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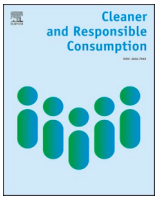

Exploring sustainable development perceptions among higher education students: An empirical study on knowledge, attitudes, and behaviours

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ABSTRACT

Higher education institutions have a role to play in developing sustainability skills and changing students' attitudes and behaviour towards sustainability issues and the Sustainable Development Goals (SDGs). This article aims to explore the knowledge, attitudes and behaviours of higher education students towards sustainability and understand how these vary in line with gender, age, level of education, the field of study and familiarity with the SDGs. A questionnaire survey was carried out among higher education students. A sample of 716 students from different European countries and Türkiye was obtained. The results show that the relationship between students' knowledge of sustainability and their behaviour towards sustainability issues is partly mediated by their attitudes towards sustainability. The practical implications of this study are that it highlights the need to strengthen education on sustainable development and the SDGs in all areas and at all levels of higher education and to provide sound training in this field from the moment students enter higher education. Although knowledge and attitudes towards sustainability are well developed, higher education institutions must train students to change their behaviour.

1. Introduction

Sustainability has moved from being a theoretical concept to becoming an imperative, with global challenges such as climate change, depleting resources, and social inequality making the pursuit of sustainable development essential. Within this context, higher education institutions (HEI) act as hubs of knowledge and innovation, tasked with fostering the next generation of sustainability leaders and thinkers while promoting sustainable development practices.

The Sustainable Development Goals (SDGs) are a comprehensive and ambitious framework comprising 17 goals, 169 targets, and 232 indicators, a complex system that requires coordinated action and collaboration (United Nations, 2015). Individual lifestyles and consumption patterns are of paramount importance in the context of sustainability. Current consumption patterns need to change, requiring societies to change their cultural norms and adopt new consumption habits that are consistent with the limits of the planet. Kiss et al. (2024) support higher education institutions in facilitating the transition to a

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more sustainable lifestyle for students. The academic position on the relationship between education and consumption is that a positive change in consumption behaviour can be achieved through the targeted implementation of educational initiatives. Education is postulated to be the most important factor influencing consumer attitudes towards conscious consumption, and higher education institutions (HEIs) are identified as the most effective providers (Al-Nuaimi and Al-Ghamdi, 2022b). Aware of their critical role, HEIs have incorporated SDG issues into their curricula (e.g., compulsory or elective courses, workshops, lectures, and other activities) but have mostly done so without a structured process or overall institutional policy (Wersun et al., 2020). In fact, Molina et al. (2023) argue that there is a lack of knowledge on the integration of the SDGs in higher education. Finnveden and Schneider (2023) emphasise that while it is still challenging to know what students should learn about SDG, it is not only skills that should be discussed but also learning outcomes.

There is an urgent need to bridge this gap and accelerate the integration of the SDGs into higher education, notably because members of the Generation Z cohort express a strong desire to take the lead in achieving sustainable development (Fromm, 2018). Pradeep and Pradeep (2023) argue that there is insufficient evidence to suggest that Generation Z's awareness and attitudes towards sustainability are reflected in their behaviour. It is therefore crucial to determine whether, and to what extent, knowledge of sustainability is useful in terms of changing consumer behaviour. HEI should therefore provide training solutions and tools. But to be effective, it is also necessary to understand the knowledge, attitudes, and behaviours of higher education students. While studies on sustainability knowledge, attitudes and behaviour have been conducted in different contexts, most are descriptive or explore the correlations between variables (Afroz and Ilham, 2020; Al-Naqbi and Alshannag, 2018; Al-Nuaimi and Al-Ghamdi, 2022a; Marcos-Merino et al., 2020; Salas-Zapata and Cardona-Arias, 2021; Varoglu et al., 2018), overlooking the role of attitudes towards sustainability in the relationship between sustainability knowledge and sustainability behaviour namely trough a cleaner and responsible consumption.

The study aims to explore and understand: 1) the knowledge, attitudes, and behaviours related with sustainability among higher education students; 2) whether knowledge of sustainability is a predictor of sustainability behaviour in higher education students, both directly and through the mediating role of attitudes towards sustainability; 3) differences in knowledge, attitudes and behaviour related with sustainability among higher education students based on gender, age, level of study, field of study, and familiarity with the SDGs. In order to achieve these aims, an empirical study was carried out based on the theory of planned behaviour (Ajzen, 1991). The theory of planned behaviour (Ajzen, 1991, 2011) has been widely used in different fields of research (e.g., Jebsen et al., 2023) that claim human motivation and behavioural intentions are in turn the result of attitudes toward behaviour, subjective norms, and perceived behavioural control. Some studies show the relevance of this theory in predicting sustainability behaviour namely for consumption choices (Cuzdriorean et al., 2020; Lukwago et al., 2023; Wang et al., 2022), sustainability-oriented entrepreneurial intentions (Lopes et al., 2023) and sustainable entrepreneurial goal orientation (Jebsen et al., 2023).

The SDGs can only be implemented, developed, and achieved if individuals have a good understanding of them. More specifically, this leads to a more positive and supportive attitude towards the SDGs which, in turn, fosters their promotion and achievement (Guan et al., 2019; Kukkonen et al., 2018). Liu et al. (2022) found that higher education students had significantly more favourable attitudes toward the educational dimension of Sustainable Development (SD) than students with lower levels of education. In addition, some studies have shown that while individuals may have a high level of knowledge about the SDGs, there is a weak correlation between knowledge and behaviours (Afroz and Ilham, 2020; Eagle et al., 2015; Nikolic et al., 2020). Our hypothesised model is depicted in Fig. 1.

A number of studies have focused on factors directly related to higher education students (Afroz and Ilham, 2020; Ahamad and Ariffin, 2018; Al-Naqbi and Alshannag, 2018; Al-Nuaimi and Al-Ghamdi, 2022a; Aleixo et al., 2021; Azhar et al., 2022; Cuzdriorean et al., 2020; Fourati-jamoussi et al., 2021; Kirby and Zwickle, 2021; Kukkonen et al., 2018; Leiva-Brondo et al., 2022; Novieastari et al., 2022; Salas-Zapata and Cardona-Arias, 2021). They have measured knowledge, attitudes and behaviours towards SD and/or the SDGs, have focused on specific countries or regions, or have used data from a single institution or different courses as their unit of analysis. While these studies provide valuable insights, their scope is limited to the specific cultural, social, and educational contexts of the regions or institutions studied. The present study stands out due to its larger sample size, its collection of data from several different countries and, most importantly, its comprehensive analysis of the multifaceted dimensions of sustainability, covering knowledge, attitudes, and behaviours, thereby offering insight into the complex interrelationships between these elements.

2. Knowledge, attitudes, and behaviours towards SD and SDGs in higher education

The literature presents various perspectives on the understanding of SD or SDGs, with analyses showing differences in awareness, understanding and implementation between higher and lower levels of education.

Borges (2019) showed that undergraduate students had a very satisfactory level of knowledge and attitude towards SD. According to Ovais (2023), the results of a study on sustainability consciousness conducted in India showed that higher education students had a better understanding of sustainability but that this was not reflected in their attitudes and behaviour.

