Model 4 β (SE)
Constant	2.067*** (0.313)	1.467*** (0.269)
Sustainability mindset/framework	0.071** (0.026)	0.047* (0.023)
Sustainability action/communication	−0.036 (0.026)	0.017 (0.023)
Conceptions of sustainability_ecosystems and nature	0.301*** (0.061)	0.108* (0.052)
Conceptions of sustainability_community and wellbeing	−0.027 (0.064)	0.066 (0.055)
Conceptions of sustainability_eco-efficiency	0.103* (0.050)	0.166*** (0.043)
Conceptions of sustainability_systemic change and innovation	0.046 (0.071)	−0.006 (0.061)
Age	−0.007 (0.010)	−0.007 (0.009)
Gender	0.228*** (0.054)	0.076 (0.047)
Educational level	0.030 (0.019)	0.020 (0.017)
R^2	0.273	0.203
F value	10.520***	7.139***

Notes: *$p < 0.05$, **$p < 0.01$ and ***$p < 0.001$

Table 4.
Impact of sustainability competences on new environmental paradigm (model 3) and PEB (model 4)

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students' PEB ($\beta = 0.047$, $t = 2.089$, $p < 0.05$). In contrast, no significant effect was found for *sustainability action/communication* ($\beta = 0.017$, $t = 0.736$, $p = 0.462$).

The results of Models 3 and 4 revealed that developing students' competences on sustainability mindset/framework is directly related to their belief in the NEP and PEB. On the other hand, to what extent students' competences on sustainability action/ communication may affect their beliefs and behaviors remains unclear. Therefore, we can only partially confirm the predictions of *H2* and *H3*.

H4 predicted that students with a higher educational level will correspond to stronger sustainability competences, compared to others with a lower educational level. To test the theoretical prediction, two one-way analysis of variance (ANOVA) tests were conducted. Pre-master's students were excluded from this analysis due to a small sample size ($n = 13$). The first ANOVA test examined how students' competences on sustainability mindset/ framework corresponded to their educational level. A nonsignificant Levene's test revealed that equal variances can be assumed $F(3, 245) = 0.721$, $p = 0.540$. The ANOVA result showed that no significant difference of *sustainability mindset/framework* can be found with respect to different educational levels $F(3, 245) = 1.196$, $p = 0.312$.

The second ANOVA test examined how students' competences on sustainability action/ communication is related to their educational level. A non-significant Levene's test revealed that equal variances can be assumed $F(3, 245) = 1.202$, $p = 0.310$. Different from the first ANOVA test, the second test revealed a significant difference in *sustainability action/ communication* in relation to educational level $F(3, 245) = 4.733$, $p = 0.003$. Moreover, the *sustainability action/communication* competences are observed to be the highest for the master's students ($n = 109$, $M = 0.181$, $SD = 0.935$), followed by the third year bachelor's students ($n = 44$, $M = 0.053$, $SD = 0.933$), then the second year bachelor's students ($n = 35$, $M = -0.009$, $SD = 1.07$). The first year bachelor's students are found to have the lowest competence on *sustainability action/communication* ($n = 61$, $M = -0.411$, $SD = 1.08$). This result verifies our hypothesis that students' sustainability competences and their educational level are related. Therefore, *H4* is partially confirmed.

Discussion

The results reveal that the only type of pedagogy that contributed to both sustainability mindset/framework and sustainability communication/action was the universal pedagogies group. This pedagogical group comprises a wide variety of methods to deliver education, such as case studies, problem-based learning (PBL) and project-based learning (PPL), which can be combined in a single course (Lozano *et al.*, 2017). Lozano *et al.* (2017) support the complementarity of different pedagogies in the development of sustainability competences. The findings suggest that the complementarity of different pedagogical methods and disciplines that form part of universal pedagogies plays an important role in fostering both mindset and action-related competences. This result is in line with previous studies that focused on the different methods that comprise such pedagogies. For instance, Sprain and Timpson (2012) find that case-based approaches contribute to the ability of students to make sense of complexity and to manage uncertainty (mindset/framework oriented) and also prompts them to generate innovative strategies (action-oriented). Brundiers and Wiek (2013) propose that a combination of PBL and PPL approaches could foster skills to both examine the problem (which is emphasized in PBL) and the ability to develop solution options (fostered by PPL).

