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Perceived interest in learning sustainability competencies among higher education students

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Abstract

Purpose – This study aims to assess higher education students' interest in learning sustainability competencies and their pro-ecological worldviews at a large research-intensive university in Finland to provide a background information for developing a sustainability science course.

Design/methodology/approach – In total, 797 students participated in the study. The data were collected through an online survey that measured students' interest in learning sustainability competencies and their pro-ecological worldviews. Participants were classified into five categories based on field of study. The data were analysed by using Pearson's correlation, independent samples *t*-tests, and analysis of variance.

Findings – The participating students perceived learning of critical thinking and values thinking most interesting. Interest in learning sustainability competencies and pro-ecological worldview appeared to differ across fields of study. Participants studying humanities expressed lower interest in collaborative use of digital technology compared to the participating students in science and agriculture. Participating students in health and welfare scored lower on interest in learning values thinking than students in other study fields.

Research limitations/implications – The response rate was low. It is likely that the participants felt strongly about sustainability challenges, therefore making them more interested in sustainability competencies. The limited number of sustainability competencies studied does not allow generalisation to all sustainability competencies.

Practical implications – The differences in interest in learning sustainability competencies and pro-ecological worldview should be understood and considered when planning sustainability education.

Originality/value – These results provide new insights into the interlinkage of students' interest in learning sustainability competencies, their pro-ecological worldviews and their field of study.

Keywords Sustainability competencies, Pro-ecological worldview, New ecological paradigm, Student perspectives, Sustainability education, Higher education

Paper type Research paper

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1. Introduction

The role of higher education institutions in addressing global sustainability challenges has garnered increasing attention from both scientific and policy communities (Franco *et al.*, 2019). As argued by scholars such as Holdsworth *et al.* (2008) and Franco *et al.* (2019), it is the responsibility of higher education institutions to help students and the academic community acquire professional skills and competencies such as critical thinking to support sustainable development, instead of mere information provision on sustainability challenges.

After the establishment of the UN Sustainable Developments Goals in 2015, universities have been actively transforming their core activities: research, teaching and serving society to address sustainability challenges. Implementing sustainability in the operations of universities has also led to an increased number of sustainability-related degree programmes (Weiss and Barth, 2019). Moreover, reporting on sustainability performance has become common with 532 universities partaking in the Times Higher Education Impacts Rankings (De la Poza, 2021).

Strategies for integrating sustainability to curricula vary among universities. Sidiropoulos (2018) suggests these strategies include adding elements of sustainability to existing programmes in a systematically and pedagogically tailored manner, creating new courses with interdisciplinary and transdisciplinary sustainability foci and establishing new study opportunities for sustainability through all degree programmes and specialisation pathways.

Universities are influential actors and change agents in society. Notwithstanding strategies of integration, universities are still lacking behind in implementation of sustainability (Leal Filho *et al.*, 2019). The concern about humans' effect on the environment has increased among young people (Speer *et al.*, 2020). However, this concern is also a strong driver to enhance sustainability transformation of universities and embedding sustainability in teaching and curricula (Korhonen-Kurki *et al.*, 2019).

Education for sustainability cannot be fully achieved by only providing knowledge and skills on advancing sustainability. The incorporation of sustainability into students' values, attitudes, motivation, worldviews and behaviour is also needed (Hay *et al.*, 2019). If education for sustainability remains superficial and disconnected from their field of study, students may not be motivated to adopt knowledge and willingness to act. It has been shown that the sustainability efforts of the university do not necessarily increase students' understanding of sustainability as a complex and multifaceted goal (Perrault and Clark, 2017). It is important that students understand the plurality in both discourses and views regarding sustainability for them to get an idea of the complexity as well as the ethics involved (Melles, 2019).

Creating a common interdisciplinary sustainability course is a widely used measure to immerse all students in sustainability education. Connecting the scientific community to the development process of the course can bring together several disciplines, discourses and views. It can also enable participation and shared ownership (Aktas *et al.*, 2015). A broad interdisciplinary course can also connect students across fields of study and therefore contribute to the social cohesion within the university (Aktas *et al.*, 2015).

Understanding the views and perceptions of students is crucial in ensuring student engagement during the development process of sustainability education, as educators need to understand environmental concerns and perceptions of students to develop more effective teaching practices in higher education (Keinonen *et al.*, 2016). Understanding complex interlinkages of social and environmental systems, uncertainty and conflicts of values requires the learners to command a broad set of sustainability competencies (Brundiers *et al.*, 2021) as well as other important general academic competencies, knowledge and expertise (Leal Filho *et al.*, 2019).