Zamora-Polo et al. (2019) developed and validated a questionnaire to assess the knowledge of SDGs among HE students with different degrees. The results show that knowledge of SDGs is low; significant differences were found between the scores obtained on the professional and personal implications of the SDGs. In another study, many students claim to be aware of the SDGs and yet the majority do not have a complete understanding of the 17 goals and their current implementation despite believing that the SDGs are important in their daily lives (Leiva-Brondo et al., 2022).

The longitudinal study by Eagle et al. (2015) showed a lower awareness of the potential impact of an individual's contribution to sustainability and environmental challenges. Students reveal a tendency to view key issues as beyond their personal control and that it is the responsibility of others to find solutions.

In a study by Afroz and Ilham (2020), respondents were found to have both a good knowledge of and a positive attitude towards SDGs.

Based on these findings, the following two hypothesis are proposed.

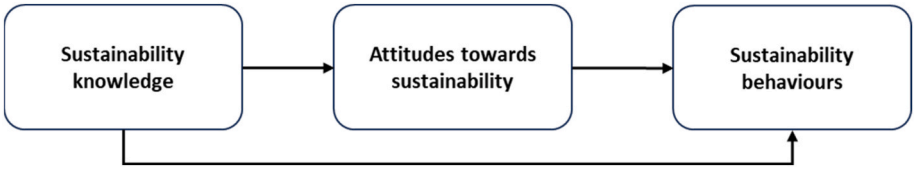

Fig. 1. Hypothesised model.

H1. Higher education students' sustainability knowledge predicts their behaviour on sustainability issues.

H2. Higher education students' sustainability knowledge predicts their attitudes towards sustainability.

Balakrishnan et al. (2020) found that respondents had positive perceptions and attitudes towards most dimensions of sustainability. In the same line, students in Serbia showed a positive attitude towards the concept of SD but most of them did not have a differentiated opinion about how it should be implemented; this is due to the entities the students believed were responsible for SD issues (Nikolic et al., 2020).

Al-Naqbi and Alshannag (2018) conducted a study to assess the knowledge, attitudes and behaviours of students toward education for SD and the environment. Students had a high level of understanding, very strong positive attitudes, and moderately positive behaviours toward ESD and the environment. A strong positive correlation was found between the attitude and practice towards SDGs (Afroz and Ilham, 2020); however, the results of this study revealed a weak negative correlation between the knowledge and practice towards SDGs. Varoglu et al. (2018) investigate the factors influencing vocational business students' sustainability consciousness and reveal that attitude toward the environment has a moderate relationship with environmental knowledge and behaviour. Based on these findings, the following two hypotheses are proposed.

H3. Higher education students' attitudes towards sustainability are a predictor of their behaviour on sustainability issues.

H4. The relationship between students' sustainability knowledge and their behaviour towards sustainability issues is partially mediated by their attitudes towards sustainability.

The existing literature suggests that gender is one of the factors that influence the differences in students' perceptions and attitudes toward sustainability. Liu and Liu (2021) surveyed 1007 business students in a vocational college in China and found that female students showed statistically significant higher levels of sustainability consciousness in terms of their environmental attitudes, economic attitudes, and the social dimension of sustainability behaviour. Olsson and Gericke (2017) find similar results but also correlate gender with age. A survey instrument was used to detect a gender gap in students' sustainability consciousness in a sample of 2413 Swedish students aged 12–19. Findings reveal a gender gap that increases over the age span and is more marked in Education for Sustainable Development (ESD) oriented schools. Based on these findings, the following hypothesis is proposed.

H5. The level of students' sustainability knowledge, their attitudes towards sustainability and sustainability behaviour differ in line with their gender.

The study by Aleixo et al. (2021), with a sample of 1257 Portuguese higher education students, shows that older students have more knowledge about the SDGs. The same study also shows that students in the 17–19 age group are the most concerned about the effects of climate change; and students in the 27+ age group are more likely to recycle. Age could therefore influence the level of sustainability knowledge, attitudes and behaviours. The following hypothesis is thus proposed.

H6. The level of students' sustainability knowledge, their attitudes towards sustainability and sustainability behaviour differ in line with their age.

In the study by Liu et al. (2022), students at higher academic levels had significantly more favourable attitudes towards the educational dimension of sustainable development. Master's students in the Leiva-Brondo et al. (2022) study show higher scores in social sustainability knowledge. Therefore, the following hypothesis is proposed.

H7. The level of students' sustainability knowledge, their attitudes towards sustainability and sustainability behaviour differ in line with their level of study.

Pena-Cerezo et al. (2019) showed that the degree of consciousness about sustainable consumption can vary between fields of study: students of degrees related with environmental and social issues (e.g., Environmental Science, Food Science, and Social Work) obtained a particularly high value in the environmental and social dimensions of the consciousness construct. Zwickle et al. (2014) report that there are variations among students based on their degree choice: aerospace engineering students attribute higher importance to economic sustainability compared to their peers in economics-related disciplines. Furthermore, Sharma et al. (2014) investigated students across different engineering specialisations and attributed the observed disparities to variations in prior knowledge and learning techniques. The findings of Aleixo et al. (2021), Leiva-Brondo et al. (2022), and Molina et al. (2023) also reveal differences between students from different scientific areas/fields on topics related to sustainability - the field of study has an influence on students' perceptions and knowledge of topics related to sustainability. Therefore, the following hypothesis is proposed.

H8. The levels of students' sustainability knowledge, their attitudes towards sustainability and sustainability behaviour differ in line with their field of study.

Existing research shows that most students do not yet fully understand what the SDGs are. In a Portuguese study with data collected in 2019, only 50.5% of students said they had heard of the SDGs and knew what they were (Aleixo et al., 2021). Regarding the approach to SD in curricular units, a recent study of Portuguese university teachers shows that only 29.06% indicate that SD is extensively or widely contemplated in their curricular units (Leal et al., 2023). The Global Survey on Sustainability and the SDGs (Frank et al., 2020) shows that the global average level of awareness of the SDGs is just under 50% (European Union: 56%). The study by Leiva-Brondo et al. (2022) and Zamora-Polo et al. (2019) also demonstrates students' limited knowledge of the SDGs. Therefore, the following hypothesis is proposed.

H9. The level of students' sustainability knowledge, their attitudes towards sustainability and sustainability behaviour differ in line with their familiarity with SDG.

3. Method

3.1. Data collection and sample

The participants in this study are higher education students from 18 different countries (from Europe and Türkiye) attending higher education institutions in 2023. The questionnaires were distributed in four different languages (English, Portuguese, Turkish and Dutch) to ensure greater diversity among the student participants.

The original questionnaire was developed in English and included the Sustainability Consciousness Questionnaire (SCQ) validated by Gericke et al. (2019), along with an additional item assessing familiarity with the Sustainable Development Goals (SDGs) and questions for socio-demographic profiling (see Measures section for further details). To adapt the SCQ for the diverse linguistic contexts represented in this study, we employed the back-translation protocol described by Beaton et al. (2000). This protocol involved translating the questionnaire into the native languages of the research team, namely Dutch, Portuguese, and Turkish. To ensure the accuracy and relevance of the translated versions, both face and content validity were rigorously assessed by bilingual professionals with expertise in sustainability.

The questionnaire was sent to students' e-mail addresses either through the administrative services of the HEIs or through contacts with university teachers. It was completed by participants online, occasionally during lectures. Students participated in the questionnaire voluntarily after completing the informed consent form and did not receive any reward for completing the questionnaire.