On the other hand, the findings reveal that both sustainability environmental education pedagogies and community and justice pedagogies contributed to the development of only one aspect of sustainability competence, either mindset/framework or action-oriented

competences, respectively. Traditionally, environmental education has been based on the understanding of the state of the environment with the objective to promote environmental awareness, which, in turn, was seen as a requirement to change one's environmental behavior (Dreyfus *et al.*, 1999). Research has shown, however, that the link between knowledge-based environmental awareness and environmental action is not linear or straightforward (Gümrükçüoglu *et al.*, 2017). Postmodern pedagogies on environmental education emphasize, however, that the role of the educational methods that are used and, in particular, the position of the student within the learning process are central in enabling an active role for the learner in society with respect to sustainability (Dreyfus *et al.*, 1999). In particular, it is important to question whether the aim of education is of social reproduction or of social transformation when selecting educational methods. According to Jickling and Wals (2008), a socio-constructivist transformative mindset is inherently connected to active pedagogies and to a willingness to cross disciplinary boundaries. In this context, Wals *et al.* (1990) and Stapp (1996) propose the use of action-research and community problem-solving to enable social change through environmental education. This approach is in line with our results which found a significant relation between community and social justice pedagogies and action-oriented competences.

Still, the study of nature and ecosystems has inspired learning theories that are rooted in holistic and constructivist frameworks of learning, which were in turn linked to an increased ecological conscience that is key for sustainability (Hill *et al.*, 2004). In this context, Bowers (2002) has proposed an eco-justice pedagogy, which is both rooted in the constructive process of understanding how the principles of ecological design can be applied to the built environment in the student's region and on the politics and context of environmentally induced inequalities (such as the unequal distribution of toxic waste) both at a local and global scale.

Based on the findings and on the insights from literature, the current research implies that environmental education should be, on the one hand, connected to social aspects of sustainability such as justice and equality to contextualize the knowledge acquired in a social transformation setting and, on the other hand, to promote the action-oriented competence of students and, at the same time, have an explicit connection to local nature and ecosystems.

Conclusion

This study investigates how different pedagogical approaches can affect students' sustainability competences distinctively, and to what extent the competences can affect students' belief in the NEP and PEBs. The contribution of this research is threefold. First, through empirically distinguishing the impact of three pedagogical approaches on students' sustainability competences, this study has important implications for systematically linking pedagogical approaches to teaching practices or concrete learning objectives in the context of sustainability education. Next, separating sustainability competences into two dimensions – sustainability mindset/framework and sustainability action/communication – provides meaningful insights for understanding the value of specific pedagogical approaches on developing different competences. Additionally, many individuals' understandings of sustainability are rooted in their education of these issues in higher education (Fisher and McAdams, 2015). Thus, examining the antecedents and consequences of students' sustainability competences in this context has important practical implications for students' personal development and future professional lives. In particular, HEIs can assess which pedagogical approaches should be adopted to effectively mitigate the "attitude–behavior gap" (Claudy *et al.*, 2013) in sustainability education.

Several limitations of the research need to be addressed. First, since the data was collected from one Dutch HEI, this research can be categorized as a case study, and the research findings need to be interpreted with caution when generalizing to other contexts. Also, because European HEIs have been taking the lead in incorporating sustainability (Lozano *et al.*, 2019), scholars may discover different results when applying the current research approach to non-Western contexts. Hence, future research can move forward to compare the impact of pedagogical approaches on students' sustainability competences in different HEIs and consider advancing knowledge of how the cultural contexts may play a role in varying the relationships.

Second, when filling out the online survey, participants who answered "no" to the question of whether they have taken any course that addressed sustainability at EUR were directed to the end of the survey. This approach made it impossible to compare the sustainability competences, belief in NEP and PEBs among the students who took one or more courses that addressed sustainability with others who did not take any. Examining how the attitudes and behaviors of the two groups may differ can provide insightful evidence for unfolding the added value of sustainability education. Therefore, future research can consider taking a comparative angle to examine whether the belief in NEP and PEBs of the students engaging in courses that address sustainability are different from other students.

Furthermore, although the distinction of sustainability mindset/framework and sustainability action/communication in this study provides important implications for sustainability education, it is purely derived from the data and lacks solid theoretical grounding. This requires scholars to further investigate how these two aspects can be theoretically distinguished and empirically measured, on the one hand, and assess their distinct drivers and impacts, on the other hand. Future research can aim at contributing to filling this void in literature.