To better understand how higher education students' interest in learning sustainability competencies associated with their pro-ecological worldviews across fields of study, we

conducted a survey as part of a development process of an interdisciplinary sustainability course at a large research-intensive university in Finland.

1.1 Interest in learning sustainable competencies matters

A major transformation is required across all disciplines and levels of study for higher education to align with the global sustainability agenda (Franco *et al.*, 2019). Instead of mere knowledge production, professional skills and capabilities to support sustainable development goals are needed (Holdsworth *et al.*, 2008). Academic experts can be seen as future drivers of global change who must be able to actively promote a good and sustainable way of living. This means making sustainability expertise part of discipline-specific knowledge and skills as well as strengthening of sustainability competencies as part of generic academic competencies.

In general, competencies are understood as a combination of knowledge, skills, and attitudes (Baartman and Ruijs, 2011). In the context of higher education, research on competencies is being pursued by scholars in various fields using different theoretical frameworks and theories. In the research area of higher education pedagogy, a range of key generic academic competencies that are perceived as important for academic professionals have been suggested (Virtanen and Tynjälä, 2018; Tuononen *et al.*, 2022). A recent review study on generic academic competencies shows that professional skills, analytical skills, problem-solving skills, communication and collaboration skills are most often measured in the studies of this field (Tuononen *et al.*, 2022).

In the research on sustainability competencies, different frameworks for key sustainability competencies that should be developed in conjunction or as part of generic academic competencies have been suggested (Wiek *et al.*, 2011; Lozano *et al.*, 2017; Brundiers *et al.*, 2021). In the context of higher education, these frameworks include 5–15 different key competencies. The competencies often identified as necessary are systems-thinking competence, anticipatory competence, normative competence, value-thinking competence, strategic competence, interpersonal competence and different generic academic competencies, such as critical thinking (Wiek *et al.*, 2011; Rieckmann, 2013; Lozano *et al.*, 2017; Brundiers *et al.*, 2021).

Brundiers *et al.* (2021) have aimed at developing "broadly acceptable and detailed descriptions" of key competencies in sustainability, based on a study with international experts in sustainability education. They distinguish these key sustainability competencies from generic academic competencies, such as basic capacities in critical thinking, communication, pluralistic thinking, problem-solving, research, data management and self-regulation (Wiek *et al.*, 2011). However, they note that also generic academic competencies are valuable as they underpin all the key competencies in sustainability. Importantly, their study revealed that competencies are not naturally developed in teaching–learning settings; instead they require targeted and ongoing efforts to learn about competencies and through working with each competency's set of concepts, methods and skills (Brundiers *et al.*, 2021).

While there is a growing agreement on what the sustainability competencies should possess as well as the pedagogies to develop them, the practice of assessing students' competencies is still in its infancy (Redman *et al.*, 2021). Although competencies for sustainability have been discussed in previous literature, the studies focusing on student perspective are somewhat lacking: the studies either focus on expert views (Brundiers *et al.*, 2021), to a rather narrow scope of competencies, such as entrepreneurial skills of students in promoting sustainability (Fabregá *et al.*, 2020), to sustainability knowledge of students in more general (Zwickle *et al.*, 2014) or to assessment practices (Redman *et al.*, 2021). However, according to Holfelder (2019) the first point (or prerequisite) for education in terms of

sustainability is to take the target group, i.e. the students, seriously. Education in sustainability must also consider explicitly societal and institutional conditions, and address them, to avoid reproducing and strengthening the current, unsustainable conditions (Holfelder, 2019). Understanding the student perspective on learning competencies and their relevance for sustainability, as well as the differences between fields of study, is thus essential in developing sustainability education. For instance, Remington-Doucette *et al.* (2013) found that an introductory sustainability course had different impacts on students' sustainability competencies depending on students' field of study.