A total of 716 students voluntarily participated in the study (Table 1), 300 (41.9%) of whom were male and 406 (56.7%) female. Most participants were aged 25 or under (n = 526; 73.5%) and most were undergraduates (n = 488; 68.2%). Although the sample includes students from all subject areas, the most common areas are social sciences, engineering and technology, and medical and health sciences. There are participants from 18 different countries (Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, England, Finland, France, Germany, Italy, Lithuania, Poland, Portugal, Slovenia, Spain and Türkiye), but most responses come from Portugal (35.2%), Türkiye (19.6%), Cyprus (15.1%) and Slovenia (13.8%).

3.2. Measures

Familiarity with Sustainable Development Goals. To test the familiarity of university students with the term Sustainable Development Goals, the following sentence was added to the questionnaire: "I am familiar with the term Sustainable Development Goals (SDGs)". The students have to express their agreement with this statement using a 5-point Likert scale (1 - strongly disagree; 5 - strongly agree).

Sustainability Consciousness. Higher education students' environmental, social and economic knowledge, attitudes and behaviours were assessed using the long version of the Sustainability Consciousness Questionnaire (Gericke et al., 2019). This questionnaire is made up of nine subscales (knowledge, attitudes and behaviours in each of the sustainability dimensions: economic, social, environmental), which are organised into a second-order construct representing sustainability knowledge, attitudes and behaviours, which in turn form a third-order construct relating to sustainability consciousness (Gericke et al., 2019). Respondents indicate their level of agreement on a 5-point Likert-scale ranging from 1 (I strongly disagree) to 5 (I strongly agree). A sample item for environmental knowledge is "Reducing water consumption is necessary for sustainable development", a sample item for social attitudes is "I think that women and men throughout the world must be given the same opportunities for education and employment", and a sample item for economic behaviour is "I often purchase second-hand goods over the internet or in a shop" (Gericke et al., 2019).

Sociodemographic variables. The socio-demographic characterisation variables were measured as described in Table 1. These qualitative variables were transformed into dummy variables for subsequent analyses. Gender was coded 1 for females and 0 for males, those who indicated another gender and those who did not respond. Age was coded 1 for students aged between 18 and 21 and 0 for older students. For the level of study, master's and doctoral students were coded as 1 and vocational and bachelor's students as 0. Three dummy variables were created for the field of study: one for students studying social sciences (1; 0 for other courses), another for engineering and technology (1; 0 for other courses), and another for natural sciences (1; 0 for other courses). For familiarity with the SDGs, students who agreed or strongly agreed with the sentence "I am familiar with the term Sustainable Development Goals (SDGS)" were coded as 1 and students who strongly disagreed, disagreed or neither agreed nor disagreed with the sentence were coded 0.

Table 1
Demographics of the study participants.

Characteristic	Count (n)	Percentage (%)
Sex		
Male	300	41.9
Female	406	56.7
Other	5	0.7
No Answer	5	0.7
Age		
18–21	323	45.1
22–25	203	28.4
26–29	47	6.6
30–39	56	7.8
40–49	48	6.7
50 and over	29	4.1
No Answer	10	1.4
Level of study		
Vocational training	30	4.2
Undergraduate	488	68.2
Post-graduate/Master	173	24.2
Doctorate	25	3.5
Field of study		
Social sciences	343	47.9
Engineering and technology	119	16.6
Medical and health sciences	135	18.9
Natural sciences	73	10.2
Agricultural sciences	22	3.1
Humanities	24	3.4
Country		
Austria	14	2.0
Belgium	29	4.1
Cyprus	108	15.1
Czechia	28	3.9
Italy	11	1.5
Poland	14	2.0
Portugal	252	35.2
Slovenia	99	13.8
Türkiye	140	19.6
Other	21	2.9

Note. N = 716. Other country: Bosnia and Herzegovina, Bulgaria, Croatia, England, Finland, France, Germany, Lithuania and Spain.

3.3. Procedures

The questionnaire was first written in English from the original scales. It was then translated into Portuguese, Dutch and Turkish by authors who were bilingual in English and each of these languages. After testing the translated versions on a target group (about 10 students for each version), minor changes were made (e.g., improving the wording of sentences).

A study protocol was reviewed and approved by the Ethics Committee, with the approval number 15-2023ESGTS. Informed consent was obtained from participants prior to their participation in the study. Data confidentiality and participant anonymity were maintained.

The four versions of the questionnaire were made available online via the SurveyMonkey platform. Each member of the research team contacted representatives of the universities (e.g., deans, presidents, department heads and professors) and asked them to distribute the version of the questionnaire in the language that best suited the profile of the students. The questionnaire was available online for two months (May and June 2023).

3.4. Data analysis

The data analysis strategy involved a number of sequential stages. First, various steps were taken to create composite indices for each of the nine dimensions of the sustainability consciousness scale (Gericke et al., 2019) using exploratory factor analyses. Factorial analyses (using the principal components method) were used to determine whether the items for each of the nine dimensions of the sustainability consciousness scale could be combined into composite indices. The use of composite indices is common in the literature (Greco et al., 2019; Ivaldi et al., 2016). The factor scores method (Hair et al., 2006) was used to calculate the composite indices, using the factor loadings to weight each item within each composite index. The composite indices representing the nine dimensions of the sustainability consciousness scale are standardised variables, with a mean of zero and a standard deviation of one. The internal consistency of the sustainability knowledge ($\alpha = .83$), the attitudes towards sustainability ($\alpha = .85$) and sustainability behaviour ($\alpha = .68$) were then calculated.

Second, a series of confirmatory factor analyses (CFA; maximum likelihood estimation method and IBM SPSS Amos software adopted across the paper) were conducted to test the measurement model. A

confirmatory factor analysis was performed to test the measurement model given that the constructs of sustainability knowledge, attitudes towards sustainability and sustainable behaviour were made up of the composite indices resulting from the previous step. As the fit of the data was not satisfactory, the data were analysed for the presence of outliers. After removing 35 outliers (about 5% of the sample), the model was re-estimated. The three-factor model fitted the data satisfactorily (χ^2 = 66.88, df = 22; CFI = 0.99; GFI = 0.98; IFI = 0.99; RMSEA = 0.055) and better than the alternative models in which the constructs were merged (Table 2). The main results of the measurement model are presented in Table 3; they include factor loadings, standardised estimates, p-values and squared multiple correlations (R^2). Following the recommendations of Kang and Ahn (2021), the association between measurement error variables is also presented.

Thirdly, the results of the study were estimated. Means, standard deviations and correlations were calculated for both the sample characterisation variables and the composite indicators. The structural equation model (SEM; maximum likelihood estimation method) was tested and direct and indirect effects were assessed. Monte Carlo bootstrap estimates of the effects were obtained with 2000 bootstrap samples. In order to explore the data and gain more detailed insights, ANOVA analyses were carried out to compare the groups in terms of the variables studied. A comparison was made of the results for: (a) women and students of other genders; (b) students aged between 18 and 21 versus students aged 22 and over; (c) postgraduate students (studying for a Master's degree or PhD) versus higher vocational courses or Bachelor's degrees; (d) students from social sciences, engineering/technology and other sciences.