References

Bamberg, S., Ajzen, I. and Schmidt, P. (2003), "Choice of travel mode in the theory of planned behavior: the roles of past behavior, habit, and reasoned action", *Basic and Applied Social Psychology*, Vol. 25 No. 3, pp. 175-187.

Barbaro, N. and Pickett, S.M. (2016), "Mindfully green: examining the effect of connectedness to nature on the relationship between mindfulness and engagement in pro-environmental behavior", *Personality and Individual Differences*, Vol. 93, pp. 137-142.

Batchelder, T.H. and Root, S. (1994), "Effects of an undergraduate program to integrate academic learning and service: cognitive, prosocial cognitive, and identity outcomes", *Journal of Adolescence*, Vol. 17 No. 4, pp. 341-355.

Bowers, C.A. (2002), "Toward an eco-justice pedagogy", *Environmental Education Research*, Vol. 8 No. 1, pp. 21-34.

Brundiers, K. and Wiek, A. (2013), "Do we teach what we preach? An international comparison of problem- and project-based learning courses in sustainability", *Sustainability*, Vol. 5 No. 4, pp. 1725-1746.

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S. and Zint, M. (2021), "Key competencies in sustainability in higher education – toward an agreed-upon reference framework", *Sustainability Science*, Vol. 16 No. 1, pp. 13-29.

Cebrián, G., Junyent, M. and Mulà, I. (2020), "Competencies in education for sustainable development: emerging teaching and research developments", *Sustainability*, Vol. 12 No. 2, pp. 579-588.

Ceulemans, K. and De Prins, M. (2010), "Teacher's manual and method for SD integration in curricula", *Journal of Cleaner Production*, Vol. 18 No. 7, pp. 645-651.

Chase, G.W. and Rowland, P. (2004), "The ponderosa project: infusing sustainability in the curriculum", in Barlett, P.F. and Chase, G.W. (Eds), *Sustainability on Campus: Stories and Strategies for Change*, MIT Press, Cambridge, MA.

Claudy, M.C., Peterson, M. and O'driscoll, A. (2013), "Understanding the attitude-behavior gap for renewable energy systems using behavioral reasoning theory", *Journal of Macromarketing*, Vol. 33 No. 4, pp. 273-287.

Delors, J. (1996), *Learning: The Treasure within, Report to UNESCO of the International Commission on Education for the Twenty-First Century*, UNESCO Publishing Press, Paris.

Demssie, Y.N., Wesselink, R., Biemans, H.J. and Mulder, M. (2019), "Think outside the European box: identifying sustainability competencies for a base of the pyramid context", *Journal of Cleaner Production*, Vol. 221, pp. 828-838.

Dreyfus, A., Wals, A.E. and van Weelie, D. (1999), "Biodiversity as a postmodern theme for environmental education", *Canadian Journal of Environmental Education*, Vol. 4, pp. 155-175.

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.

Dunlap, R.E., Van Liere, K.D., Mertig, A.G. and Jones, R.E. (2000), "New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale", *Journal of Social Issues*, Vol. 56 No. 3, pp. 425-442.

DuPuis, E.M. and Ball, T. (2013), "How not what: teaching sustainability as process", *Sustainability: Science, Practice and Policy*, Vol. 9 No. 1, pp. 64-75.

Evans, T.L. (2019), "Competencies and pedagogies for sustainability education: a roadmap for sustainability studies program development in colleges and universities", *Sustainability*, Vol. 11 No. 19, pp. 1-36.

Fadeeva, Z., Mochizuki, Y., Hopkinson, P. and James, P. (2010), "Practical pedagogy for embedding ESD in science, technology, engineering and mathematics curricula", *International Journal of Sustainability in Higher Education*, Vol. 11 No. 4, pp. 365-379.

Fisher, P.B. and McAdams, E. (2015), "Gaps in sustainability education: the impact of higher education coursework on perceptions of sustainability", *International Journal of Sustainability in Higher Education*, Vol. 16 No. 4, pp. 407-423.

Foy, G. (1990), "Economic sustainability and the preservation of environmental assets", *Environmental Management*, Vol. 14 No. 6, pp. 771-778.

Gruenewald, D.A. (2003), "The best of both worlds: a critical pedagogy of place", *Educational Researcher*, Vol. 32 No. 4, pp. 3-12.