Interest has been recognised as a key condition for learning that engages students into learning content and helps them to develop meaningful connections to a field of study (Sun *et al.*, 2018; Mikkonen *et al.*, 2013). In general, interest often refers to a motivational variable with both cognitive and affective, and situational and individual dimensions. Individual interest has been found to have a positive impact on students' attention, persistence, effort and learning outcomes (Hidi and Renninger, 2006; Mikkonen *et al.*, 2013). It is a "power behind the growth towards expertise" (Mikkonen *et al.*, 2013, p. 72). The development of interest is not dependent solely on the teacher's activities, but the student must be involved in the process (Lonka, 2015). There is evidence that perceived interest and relevance is positively associated with learning of generic skills (Lizzio and Wilson, 2004). In addition, prior knowledge and previous experiences are related to learning processes and outcomes (Biggs, 2003; Biggs and Tang, 2011). Therefore, previous study and work experience related to sustainability may also have an influence on interest in learning sustainability competencies. For example, if these skills are seen as important and relevant in other contexts such as work, students might be more willing to learn them. The individual interest in learning sustainability competencies can be a prerequisite for acquiring the learning objectives in and for sustainability.

1.2 Students' pro-ecological worldviews

Individuals' views about sustainability are based on their fundamental beliefs about nature and humans' position in it. There is growing evidence that a coherent environmental belief system forms a pro-ecological worldview (Xiao *et al.*, 2019). It is believed to influence a wide range of more specific pro-environmental beliefs, attitudes (Switzer and Vedlitz, 2017) and behaviours (Gatersleben *et al.*, 2014). According to the value-belief-norm theory of environmentalism, the association between a pro-ecological worldview and pro-environmental behaviours is mediated by beliefs about the environmental effects, as well as beliefs about one's responsibility to act pro-environmentally (Stern, 2000; Steg *et al.*, 2005).

The New Environmental Paradigm (NEP) developed by Dunlap and Van Liere (1978) is the most widely used framework to measure individuals' pro-ecological worldviews. Pro-ecological worldview includes five components:

(1) limits to economic growth;

(2) anti-anthropocentrism;

(3) the fragility of nature's balance;

(4) rejection of human exemptionalism (the belief that people are not bound by the constraints of nature); and

(5) the possibility of potentially catastrophic environmental changes or eco-crises affecting people (Dunlap *et al.*, 2000).

According to Lundmark (2007), a pro-ecological worldview includes a specific ethical perspective, ecocentrism.

The NEP paradigm has been found to be useful in exploring students' sustainability-related values and dispositions in higher education (Harraway *et al.*, 2012; Woodworth *et al.*, 2011). For example, sustainability education has been found to alter students' pro-ecological worldviews (Steg *et al.*, 2014). In a study conducted by Woodworth *et al.* (2011), environmental studies increased the level of pro-ecological worldview among university students, and the effect was greater among those who initially had a low level of pro-ecological worldview. Moreover, students of biological disciplines (Harraway *et al.*, 2012) and women (Zelezny *et al.*, 2000; Shephard, 2009) have stronger pro-ecological worldviews than other students. Moreover, a study reported by Harraway *et al.* (2012) found a decline in first-year university students' pro-ecological worldviews, suggesting that they are shaped by multiple factors occurring simultaneously in students' lives. Students' worldviews may have a significant impact on individual interests in learning sustainability competencies. Woodworth *et al.* (2011) suggest that a weak pro-ecological worldview may change relatively more because of sustainability education than a worldview that is strongly pro-ecological. However, there is less evidence about the effect of pro-ecological worldviews on students' learning, or their interest in learning about sustainability.

1.3 Aims and research questions

The present study aims to explore higher education students' interest in learning sustainability competencies and their pro-ecological worldview and how these phenomena vary across different fields of study. The main research question is:

RQ1. How interesting do the students perceive the learning of different sustainability competencies?

More specifically, we set out to explore:

RQ2. How are students' interest in learning sustainability competencies related to their pro-ecological worldviews?

RQ3. How are students' interest in learning of sustainability competencies and pro-ecological worldview related to field of study?

RQ4. How is previous study or work experience related to sustainability associated with interest in learning of sustainability competencies?

2. Materials and methods

This study was carried out in a large (30,000 students) multidisciplinary research-intensive Finnish university. This survey was sent to all degree students in the university.

The survey was a part of a wider effort to develop a university-wide sustainability-themed introductory course for all university students. The aim was to create better understanding of the students' interest in learning sustainability competencies and its associations with pro-ecological worldview. The new Sustainability Course is a 3 ECTS credit interdisciplinary online course that deals with sustainability from the perspective of several different fields of science. It targets undergraduates in all degree programs. The data used in this study was collected through an online survey in spring 2020 (see Appendix for the details). The survey was advertised through the Student Union newsletter, on social media, and through student organisations and mailing lists. The questionnaire was provided in the languages used in instruction in the university. Voluntary participation,

informed consent and anonymity of the participants were ensured and communicated to respondents (Finnish National Board on Research Integrity, 2019).