As the source of all variables was in one instrument, Common Method Bias (CMB) can confound our results (Podsakoff et al., 2012). Harman's single-factor test was used to control for the effect of CMB (Podsakoff et al., 2003). CMB is present when an exploratory factor analysis including all primary study variables results in one factor accounting for more than 50% of the variance (Fuller et al., 2016; Kock et al., 2021). In the present study, Harman's test provided a satisfactory result as the variance explained by a single factor was 27.91% of the total variance in the data, which is less than the 50% benchmark. This suggests that our data was not significantly affected by Common Method Bias.

Table 2
Goodness of fit indices of the measurement model.

Model	χ2	df	GFI	RMSEA	CFI	IFI	Δχ2
Three-factor model	66.88	22	0.98	0.055	0.99	0.99	–
Sustainability knowledge and attitudes towards sustainability merged	118.77	24	0.96	0.076	0.97	0.97	Δχ2(2) = 51.89; p < .001
Sustainability knowledge and sustainability behaviours merged	81.21	24	0.97	0.059	0.98	0.98	$\Delta\chi^2$(2) = 14.33; p < .001
Attitudes towards sustainability and sustainability behaviours merged	82.48	24	0.97	0.060	0.98	0.98	$\Delta\chi^2$(2) = 15.60; p < .001
All indicators merged	126.50	25	0.96	0.077	0.97	0.98	Δχ2(3) = 59,62; p < .001

Notes: df = degree of freedom; GFI = goodness-of-fit index; RMSEA = root mean squared error of approximation; CFI = comparative normed fit index; IFI = Incremental Fit Index.

4. Results

Means, standard deviations and Pearson correlations are shown in Table 4. The nine composite indexes representing knowledge of sustainability across the environmental, social and economic dimensions, attitudes towards sustainability across the environmental, social and economic dimensions, and sustainability behaviours across the environmental, social and economic dimensions are all positively correlated, with Pearson correlations ranging from 0.25 (p < .01) to 0.72 (p < .01). Female gender is positively correlated with all sustainability variables; the 18–21 year age group is negatively correlated with all sustainability variables; being a postgraduate student is positively correlated with some, but not all, sustainability variables; students from different fields have different correlations with sustainability issues (e.g., more negative correlations for engineering and technology students; and more non-significant correlations for science students). Approximately 58% of students agree or strongly agree with the statement "I am familiar with the term Sustainable Development Goals", indicating at least moderate familiarity with SDGs. However, it means that a significant proportion of students (42%) have little or no familiarity with the term. Familiarity with the term Sustainable Development Goals (SDGs) is positively related to all sustainability variables.

Structural equation modelling was used to test the model (Fig. 2). The hypothesised model fits the data well (χ^2(22) = 66.88; CFI = 0.99; GFI = 0.98; IFI = 0.99; RMSEA = 0.055). Students' sustainability knowledge has a positive direct effect on attitudes towards sustainability (β = 0.91; p = .001) and on sustainability behaviour (β = 0.44, p = .017), confirming hypotheses 1 and 2. Attitudes towards sustainability has a positive direct effect on students' sustainability behaviour (β = 0.46, p = .009), confirming hypothesis 3. Hypothesis 4 predicted that the relationship between students' sustainability knowledge and their sustainability behaviour would be partially mediated by their attitudes towards sustainability. To test this, indirect effects were calculated, and confidence intervals and p-values were obtained using Monte Carlo bootstrap estimation (Table 5). The results show that the students' sustainability knowledge has an indirect significant effect on students' sustainability behaviour (β = 0.41; p = .009; confidence interval does not include zero), confirming hypothesis 4. Students' sustainability knowledge explains 82% of the variance in attitudes towards sustainability, while sustainability knowledge and attitudes towards sustainability explain 77% of the variance in students' sustainability behaviour.

In order to better understand the results obtained, the analysis was continued by exploring the data, in particular by examining the differences in the variables studied between the different groups (with ANOVA). This was analysed in terms of gender, age, level of study, field of study and familiarity with the SDGs.

There are significant gender differences. For all dimensions of sustainability knowledge, attitudes towards sustainability and sustainability behaviour, female students have higher mean scores than male students (Table 6). This result confirms hypothesis 5. However, according to Cohen's classification (Cohen, 1988), the effect of gender on the different dimensions of sustainability tends to be small, with effect sizes ranging between 0.225 and 0.382.

There are also significant differences between students of different age groups. For all dimensions of sustainability knowledge, attitudes towards sustainability and sustainability behaviour, the younger students (i.e., students aged between 18 and 21 years) have lower scores (Table 7). This finding confirms hypothesis 6. According to Cohen's classification (Cohen, 1988), the effect of age group on the different dimensions of sustainability is intermediate, with effect sizes ranging between 0.251 and 0.468.

There are significant differences between students at different levels of study, but not for all variables. Postgraduate and doctoral students show higher mean scores on the three domains of sustainability knowledge and attitudes towards economic sustainability, and also more proactive behaviour in the environmental and economic domains

Table 3
Loadings of measurement model.

Estimates of loadings					
Latent variables	Measurement variables	Loadings	Standardised estimates	p-value	R^2
Sustainability Knowledge	K_ENV	0.98	0.79	<0.001	0.28
	K_SOC	0.97	0.79	<0.001	0.42
	K_ECO	1.00	0.85	–	0.22
Attitudes towards sustainability	A_ENV	0.82	0.70	<0.001	0.49
	A_SOC	1.06	0.87	<0.001	0.76
	A_ECO	1.00	0.83	–	0.70
Sustainability behaviours	B_ENV	1.12	0.53	<0.001	0.62
	B_SOC	1.31	0.65	<0.001	0.62
	B_ECO	1.00	0.47	–	0.71

Covariances of measurement error				
Measurement variables		**Covariances**	**Correlations**	**p-value**
K_ENV	K_ECO	−0.07	−0.26	<0.001
B_ENV	B_ECO	0.28	0.41	<0.001

Note: N = 681.

(Table 8). This result partially confirms hypothesis 7. According to Cohen's classification (Cohen, 1988), the effect of level of study on most the different dimensions of sustainability is small, with effect sizes ranging between 0.248 and 0.348. In three variables, there is no effect ($d < 0.20$).

There are significant differences between students from different fields of study (Table 9 and Fig. 3), namely between students from social sciences, engineering and technology and other sciences. The post-hoc Tukey tests ($p < .05$) show that for most (but not all) variables, students from engineering and technology courses have significantly lower values than students from social sciences courses (knowledge of environmental sustainability, knowledge of economic sustainability, attitudes towards sustainability in the three areas, behaviours towards social sustainability) and other sciences (knowledge of environmental sustainability, knowledge of social sustainability, knowledge of economic sustainability, attitudes towards sustainability in the three areas, behaviours towards social and economic sustainability). These results confirm Hypothesis 8. According to Cohen's classification (Cohen, 1988), the effect of field of study on the different dimensions of sustainability ranges from small to intermediate, with effect sizes between 0.212 and 0.629.

Note: N = 681. Other sciences include medical and health sciences courses, natural sciences courses, agricultural sciences courses, and humanities courses.

Moreover, there are significant differences between students with different levels of familiarity with the SDGs. For all dimensions of sustainability knowledge, attitudes towards sustainability and sustainability behaviour, the students with greater familiarity with the term Sustainable Development Goals (SDGs) have higher scores (Table 10). This result confirms Hypothesis 9. According to Cohen's classification (Cohen, 1988), the effect of level of familiarity with SDG on the different dimensions of sustainability is intermediate, with effect sizes between 0.388 and 0.594.