Gümrükçüoglu, N., Sarimehmet, D. and Hintistan, S. (2017), "Environmental awareness and knowledge level of higher education students", *TOJET: The Turkish Online Journal of Educational Technology*, Spec Iss, pp. 1074-1079.

Hill, S.B., Wilson, S. and Watson, K. (2004), "Learning ecology. A new approach to learning and transforming ecological consciousness", in O'Sullivan E.V. and Taylor M.M. (Eds), *Learning toward an Ecological Consciousness: Selected Transformative Practices*, Palgrave Macmillan, New York, NY.

Hsu, S.J. (2004), "The effects of an environmental education program on responsible environmental behavior and associated environmental literacy variables in Taiwanese college students", *The Journal of Environmental Education*, Vol. 35 No. 2, pp. 37-48.

Jackson, T. (2005), "Live better by consuming less?: Is there a 'double dividend' in sustainable consumption?", *Journal of Industrial Ecology*, Vol. 9 Nos 1/2, pp. 19-36.

Jickling, B. and Wals, A.E. (2008), "Globalization and environmental education: looking beyond sustainable development", *Journal of Curriculum Studies*, Vol. 40 No. 1, pp. 1-21.

Jones, B. and Iredale, N. (2010), "Enterprise education as pedagogy", *Education + Training*, Vol. 52 No. 1, pp. 7-19.

Kagawa, F. (2007), "Dissonance in students' perceptions of sustainable development and sustainability", *International Journal of Sustainability in Higher Education*, Vol. 8 No. 3, pp. 317-338.

Lam, J.C., Walker, R.M. and Hills, P. (2014), "Interdisciplinarity in sustainability studies: a review", *Sustainable Development*, Vol. 22 No. 3, pp. 158-176.

Lambrechts, W., Mulà, I., Ceulemans, K., Molderez, I. and Gaeremynck, V. (2013), "The integration of competences for sustainable development in higher education: an analysis of bachelor programs in management", *Journal of Cleaner Production*, Vol. 48, pp. 65-73.

Lozano, R., Barreiro-Gen, M., Lozano, F.J. and Sammalisto, K. (2019), "Teaching sustainability in European higher education institutions: assessing the connections between competences and pedagogical approaches", *Sustainability*, Vol. 11 No. 6, pp. 1602-1619.

Lozano, R., Merrill, M.Y., Sammalisto, K., Ceulemans, K. and Lozano, F.J. (2017), "Connecting competences and pedagogical approaches for sustainable development in higher education: a literature review and framework proposal", *Sustainability*, Vol. 9 No. 10, pp. 1889-1903.

Lundholm, C. (2005), "Learning about environmental issues: postgraduate and undergraduate students' interpretations of environmental contents in education", *International Journal of Sustainability in Higher Education*, Vol. 6 No. 3, pp. 242-253.

McMillan, E.E., Wright, T. and Beazley, K. (2004), "Impact of a university-level environmental studies class on students' values", *The Journal of Environmental Education*, Vol. 35 No. 3, pp. 19-27.

Pallant, J. (2010), *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS*, Open University Press.

Pappas, E., Pierrakos, O. and Nagel, R. (2013), "Using bloom's taxonomy to teach sustainability in multiple contexts", *Journal of Cleaner Production*, Vol. 48, pp. 54-64.

Remington-Doucette, S.M., Connell, K.Y.H., Armstrong, C.M. and Musgrove, S.L. (2013), "Assessing sustainability education in a transdisciplinary undergraduate course focused on real-world problem solving", *International Journal of Sustainability in Higher Education*, Vol. 14 No. 4, pp. 404-433.

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.

Rieckmann, M. (2017), *Education for Sustainable Development Goals: Learning Objectives*, Unesco Publishing.

Rowe, D. (2002), "Environmental literacy and sustainability as core requirements: success stories and models", in Leal Filho, W. (Ed.), *Teaching Sustainability at Universities. Frankfurt Am Main*, Peter Lang, Germany.

Ryu, H.C. and Brody, S.D. (2006), "Examining the impacts of a graduate course on sustainable development using ecological footprint analysis", *International Journal of Sustainability in Higher Education*, Vol. 7 No. 2, pp. 158-175.