2.1 Study sample

Altogether 797 students participated, which represents 2.6% of the total student population. Women were somewhat overrepresented as 74.9% of the respondents were women, compared to the percentage of women (64.5%) in the total student population. About 19.7% of respondents were men, and approximately 6% of the participants did not identify their gender or responded "other".

About 51% of the respondents stated that an upper secondary degree (high school diploma or equivalent) was the highest degree they had completed. About 8.6% of the respondents had completed a bachelor's degree, and 15.8% of the respondents had completed a master's degree. About 60% of the respondents reported having completed between 0 and 120 ECTS. 20.2% of respondents had completed between 121 and 180 ECTS, and 12.6% had completed 181 and 240 ECTS. About 7.4% had completed over 241 ECTS. The recommended annual course load is 60 ECTS and the required studies to gain a bachelor's degree is 180 ECTS. For background information, the participants were asked about their degree program, and previous study and work experience related to sustainability. Most of the participants had completed previous sustainability-oriented courses or work experience. More precisely, 59% had previous sustainability education, 31% had working life experience in the field sustainability and 39% had participated in voluntary activities related to sustainability issues.

2.2 Questionnaire

The questionnaire measured students' interest in learning sustainability competencies and their pro-ecological worldview. Interest in learning sustainability competencies was measured with 39 items, which were formulated based on the previous studies on generic academic competencies (Tynjälä *et al.*, 2016; Muukkonen *et al.*, 2019) and sustainability competencies (Wiek *et al.*, 2015; Lozano *et al.*, 2017) including competencies such as critical thinking, self-regulation, values thinking, communication and collaboration. All items were rated on a seven-point Likert scale (1 = not at all interested; 7= very interested).

Students' pro-ecological worldview was measured with the NEP questionnaire (Dunlap *et al.*, 2000). The scale included 15 items which were rated on a seven-point Likert scale (1 = completely disagree; 7 = completely agree). For NEP, a mean score of the items were used in the analyses as recommended by Dunlap (2008) and Steg *et al.* (2005). Its Cronbach's alpha was satisfactory ($\alpha = 0.76$).

2.3 Statistical analyses

SPSS version 27 was used for the analyses. As the section measuring students' interest in learning sustainability competencies was used for the first time, its functionality was examined with explorative factor analysis. For extraction, principal axis factoring was chosen, as it entails no distributional assumptions (Fabrigar *et al.*, 1999). The factors were assumed to correlate with each other, thus Promax rotation was chosen (Costello and Osborne, 2005). An examination of the Kaiser–Meyer–Olkin measure of sampling adequacy suggested that the items were factorable (KMO = 0.94). Analysis indicated a five-factor solution with the best fitting 24 items (Table 1). The first factor includes six items measuring critical thinking. The four items in the second factor measure values thinking, while the six items in the third factor measure interpersonal competence. The fourth factor includes four items measuring self-regulation and the fifth factor with three items measured

Table 1.
Scales measuring interest in learning sustainability competencies, their Cronbach's alphas and ranges of the item factor loadings

Scales (range 1–7)	Items	Ranges of the item factor loadings	Cronbach's alpha	Mean (SD)
Critical thinking	Evaluating knowledge from different perspectives Questioning knowledge Identifying central knowledge in your field Seeking domain-specific knowledge from different sources Analysing knowledge Solving domain-specific problems	0.52–0.76	0.83	6.04 (0.80)
Values thinking	Understanding ethical questions related to sustainability Understanding the philosophical questions related to sustainability Understanding the relationship between humans and the environment, and grasping the notion of limits to growth Understanding sustainable development in the context of your own studies, and understanding its interconnections to your field of study	0.76–0.86	0.85	6.04 (0.80)
Interpersonal competence	Verbal communication of domain-specific knowledge Communicating domain-specific knowledge in a foreign language Providing convincing arguments for your own conclusions Working in a group Goal-oriented work with others Goal-oriented negotiation with others Leading group work	0.54–0.82	0.86	5.24 (1.14)
Self-regulation	Planning your own use of time Taking responsibility of your own studies Evaluating your own competencies Organising your own activities	0.35–0.84	0.80	5.50 (1.11)
Collaborative use of digital technology	Using various digital applications Using technology to advance collaborative work Developing products collaboratively by using technology	0.72–0.87	0.87	4.84 (1.36)

collaborative use of digital technology. The 15 items (e.g. Acting strategically, Systems thinking, or Tolerating ambiguity and uncertainty) either cross-loaded on several items or their loadings remained below 0.32 (Tabachnick and Fidell, 2014). These items were removed from the subsequent analysis.