5. Discussion

The results suggest that, in higher education, students' knowledge of sustainability has a positive direct effect on their attitudes towards sustainability and their sustainability behaviour. The explained variance is high for both attitudes towards sustainability and sustainability behaviour (82% and 77% respectively). These results are consistent with previous studies conducted in different geographical locations, such as India (Ovais, 2023) and the Dominican Republic (Colón-Flores et al., 2023). A study with higher education students in the United Arab Emirates shows that higher levels of knowledge about sustainable living correlate with a strong tendency to engage in sustainable behaviour (Romdhane et al., 2023). Furthermore, the relationship between sustainability knowledge and sustainability behaviour was shown to be mediated by favourable attitudes towards sustainability. In the study by Colón-Flores et al. (2023), the environmental and social attitudes also mediate the relationship between knowledge about sustainable development and sustainable behaviour. Sustainable attitudes might also moderate the relationship between other student variables (e.g. employability) and sustainable behaviour, as in the Liu et al. (2023) study. These findings are explained by the theory of planned behaviour (Ajzen, 1991, 2005, 2011), according to which individual behaviour is the result of a complex cognitive and decision-making process; i.e., behavioural intentions and attitudes lead to behaviour, but do not always guarantee behaviour. The process of developing sustainability competences during the students' educational process will tend to lead to more favourable attitudes towards sustainable development issues; these attitudes, in turn, will translate into individual and proactive behaviour towards a more sustainable world.

Theory of planned behaviour has been successfully used to understand sustainability behaviour in several domains (e.g., Lopes et al., 2023). However, this result does not guarantee that sustainability knowledge and positive attitudes towards sustainability always translate into actual sustainability behaviour. Previous studies have shown that, despite having knowledge about sustainability, students may not be motivated to change their behaviour through practical action (Ahamad and Ariffin, 2018). Approaches such as project-based learning, service-learning and simulation-based or gamified learning could be useful to promote changes in students' sustainability behaviour (e.g., Birdman et al., 2022; Gatti et al., 2019; Ribeiro et al., 2023).

Social identity theory (Tajfel, 1978, 1982; Tajfel and Turner, 1985) can also be used to explain students' sustainability behaviour. Evidence from environmental psychology suggests that individuals are more likely to participate in collective pro-environmental actions when these are organised by pro-environmental groups with which they identify (Schulte et al., 2020). This study did not control for students' participation in groups that value and promote sustainability practices. However, given the findings of Schulte et al. (2020), it is suggested that the development of pro-sustainability activities in student groups (e.g. student unions) could bring clear benefits in terms of translating the sustainability knowledge acquired into more favourable attitudes and pro-sustainability behaviour.

Female students have higher mean scores than male students for all dimensions of sustainability knowledge, attitudes towards sustainability and sustainability behaviour. Similar results were found by Morales-Baños et al. (2023). Al-Naqbi and Alshannag (2018) also found higher levels of knowledge among women, although no significant differences were identified in attitudes and behaviour. In the study by Liu et al.

Table 4
Means, standard deviations and Pearson correlations.

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Gender[a]	0.58	0.49															
2. Age [18–21][b]	0.45	0.5	0.07														
3. Post-Graduate[c]	0.28	0.45	−0.03	−0.489**													
4. Social Sciences[d]	0.48	0.5	0.13**	−0.04	0.10*												
5. Engineering technology[e]	0.16	0.37	−0.31**	−0.06	0.04	−0.42**											
6. Natural sciences[f]	0.10	0.3	−0.12**	0.01	−0.07	−0.32**	−0.15**										
7. Familiarity SDG[g]	0.58	0.49	0.06	−0.20**	0.23**	0.12**	−0.08*	−0.09*									
8. K_ENV	0.05	0.94	0.15**	−0.23**	0.13**	0.03	−0.16**	0.04	0.24**								
9. K_SOC	0.05	0.94	0.15**	−0.18**	0.11**	−0.06	−0.12**	0.02	0.22**	0.60**							
10. K_ECO	0.08	0.9	0.13**	−0.21**	0.15**	0.06	−0.16**	0.06	0.24**	0.58**	0.68**						
11. A_ENV	0.07	0.88	0.16**	−0.12**	0.04	0.05	−0.13**	−0.03	0.22**	0.52**	0.46**	0.50**					
12. A_SOC	0.07	0.91	0.17**	−0.15**	0.07	0.05	−0.21**	0.03	0.21**	0.64**	0.65**	0.66**	0.62**				
13. A_ECO	0.08	0.9	0.16**	−0.19**	0.12**	0.15**	−0.17**	−0.02	0.22**	0.61**	0.55**	0.65**	0.60**	0.72**			
14. B_ENV	0.03	0.96	0.11**	−0.18**	0.14**	−0.08*	−0.01	0.01	0.28**	0.35**	0.41**	0.36**	0.31**	0.40**	0.38**		
15. B_SOC	0.05	0.92	0.19**	−0.17**	0.07	0.13**	−0.17**	0.01	0.19**	0.44**	0.45**	0.45**	0.40**	0.47**	0.48**	0.33**	
16. B_ECO	0.04	0.97	0.14**	−0.18**	0.12**	−0.07	−0.09*	0.04	0.25**	0.27**	0.41**	0.34**	0.25**	0.33**	0.32**	0.55**	0.32**

Notes. N = 681. * p-value <0.05; **p-value<0.01. [a] Female = 1, other = 0; [b] Age[18–21] = 1, Age [22 or above] = 0; [c] Post-graduate students (master's, PhD) = 1; Vocational and graduates students = 0; [d] Students from social sciences courses = 1, other courses = 0; [e] Students from engineering and technology courses = 1, other courses = 0; [f] Students from natural sciences courses = 1, other courses = 0; [g] Agree or strongly agree with the sentence "I am familiar with the term Sustainable Development Goals (SDGS)" = 1; strongly disagree, disagree or neither agree nor disagree with the sentence = 0; K_ENV: Environmental sustainability knowledge; K_SOC: Social sustainability knowledge; K_ECO: Economic sustainability knowledge; A_ENV: Attitudes towards environmental sustainability; A_SOC: Attitudes towards social sustainability; A_ECO: Attitudes towards economic sustainability; B_ENV: Environmental sustainability behaviour; B_SOC: Social sustainability behaviour; B_ECO: Economic sustainability behaviour.

(2022), female students had significantly more positive attitudes towards environmental and educational dimensions of sustainable development than male students. Čiarnienė et al. (2020) also find a higher level of sustainability issues among female respondents. Meyer (2016) found that female students engaged in significantly higher levels of green behaviour, including recycling and double-sided printing. However, Leiva-Brondo et al. (2022) found no significant differences between the genders in terms of sustainability knowledge. Meinzen-Dick et al. (2014) state that "gender matters for sustainability" (p. 47). Women tend to be more proactive in green initiatives, minimising waste, consumer behaviour and reusing products (Čiarnienė et al., 2020; Ovais, 2023). "But this does not mean that women (or men) are inherently more resource-conserving" (Čiarnienė et al., 2020, p. 47). As both genders have a role to play in promoting sustainability, the fact that women tend to be more aware of sustainability issues highlights the need to increase the involvement of men in sustainability training and activities.