Segalàs, J., Ferrer-Balas, D. and Mulder, K.F. (2010), "What do engineering students learn in sustainability courses? The effect of the pedagogical approach", *Journal of Cleaner Production*, Vol. 18 No. 3, pp. 275-284.

Smith-Sebasto, N.J. (1995), "The effects of an environmental studies course on selected variables related to environmentally responsible behavior", *The Journal of Environmental Education*, Vol. 26 No. 4, pp. 30-34.

Sprain, L. and Timpson, W.M. (2012), "Pedagogy for sustainability science: case-based approaches for interdisciplinary instruction", *Environmental Communication*, Vol. 6 No. 4, pp. 532-550.

Stapp, W.B. (1996), *Environmental Education for Empowerment: Action Research and Community Problem Solving*, Kendall/Hunt Publishing, Ann Arbor.

Stern, P.C., Dietz, T. and Guagnano, G.A. (1995), "The new ecological paradigm in social-psychological context", *Environment and Behavior*, Vol. 27 No. 6, pp. 723-743.

Stewart, M. (2010), "Transforming higher education: a practical plan for integrating sustainability education into the student experience", *Journal of Sustainability Education*, Vol. 1 No. 1, pp. 195-203.

Sturmberg, J.P. and Hinchy, J. (2010), "Borderline competence – from a complexity perspective: conceptualization and implementation for certifying examinations", *Journal of Evaluation in Clinical Practice*, Vol. 16 No. 4, pp. 867-872.

Tang, K.H.D. (2018), "Correlation between sustainability education and engineering students' attitudes towards sustainability", *International Journal of Sustainability in Higher Education*, Vol. 19 No. 3, pp. 459-472.

Thøgersen, J. and Ölander, F. (2006), "To what degree are environmentally beneficial choices reflective of a general conservation stance?", *Environment and Behavior*, Vol. 38 No. 4, pp. 550-569.

Velazquez, L., Munguia, N. and Sanchez, M. (2005), "Deterring sustainability in higher education institutions: an appraisal of the factors which influence sustainability in higher education institutions", *International Journal of Sustainability in Higher Education*, Vol. 6 No. 4, pp. 383-391.

Vicente-Molina, M.A., Fernández-Sáinz, A. and Izagirre-Olaizola, J. (2013), "Environmental knowledge and other variables affecting pro-environmental behaviour: comparison of university students from emerging and advanced countries", *Journal of Cleaner Production*, Vol. 61, pp. 130-138.

Wals, A.E., Beringer, A. and Stapp, W. (1990), "Education in action. A community problem-solving program for schools", *The Journal of Environmental Education*, Vol. 21 No. 4, pp. 13-19.

Wang, Y. Sommier, M. and Vasques, A. (2021), "How to develop higher education students' sustainability-oriented competences?", EUR, available at: https://my.eur.nl/en/news/how-develop-higher-education-students-sustainability-oriented-competences?utm_source=Strategy_Update_mei_2021&utm_medium=Yijing_Wang_duurzaam_onderwijs&utm_campaign=Strategy2024

Whitmarsh, L. and O'Neill, S. (2010), "Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours", *Journal of Environmental Psychology*, Vol. 30 No. 3, pp. 305-314.

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.

Wiek, A., Bernstein, M., Foley, R., Cohen, M., Forrest, N., Kuzdas, C., Kay, B. and Withycombe Keeler, L. (2015), "Operationalising competencies in higher education for sustainable development", in Barth, M., Michelsen, G., Rieckmann, M. and Thomas, I. (Eds), *Handbook of Higher Education for Sustainable Development*, Routledge, London, pp. 241-260.

Woodworth, B.L., Steen-Adams, M.M. and Mittal, P. (2011), "Role of an environmental studies course on the formation of environmental worldviews: a case study of a core curriculum requirement using the NEP scale", *Journal of Environmental Studies and Sciences*, Vol. 1 No. 2, pp. 126-137.

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, JCMC*, Vol. 10 No. 3, p. 1034.

Zidny, R., Sjöström, J. and Eilks, I. (2020), "A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability", *Science and Education*, Vol. 29 No. 1, pp. 145-185.

Zsóka, A., Szerényi, Z., Széchy, A. and Kocsis, T. (2012), "Greening due to environmental education? Environmental knowledge, attitudes, consumer behaviour and everyday pro-environmental activities of Hungarian high school and university students", *Journal of Cleaner Production*, Vol. 48, pp. 126-138.

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