For the analysis, students were classified into five categories in terms of field of study. The classification was based on the International Standard Classification of the fields of education with some regrouping of small categories. The final categories were: 1) humanities (n = 153, 19%; including humanities, arts and theology), 2) social science (n = 267, 34%; including social science, education, and law), 3) science (n = 193, 25%; including life science, physical sciences, mathematics, data science and computer science), 4) agriculture (n = 108, 14%; including agriculture, forestry and veterinary) and 5) health and welfare (n = 60, 8%; including medicine and pharmacy). The representativeness of the data by field of study was rather good. Humanities and health and welfare were slightly underrepresented, while social science, science and agriculture were slightly overrepresented compared to the total degree student population.

The relationship between interest in learning sustainability competencies and pro-ecological worldview was explored by using Pearson's correlation. The relationship of interest in learning sustainability competencies and pro-ecological worldview with the field of study was explored with analysis of variance (ANOVA). The relationship between previous study and work experience and interest in learning of sustainability competencies was explored with independent samples t-tests.

3. Results

Based on these results, students perceived learning of critical thinking, values thinking, self-regulation and interpersonal competency as the most interesting sustainability competencies (Table 1). Collaborative use of digital technology appeared to be the least interesting competency. The results also indicate that students' interest in learning sustainability competencies was related to their pro-ecological worldview. The results suggest that pro-ecological worldview is correlated positively with values thinking and critical thinking as well as communication and collaboration skills and self-regulation (Table 2).

Next, we explored how interest in learning of sustainability competencies and pro-ecological worldview are related to field of study. The results indicate that students' interest in learning sustainability competencies and pro-ecological worldview differed across fields of study (Table 3). More precisely, students in humanities scored lower on collaborative use of digital technology compared to the students in science and agriculture. Students in health and welfare had lower scores on interest in learning values thinking than students in other

Table 2. The Pearson correlations between interest in learning sustainability competencies and students' pro-ecological worldview

Sustainability competencies	Pro-ecological worldview
Critical thinking	0.208**
Values thinking	0.368**
Interpersonal competence	0.099**
Collaborative use of digital technology	−0.041
Self-regulation	0.074*

Notes: *$p < 0.05$; **$p < 0.01$

Table 3.
ANOVA table of differences between study fields in perceived interest of learning of sustainability competencies and the endorsement of pro-ecological worldview

Sustainability competencies and pro-ecological worldview	Humanities (n = 153) Mean (SD)	Social sciences (n = 267) Mean (SD)	Science (n = 193) Mean (SD)	Agriculture (n = 108) Mean (SD)	Health and welfare (n = 60) Mean (SD)	F
Sustainability competencies						
Critical thinking	6.12 (0.82)	6.10 (0.78)	6.03 (0.73)	6.07 (0.85)	5.90 (0.91)	1.00
Values thinking	5.72 (1.13)	5.70 (1.19)	5.63 (1.28)	5.79 (1.23)	4.77 (1.57)	7.90***
Interpersonal competence	5.21 (1.07)	5.35 (1.10)	5.09 (1.18)	5.29 (1.13)	5.08 (1.32)	1.76
Self-regulation	5.56 (1.13)	5.57 (1.08)	5.37 (1.12)	5.47 (1.20)	5.47 (1.06)	0.96
Collaborative use of digital technology	4.46 (1.37)	4.81 (1.39)	5.06 (1.39)	5.06 (1.38)	4.77 (1.29)	4.83**
Pro-ecological worldview						
Pro-ecological worldview	5.38 (0.62)	5.34 (0.56)	5.26 (0.63)	5.22 (0.66)	4.98 (0.79)	5.22***

Notes: **$p < 0.01$; ***$p < 0.001$

study fields. Health and welfare students had lower scores on pro-ecological worldview than the other students, except for agriculture students.