Younger students (i.e., students aged between 18 and 21 years) have lower scores in all dimensions of sustainability knowledge, attitudes towards sustainability, and sustainability behaviour. These results are in line with Čiarnienė et al. (2020), who found that people from the baby boomer generation [born between 1946 and 1965 (Lissitsa and Laor, 2021)] had the highest scores on economic, environmental, and social behaviours when compared with younger participants (Gen X [born between 1966 and 1980] and Gen Y [born between 1981 and 1994]). Kirby and Zwickle (2021) found that age was a predictor of university students' sustainability knowledge but not of their sustainability attitudes and behaviour. In the study by Meyer (2016), age was not a predictor of students' pro-environmental behaviour; the results related to age in terms of sustainability knowledge, attitudes and behaviour are therefore mixed. There is a significative positive correlation between the age of students and the frequency of postgraduate studies: it is therefore assumed that the more favourable effect on knowledge, attitudes and behaviour is partly due to the fact that older students attend more advanced levels of higher education and have more years of education.

Postgraduate and doctoral students have higher mean scores in the three domains of sustainability knowledge and attitudes towards economic sustainability, and also more proactive behaviour in the environmental and economic domains. These results are also consistent with some previous studies (Al-Naqbi and Alshannag, 2018; Leiva-Brondo et al., 2022; Liu et al., 2022). Al-Naqbi and Alshannag (2018) found evidence that 4th and 5th year students (which in Europe can be compared to postgraduate studies as most universities offer three-year degrees) have more positive sustainability behaviours than 1st year students. In the study by Liu et al. (2022), students at higher academic levels had significantly more favourable attitudes towards the educational dimension of sustainable development as compared to students at lower academic levels. Master's students in the Leiva-Brondo et al. (2022) study obtained higher scores in sustainability knowledge compared with bachelor students. These results underline the need to strengthen education on sustainable development from the very start of academic training, across all courses and disciplines, and not to leave such issues to later years or postgraduate studies.

There are significant differences between students from different fields of study, with students from engineering and technology courses scoring lower in most areas of sustainability knowledge, attitudes and behaviour (except for environmental behaviour). As expected, there are differences in sustainability knowledge, attitudes, and behaviour between students' fields of study. For example, the results of Leiva-Brondo et al. (2022) reveal that students from environmental science courses have the highest scores for environmental sustainability knowledge, and students from aerospace engineering have the lowest scores. On the other hand, the Leiva-Brondo study shows no significant differences between the degrees for economic sustainability knowledge. However, the result for engineering students is surprising as engineers need to create sustainable solutions for the future and therefore education for

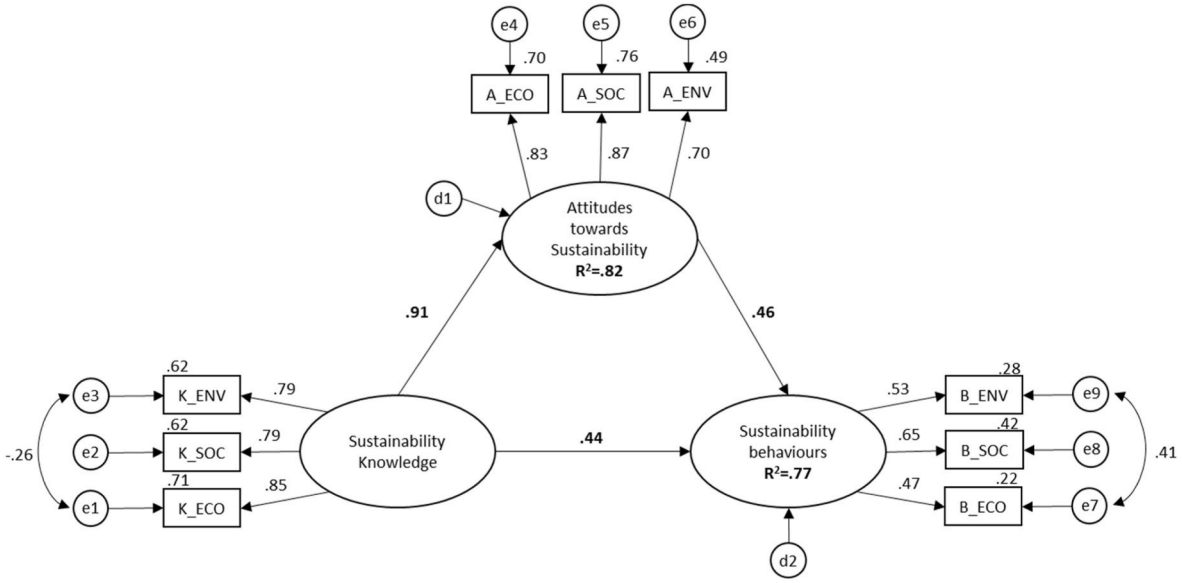

Fig. 2. SEM results for the hypothesised model predicting higher education students' sustainability behaviours based on sustainability knowledge, with mediating effect of attitudes towards sustainability
Note: N = 681. Statistics are standardised estimates.

Table 5
– Standardised direct, indirect and total effects.

Endogenous variables	Exploratory variables	Standardised Direct Effects			Standardised Indirect effects			Standardised Total effects		
		beta	90% CI	p-value	beta	90% CI	p-value	beta	90% CI	p-value
Attitudes towards sustainability	Sustainability Knowledge	0.91	0.88–0.93	0.001	–	–	–	0.91	0.88–0.93	0.001
Sustainability behaviour	Attitudes towards sustainability	0.46	0.19–0.74	0.009	–	–	–	0.46	0.19–0.74	0.009
Sustainability behaviour	Sustainability Knowledge	0.44	0.15–0.71	0.017	0.41	0.17–0.67	0.009	0.85	0.79–0.92	0.001

Note: Confidence intervals and p-values obtained by Bootstrap simulation (N = 2000 bootstrap samples; bias-corrected confidence intervals reported).

Table 6
– Means, standard deviations, and One-Way Analyses of Variance by gender.

Measure	Mean		Std. Deviation		Robust Tests of Equality of Means (Welch)				Effect size *d* (*)
	Female	Male	Female	Male	Statistic[a]	df1	df2	Sig.	
K_ENV	0.17	−0.12	0.89	0.99	14.84	1	580.80	0.000	0.304
K_SOC	0.17	−0.12	0.88	0.99	15.96	1	578.78	0.000	0.316
K_ECO	0.17	−0.06	0.85	0.94	11.09	1	586.34	0.001	0.262
A_ENV	0.19	−0.08	0.80	0.95	15.98	1	555.12	0.000	0.319
A_SOC	0.21	−0.11	0.82	1.00	19.94	1	544.78	0.000	0.357
A_ECO	0.20	−0.09	0.83	0.97	17.27	1	559.55	0.000	0.331
B_ENV	0.13	−0.09	0.89	1.03	8.01	1	565.94	0.005	0.225
B_SOC	0.19	−0.15	0.82	1.02	22.66	1	538.71	0.000	0.382
B_ECO	0.16	−0.12	0.91	1.03	13.35	1	574.51	0.000	0.289

Note. N = 681. [a] Asymptotically F distributed. As homogeneity of variances was not proved, the Welch test was used. (*) Effect sizes *d* were calculated using calculators provided by Lenhard and Lenhard (2022).