Then, we explored the relationship between previous study or work experience and students' interest in learning sustainability competencies with *t*-test. The results suggest that previous study experience related to sustainability was related to higher interest in learning of critical thinking and values thinking and collaborative use of digital technology (Table 4). Similarly, students with prior work experience related to sustainability seemed to have more positive perceptions of learning of collaborative use of digital technology, interpersonal competence and values thinking than students without sustainability work experience. Previous experience of organisational and voluntary activities was related to higher interest in learning critical thinking, values thinking and interpersonal competence.

4. Discussion

In this study, we examined how interesting do the students perceive the learning of different sustainability competencies. Our findings suggest that the participants' interest in learning sustainability competencies was high. The greatest interest in learning was towards critical thinking, which was the most interesting sustainability competence among students in all study fields, followed by values thinking, interpersonal competence and self-regulation skills. These are important findings, as it is known from the earlier research that interest is influencing students' learning outcomes (Hidi and Renninger, 2006; Mikkonen *et al.*, 2013). Students in different fields of study appear to have similar levels of interest in learning critical thinking, interpersonal competence and self-regulation skills. Based on the results of this study it seems that students from health and welfare appear to be less interested in learning values thinking and students from humanities appear less interested in learning collaborative use of digital technology in comparison to the students from other fields. However, more research is needed to better understand disciplinary differences.

Our results indicate potential differences between fields of study in the endorsement of the pro-ecological worldview. In this study, participants studying humanities had the highest, and participants studying health and welfare had the lowest endorsement of pro-ecological worldview. Field of study has also previously been shown to relate to differences in pro-ecological views. Sidiropoulos (2018) showed that students from arts, science and education have higher NEP scores than students from business management, IT and architecture and engineering. Harraway *et al.* (2012) and Shephard *et al.* (2015) showed that surveying students hold weaker while zoology students hold stronger pro-ecological views than others in a multidisciplinary student cohort. However, previous studies indicate that participation in sustainability education may strengthen students' pro-ecological worldviews (Sidiropoulos, 2018) and that the effect is particularly strong among those, whose pro-ecological worldview was initially weak (Woodworth *et al.*, 2011). Therefore, it is possible that students' pro-ecological worldviews, and interest in learning sustainability competencies may grow after they have participated in sustainability education. This is a question that needs to be explored in future studies.

Students in humanities and social sciences had at least as high endorsement of pro-ecological worldview as students in natural and agricultural sciences where environmental issues have been traditionally an essential part of studies. The relatively low endorsement of pro-ecological worldviews among health and welfare students might suggest that the relationship between issues of health and those of ecological sustainability should be highlighted in the sustainability education in these fields of study.

The results indicate that previous study experience related to sustainability may be related to a higher interest in learning critical thinking, values thinking and the

Table 4. Perceived interest in learning sustainability competencies in relation to previous experience of sustainability related studies, work and voluntary activities. Means, standard deviations and statistically significant results of independent samples *t*-tests

Sustainability competencies	Study experience Yes Mean (SD)	Study experience No Mean (SD)	*T*	Work experience Yes Mean (SD)	Work experience No Mean (SD)	*t*	Voluntary activities Yes Mean (SD)	Voluntary activities No Mean (SD)	*t*
Critical thinking	6.14 (0.72)	5.97 (0.90)	−2.64**	6.12 (0.78)	6.04 (0.81)		6.15 (0.75)	6.03 (0.82)	−2.01*
Values thinking	4.94 (0.13)	4.67 (1.50)	−5.59***	5.76 (1.16)	5.56 (1.31)	−2.00*	5.96 (0.97)	5.43 (1.38)	−6.12***
Interpersonal competence	4.29 (1.08)	5.14 (1.22)		5.37 (0.05)	5.17 (1.18)	−2.40*	5.40 (0.96)	5.14 (1.23)	−3.21**
Self-regulation	5.52 (1.06)	5.46 (1.20)		5.56 (1.14)	5.46 (1.11)		5.57 (1.12)	5.45 (1.11)	
Collaborative use of digital technology	4.94 (1.30)	4.67 (1.50)	−2.57*	5.01 (1.44)	4.75 (1.37)	−2.39*	4.86 (1.39)	4.81 (1.40)	

Notes: $*p < 0.05$; $**p < 0.01$; $***p < 0.001$

collaborative use of digital technology. This suggests that it is possible that students' interest in learning these sustainability competencies may grow as they study sustainability-related courses. Therefore, including sustainability education in the early phases of studies could potentially be beneficial in increasing the interest towards learning sustainability and other relevant competencies. At the same time, work experience related to sustainability was related to higher interest in learning of interpersonal competence, collaborative use of digital technology and values thinking. These sustainability competencies are also needed in working life (Lohberger and Braun, 2022), which may be associated with an increase in interest in sustainability competences as the work experience increases. An interest in sustainability and learning sustainability skills can also be linked to applying for studies or work related to sustainability.

Apart from collaborative digital skills, the endorsement of pro-ecological worldview was associated with an interest in learning all sustainability competencies, especially with values thinking and critical thinking. This finding suggests that sustainability studies are likely to attract those students who already have a strong pro-ecological worldview and an anxiety about the environment. The concern about the environment and climate change has increased among freshmen in the USA during the 2010s and the concern further increases during their course of studies (Speer *et al.*, 2020). Institutions of higher education would benefit from coming to terms with sustainability education as a response to the growing environmental concern and a way to help students become specialists and decision-makers able to create solutions to environmental, social and economic problems. Moreover, curriculum development should respond to the worldviews of students and acknowledge the social dimensions of environmental problems (Leichenko and O'Brien, 2020). The association of pro-ecological worldview and interest in learning sustainability that seems to exist based on these findings can be a foundation that enables universities to deliver transformative sustainability education, which can lead to attainment of the sustainability competencies, most importantly embodying sustainability values and taking actions (Bianchi *et al.*, 2022).

4.1 Limitations

The empirical results obtained in the study have some limitations. Firstly, the response rate of the survey was low, which likely impacts the collected data and the generalisability of the results. It is likely that the participants felt strongly about sustainability challenges, therefore making them more interested in sustainability competencies. Thus, the findings of this study should not be interpreted as an accurate prediction of the entire student population in our context or in other contexts. Our sample was not totally representative in terms of fields of studies either, and therefore differences between them should be interpreted with caution. The findings of this study rather deepen understanding of this little-studied phenomena and offer insights into variation in students' interest in learning sustainability competencies. Therefore, further studies with larger datasets on the current topic are recommended. Furthermore, the study focuses on a limited number of sustainability competencies and cannot be generalised to apply to all sustainability competencies. The study only examined the interest in learning these competencies instead of the level students are at, or how these competencies can be learned. In future studies, exploring the development of sustainability competencies during university studies across different fields would be important. Finally, the study is limited by a lack of robust instruments for measuring these competencies, and lack of a coherent theoretical framework (Tuononen *et al.*, 2022). For example, there are different definitions and lists of sustainability

competencies. Thus, developing an instrument to measure them would be important in the future.

4.2 Implications to developing sustainability education

According to our findings students representing different field of study may differ both in their interest in learning certain sustainability competences (values thinking and collaborative use of digital technology) and in their pro-ecological worldview. Epistemological and ontological differences between disciplines could potentially cause divergent conceptualisations of sustainability, and different views on the justification of exploiting natural resources. These epistemological and disciplinary silos may be reflected in students' pro-ecological worldviews and should be addressed when developing sustainability education. Our findings imply that sustainability education should be developed considering these differences. Teaching and learning need to be arranged in a more tailored way by, e.g. offering more disciplinary based and individually customizable learning contents. Also, receptivity of students may differ between students with different disciplinary and cultural background, age and personal values. This calls for adapting sustainability education to diverse needs and including personal reflection and close connection to disciplinary contents. In the future, sustainability competencies can be even more relevant in working life so that the activities of different industries can be transitioned to a more sustainable operating model. For this also the workforce would need to be upskilled (Bianchi *et al.*, 2022).

We show that strong pro-ecological worldview is connected to interest in learning values thinking. In addition, previous sustainability work and study experiences and voluntary activities were related to higher interest in values thinking. This finding shows that caring for the environment, gaining sustainability knowledge and acting or working for sustainability are connected to values thinking. This is important as to further sustainability, values, attitudes, motivation, worldviews and behaviour are needed in addition to knowledge and skills (Hay *et al.*, 2019). Previous studies suggest that environmental and sustainability knowledge provided by formal education promotes environmental attitudes, but the contribution to students' engagement in direct environmental behaviours is weak or non-existent (Janmaimool and Khajohnmanee, 2019; Kyriakopoulos *et al.*, 2020). Heeren *et al.* (2016) show that sustainability knowledge has significant, but weak correlation with sustainability behaviour. However, their study found no effect of knowledge on behaviours, when students' attitudes, norms and perceived behavioural control were controlled for. Future studies should address the issue of how to design and deliver sustainability education with an impact in values and attitudes together with behaviours.