sustainable development will be very important to students' careers (Colón-Flores et al., 2023). Molina et al. (2023) indicate that the integration of SDGs is more common in engineering and technology and humanities and social sciences, compared to health care, for example. In the Global Survey on Sustainability and the SDGs (Frank et al., 2020), negative awareness of the SDGs is obtained from respondents in academia, and from economics, natural sciences, and medical and health sciences areas; engineering and technology is ranked 4th in negative awareness (in a list of 10). The lower scores in the sustainability dimensions among engineering and technology students can be attributed to two primary factors. First, these disciplines often prioritize the development of technical skills and problem-solving methodologies, rather than adopting holistic and interdisciplinary approaches where sustainability is typically integrated (Colón-Flores et al., 2023). Second, the emphasis on efficiency, innovation, and technical performance in engineering and technology courses contrasts with the focus on critical thinking more commonly found in the social sciences, potentially leading to a diminished emphasis on sustainability-related competencies (Colón-Flores et al., 2023; Kurnaz and Aniktar, 2024). Moreover, while sustainability topics are addressed within engineering and technology curricula, they are frequently approached from a practical perspective, oriented towards solving real-world problems (e.g., the technological development of cleaner energy products or the enhancement of technological processes to promote more sustainable production). However, these practical approaches to sustainability may not be fully captured by the Sustainability Consciousness Questionnaire (Gericke et al., 2019),

Table 7
Means, standard deviations, and One-Way Analyses of Variance by group age.

Measures	Age 18-21		Age 22 and over		F (1,679)	Sig	Effect size d (*)
	M	SD	M	SD			
K_ENV	−0.19	0.93	0.24	0.91	36.798	0.000	0.468
K_SOC	−0.13	0.96	0.20	0.89	22.132	0.000	0.363
K_ECO	−0.13	0.90	0.24	0.86	29.764	0.000	0.421
A_ENV	−0.05	0.91	0.17	0.83	10.598	0.001	0.251
A_SOC	−0.08	0.95	0.19	0.86	15.152	0.000	0.300
A_ECO	−0.10	0.93	0.23	0.85	24.037	0.000	0.378
B_ENV	−0.15	1.00	0.19	0.90	21.855	0.000	0.360
B_SOC	−0.13	0.96	0.19	0.87	20.165	0.000	0.346
B_ECO	−0.15	0.99	0.20	0.93	22.808	0.000	0.368

Note. N = 681. (*) Effect sizes d were calculated using calculators provided by Lenhard and Lenhard (2022).

Table 8
Means, standard deviations, and One-Way Analyses of Variance by level of study.

Measures	Postgraduate & PhD		VET & Undergraduate		F (1,679)	Sig	Effect size d (*)
	M	SD	M	SD			
K_ENV	0.24	0.95	−0.03	0.93	11.542	0.001	0.290
K_SOC	0.22	0.95	−0.01	0.93	8.413	0.004	0.248
K_ECO	0.30	0.88	−0.01	0.89	16.594	0.000	0.348
A_ENV	0.13	0.88	0.05	0.87	0.894	0.345	0.081
A_SOC	0.17	0.92	0.03	0.91	2.930	0.087	0.146
A_ECO	0.26	0.90	0.01	0.89	10.494	0.001	0.277
B_ENV	0.25	0.87	−0.05	0.98	13.520	0.000	0.314
B_SOC	0.15	0.88	0.01	0.94	3.142	0.077	0.151
B_ECO	0.22	0.96	−0.03	0.96	9.464	0.002	0.263

Note. N = 681. (*) Effect sizes d were calculated using calculators provided by Lenhard and Lenhard (2022).

which could potentially influence the results obtained in this study.

For all dimensions of sustainability knowledge, attitudes towards sustainability and sustainability behaviour, the students with greater familiarity with the term Sustainable Development Goals (SDGs) have higher scores. Although this result is not surprising, it is worrying that around 42% have little or no familiarity with the SDGs. There were similar findings in Spanish research; although many students in this study said they were aware of the SDGs, most did not fully understand these 17 goals and their current implementation (Leiva-Brondo et al., 2022), or had very limited knowledge of the SDGs (Zamora-Polo et al., 2019). The findings of the Global Survey on Sustainability and the SDGs (Frank et al., 2020) are also similar as they show that the global average level of awareness of the SDGs is just under 50% (European Union: 56%). These results can be partly explained by the findings of Leal Filho et al. (2019) , namely only 32 per cent of participants (which include university professors, researchers, university rectors or presidents, among other internal university stakeholders) fully apply the SDGs in university activities; and only 43% indicate that the university where they work has made a strategic decision to integrate the SDGs into course curricula.

Nine years after the publication of the SGDs, it is still necessary to strengthen higher education students' knowledge of them and develop relevant activities. The way in which HEIs integrate sustainability issues tends to vary considerably from one institution to another and shows different levels of maturity (Pizzutilo and Venezia, 2021). It is suggested that mixed approaches should be adopted through the design of curricula and pedagogies that address the SDGs, and SDG-focused extracurricular activities, including study tours, hackathons, conferences, youth training, leadership programmes, volunteering, internship or work experience opportunities that address the SDGs (Holmes et al., 2022). Annan-Diab and Molinari (2017) highlight the need for HEIs to adopt an interdisciplinary approach to SDG education, particularly in management education. Leiva-Brondo et al. (2022) also call for future training and awareness-raising activities to improve sustainability education strategies. Open access courses on sustainability are now available where teachers and students can deepen their knowledge of sustainability issues (Moreno Pires et al., 2022). Teachers from different disciplines could use them to improve sustainability education. Given that the Lozano et al. (2023) study showed that the universal and social pedagogical approaches have the strongest impact on sustainability competences, participatory action research, community service learning, project- or problem-based learning and case studies should be prioritised as pedagogical choices.

6. Conclusion

Today's students will be tomorrow's leaders. In the very near future, these students will be making decisions that have an impact on all aspects of sustainability (environmental, social and governance). Never has it been so important or urgent to ensure that we are educating students to make decisions and adopt attitudes and behaviours that promote sustainability and fostering sustainable consumption practices. Changing the behaviour of each and every one of us, whether at an individual, corporate, governmental, national, or even international level, is crucial to achieving a more sustainable future.

The results of this study therefore highlight the importance not only of higher education institutions equipping students with more knowledge in the area of sustainability, but also of the use of practical teaching methods that facilitate the translation of this knowledge into more favourable attitudes towards sustainability and, above all, into more pro-sustainable actions on the ground. Some of these teaching methods include project-based learning, service learning, simulation-based or gamified learning. Informal learning through extracurricular activities, study visits, hackathons and volunteering can make a significant contribution to developing skills and changing attitudes and behaviours

Table 9
Means, standard deviations, and One-Way Analyses of Variance by field of study.

Measures	Social Sciences		Engineering and Technology		Other Sciences		F(1,679)	Sig	Effect size d (*)
	M	SD	M	SD	M	SD			
K_ENV	0.08	0.92	−0.29	0.95	0.15	0.94	9.009	0.000	0.475
K_SOC	−0.01	0.99	−0.21	0.92	0.25	0.84	11.014	0.000	0.503
K_ECO	0.13	0.89	−0.24	0.95	0.15	0.86	8.370	0.000	0.437
A_ENV	0.12	0.85	−0.19	0.91	0.14	0.87	6.245	0.002	0.376
A_SOC	0.12	0.85	−0.36	1.08	0.20	0.85	16.003	0.000	0.629
A_ECO	0.22	0.85	−0.28	0.98	0.05	0.89	13.358	0.000	0.563
B_ENV	−0.05	0.99	0.01	0.97	0.16	0.91	3.179	0.042	0.212
B_SOC	0.17	0.89	−0.31	1.03	0.04	0.87	11.839	0.000	0.535
B_ECO	−0.03	1.00	−0.16	0.95	0.22	0.91	7.590	0.001	0.400

Note. N = 681. $N_{Social\ sciences}$ = 326; $N_{Engineering\ and\ technology}$ = 111; $N_{Other\ sciences}$ = 244. Other sciences include Medical and health sciences, Natural sciences, Agricultural sciences, and Humanities. (*) Effect sizes d were calculated using calculators provided by Lenhard and Lenhard (2022).

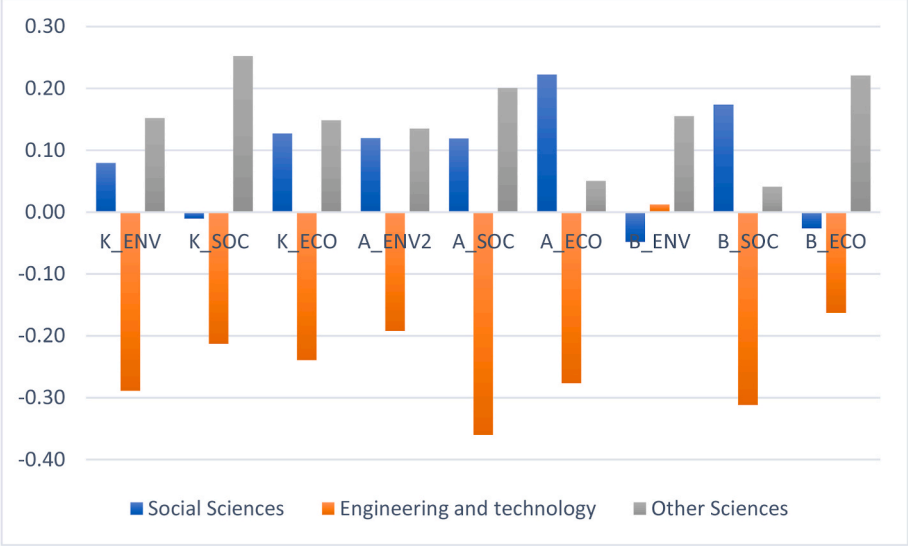

Fig. 3. – Means on the study variables by field of study.

Table 10
Means, standard deviations, and One-Way Analyses of Variance by level of familiarity with SDG.

Measures	Low Familiarity with SDG		High Familiarity with SDG		F (1,679)	Sig	Effect size d (*)
	M	SD	M	SD			
K_ENV	−0.22	0.94	0.24	0.90	40.922	0.000	0.497
K_SOC	−0.19	0.94	0.23	0.90	35.234	0.000	0.461
K_ECO	−0.18	0.88	0.26	0.86	42.324	0.000	0.505
A_ENV2	−0.15	0.94	0.24	0.79	33.211	0.000	0.448
A_SOC	−0.15	0.94	0.23	0.85	30.238	0.000	0.427
A_ECO	−0.15	0.91	0.25	0.86	33.130	0.000	0.447
B_ENV	−0.28	0.92	0.27	0.93	58.388	0.000	0.594
B_SOC	−0.16	0.98	0.20	0.85	24.903	0.000	0.388
B_ECO	−0.24	0.92	0.25	0.95	45.444	0.000	0.524

Note: N = 681. Familiarity with the SDGs was classified according to students' agreement with the sentence "I am familiar with the term Sustainable Development Goals (SDGs)". Low familiarity if students answered 'strongly disagree', 'disagree' or 'neither agree nor disagree'. High familiarity if students answered 'agree' or 'strongly agree'. (*) Effect sizes d were calculated using calculators provided by Lenhard and Lenhard (2022).

among higher education students in the area of sustainability. Extracurricular activities related to the environment (e.g., removing plastic from beaches) can encourage students to become more engaged with sustainability challenges in the real world. Study visits to green companies or companies with sustainable business models can inspire them to follow these examples. Sustainability hackathons encourage innovation, creative problem solving and enhance employability skills. Volunteering, particularly in social enterprises, allows students to engage with real-world economic, social and environmental issues. Education for sustainable development also takes place informally in professional contexts, which can be accessed by students through volunteering. Higher education institutions also have a crucial role in ensuring that, in the long term, students find meaning and purpose in life through their careers. By integrating sustainability early in students' educational pathways, both formally and through informal activities, there is an increased likelihood that sustainability will become a core value for them. This approach can support students in discovering a sense of purpose and vocation aligned with sustainability, fostering a deeper commitment to seeking genuine vocations connected to this theme (Karjanto, 2022).

By examining a diverse sample of 716 higher education students from different European countries and Türkiye, the study provides valuable insights into how these factors vary by gender, age, education level, field of study, and familiarity with the SDGs. The findings highlight the importance of attitudes towards sustainability as an important mediator between knowledge and actual sustainable behaviour. This suggests that, in addition to knowledge transfer, HEIs need to focus on shaping positive attitudes in order to effectively translate knowledge into sustainable behaviours. The study's empirical evidence supports the theory of planned behaviour by showing that attitudes towards sustainability significantly predict students' sustainability behaviour.

At a macro level, the study provides insights for policymakers on how to better structure sustainability education to promote responsible consumption behaviours among higher education students. Some recommendations for policymakers: (a) Education for sustainability and the SDGs should be integrated into all courses in a cross-curricular manner to ensure that all students, regardless of their field of study, acquire relevant sustainability competencies; (b) Given that attitudes partly mediate the relationship between knowledge and behaviour, policymakers can support initiatives that engage higher education students and promote positive attitudes towards sustainability through workshops, campaigns, informal and innovative learning opportunities; (c) Increase students' familiarity with the SDGs not only through course syllabi, but also through on-campus activities (e. g., sustainable consumption practices in canteens and bars).

In conclusion, this study emphasises the need for HEIs to adopt a comprehensive approach to sustainability education. This approach should not only influence knowledge, but also actively promote positive attitudes and behaviours towards sustainability and responsible consumption. In this way, HEIs can play a crucial role in equipping the next generation of leaders and decision-makers with the knowledge and skills needed to address the urgent sustainability challenges of our time.

This study is not without its limitations. Firstly, the possibility of errors related to the variance of the common method cannot be excluded. To overcome this shortcoming, future studies should consider collecting data on the dependent and independent variables at different points in time. On the other hand, despite the inclusion of students from different countries in the sample, it is not suggested that the results of the study are representative of what happens in these countries.

Future studies could also investigate whether sustainability activities organised by the groups in which students participate and with which they identify (e.g., student associations) subsequently lead to more sustainability behaviour on the part of these students. Future studies

should also provide a more in-depth analysis of the relationship between sustainability knowledge, attitudes and behaviours in fields such as engineering (given the active role that engineers play in finding solutions for our common future) or management (given that managers and leaders in companies make the most important decisions with an impact on sustainability).

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CRediT authorship contribution statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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