5. Conclusions

This study set out to explore higher education students' interest in learning sustainability competencies and their pro-ecological worldviews. Taken together, this study has shown that both interest in learning sustainability competencies and students' pro-ecological worldviews of the participants vary across different fields of study. The research has also shown that participating students' interest in learning sustainability competencies is connected to their pro-ecological worldviews, fields of study and their previous study and work experience related to sustainability. The endorsement of pro-ecological worldview showed strongest positive correlation with interest in learning values thinking, critical thinking and interpersonal competence. Overall, this study strengthens the idea that understanding the student perspective on learning competencies and their relevance for sustainability, as well as the variation between

disciplines, is essential in developing sustainability education. Understanding higher education students' interest in learning sustainability competencies and their pro-ecological worldview in the different fields of study can facilitate the development of sustainability education.

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Appendix. Survey questions

Section 1: Background information

- Year of birth
- Gender
  - Male
  - Female
  - Other
  - Prefer not to answer
- Which year did you start university?
- Which faculty and degree programme do you study at the University ? If there are more than one, please choose your primary programme.
  - <List of all Faculties>
  - <List of all Degree Programmes>
- The highest degree you have completed
  - High school diploma or equivalent
  - Vocational school
  - Bachelor's degree
  - Master's degree
  - Doctoral degree
- How many ECTS have you completed in your current, primary degree programme?
  - 0–120
  - 121–180
  - 181–240
  - 241 or more

Section 2: Interest in learning sustainability competencies

- How interested are you in learning following competencies as a part of your studies at the university? Please answer using the scale from 1 (not at all interested) to 7 (very interested).

(1) (2) (3) (4) (5) (6) (7)

1. Goal-oriented work with others
2. Using technology to advance collaborative work
3. Analysing knowledge
4. Working in a group
5. Verbal communication of domain-specific knowledge
6. Communicating domain-specific knowledge in a foreign language
7. Providing convincing arguments for your own conclusions
8. Organising your own activities
9. Leading group work
10. Evaluating your own competences
11. Understanding the philosophical questions related to sustainability
12. Using various digital applications
13. Seeking domain-specific knowledge from different sources
14. Understanding the relationship between humans and the environment, and grasping the notion of limits to growth
15. Goal-oriented negotiation with others
16. Developing products collaboratively by using technology
17. Understanding sustainable development in the context of your own studies, and having an understanding of its interconnections to your field of study
18. Identifying central knowledge in your field
19. Questioning knowledge
20. Evaluating knowledge from different perspectives
21. Solving domain-specific problems
22. Understanding ethical questions related to sustainability
23. Taking responsibility of your own studies
24. Planning your own use of time

(*continued*)

Section 3: Attitudes towards sustainability

- What do you think of the following statements regarding the relationship between humans and nature? Please answer on a scale from 1 (strongly disagree) to 7 (strongly agree).

(1) (2) (3) (4) (5) (6) (7)

1. We are approaching the limit of the number of people the Earth can support
2. Humans have the right to modify the natural environment to suit their own needs
3. When humans interfere with nature, it often produces disastrous consequences
4. Human ingenuity will insure that we do not make the Earth unlivable
5. Humans are seriously abusing the environment
6. The Earth has plenty of natural resources if we just learn how to develop them
7. Plants and animals have as much right as humans to exist
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations
9. Despite our special abilities, humans are still subject to the laws of nature
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated
11. The Earth is like a spaceship with very limited room and resources
12. Humans were meant to rule over the rest of nature
13. The balance of nature is very delicate and easily upset
14. Humans will eventually learn enough about how nature works to be able to control it
15. If things continue on their present course, we will soon experience a major ecological catastrophe

Section 4: Meaningful experiences

- How many sustainability-related courses have you completed?
  - 1. None
  - 2. A few
  - 3. Some
  - 4. Very many
- How much sustainability-related work experience do you have?
  - 1. None
  - 2. A little
  - 3. Some
  - 4. A lot

- How much sustainability-related experience do you have from volunteering or other similar activities?
  - 1. None
  - 2. A little
  - 3. Some
  - 4. A lot

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