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Is university teaching aligned with the sustainable development goals possible? An approach through the virtual training of university professors

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Abstract

Purpose – This study aims to determine the degree of knowledge acquired by university professors after receiving virtual training on the sustainable development goals (SDGs) and their relationship with the contents of the subjects taught.

Design/methodology/approach – A 40-h virtual course on SGDs and higher education was designed. To evaluate professor knowledge, a questionnaire was administered to professors from different fields of

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knowledge. The questionnaire consists of 25 questions divided into two sections: Section 1: Q1–Q8 (knowledge and access to information) and Section 2: Q9–Q25 (the relationship of the subjects taught with the 17 SDGs). The virtual classroom was used to do the questionnaire and it lasted 10 min. The internal consistency of the different constructs was analyzed by Cronbach's alpha, Kaiser–Meyer–Olkim test and Marlett test. Descriptive and inferential analysis were also performed.

Findings – Statistical analysis showed a high reliability for the constructs (smallest Cronbach's alpha = 0.908). Virtual teaching to teachers significantly improves the results of Section 1 (Q1–Q8) ($p < 0.001$) and Section 2 (Q9–Q25) ($p < 0.001$) of the questionnaire. Teachers aged 40–50 years significantly associate the contents of their subjects with SDG1 (Q9, $p = 0.02$), SDG2 (Q10, $p = 0.00$) and SDG8 (Q16, $p = 0.04$) previous course. In addition, the area of origin may influence knowledge about the SDGs. At the end of the course, there were no significant differences between teachers by age, field of knowledge or academic category.

Originality/value – Virtual training on SDGs unifies the knowledge of university faculty, promoting academic curricula aligned to sustain-able training, regardless of age, gender, academic category or field of knowledge.

Keywords SDGs, Higher education, Virtual training, Sustainable, Teacher training, Digitalisation

Paper type Research paper

1. Introduction

The importance of transversal competences in university education has grown in recent years (Aránguiz Salazar, 2012; Salcines Talledo *et al.*, 2018). Transversal competencies can be defined as those competencies that are important for different areas of knowledge, work sectors and that can be applied in different contexts. These competencies are not related to a specific profession. The European higher education area has revitalised the role of this type of teaching, considering it to be a basic element for the social transformation that universities must lead (Mir-Acebrón, 2008). Numerous studies have analysed the impact of specific competences (directly related to the profession) and those related to the exercise of a committed and critical citizenship on the teaching of students (Zamora-Polo *et al.*, 2019). In this context, it is necessary to introduce into the field of higher education the major global challenges facing today's society, and to which the university cannot remain indifferent (Ferrer-Carbonell *et al.*, 2004). These challenges have to do with aspects related to globalisation, ecological transition, digitalisation and the well-being of society, among others (Acevedo-Duque *et al.*, 2023; Confraria *et al.*, 2024). For universities to respond to these questions, the following premises must be followed:

- to address the social challenges of our times from a global approach, integrating a joint vision between disciplines; and
- to implement specific training for all university teaching staff (Miró and Jaume i Capó, 2011; Grácio *et al.*, 2023).

To develop this training, initiatives and projects are emerging that consider the introduction of specific elements for teacher training in relation to this sensitivity (Morales and Cuevas, 2012).

1.1 Sustainable development as cross-cutting content in teaching-learning processes

Within this field of soft skills, the sustainable development goals (SDGs) are an important reference, constituting a challenge for university teaching (Blanco-Portela *et al.*, 2020; Expósito and Sánchez, 2020; Anderson *et al.*, 2024). Since their adoption by the UN in 2015, the SDGs have provided a framework for all levels of society, committing nations to the achievement of the goals outlined for building a sustainable society (De la Rosa Ruiz *et al.*, 2019).

The SDGs approved in 2015 represent a work agenda for the period from 2015 to 2030. In the context of higher education, numerous studies have addressed the catalytic impact of universities on the achievement of the SDGs (Boni *et al.*, 2016). One of the main

characteristics of the SDGs, compared to the millennium development goals (their predecessors), is that they are aimed at both developing and developed countries.

A detailed analysis of the institutional documents published by associations and governmental entities is beyond the scope of this paper. However, by way of example, institutions such as UNESCO have a roadmap for the promotion of education for sustainable development in the context of the SDGs (UNESCO, 2020). Similarly, a reflection on the role of universities in the achievement of the SDGs sponsored by UNESCO can be found in UNESCO (2022). In the same way, SDSN Australia/Pacific published guidance on the role of higher education institutions and academia in achieving the SDGs (SDSN, 2017).

On the other hand, tools for evaluating the implementation of the SDGs in universities are proliferating. For example, the International Institute for Higher Education in Latin America and the Caribbean has created the SET4HEI tool (UNESCO IESALC, 2024).

Previous studies have highlighted the role of the university in achieving sustainable social development (Green, 2013; Sonetti *et al.*, 2021; Tziganuk and Gliedt, 2017). In any case, it is necessary to introduce the SDGs at the university level. Thus, some studies see the SDGs as both a challenge and an opportunity for university education (Gonzaga Añazco *et al.*, 2021; Leal Filho *et al.*, 2019; Litzner Ordóñez and Rieß, 2019; Lytovchenko *et al.*, 2021).

Among the difficulties encountered in previous studies for the integration of the SDGs in the curriculum is the lack of teacher training (Leal Filho, 2019) and the low appreciation of this type of initiatives in the teachers' professional curriculum.

Other studies suggest that university education can be used to build a better world through soft skills related to the SDGs. In this sense, there are previous experiences in the field of experimental sciences (Tomazello and Guimarães, 2007), environmental education, linking the contents of this subject to SDG13 and SDG15, linking the environment to the SDGs (Vega-Marcote and Álvarez-Suárez, 2005; Sierra *et al.*, 2016), with educational sciences (Reyes Sánchez *et al.*, 2016), with health sciences (Anderson *et al.*, 2024) or around social sciences relating to some SDGs such as SDG13, SDG15 or SDG4, respectively (Place, 2010).

On the other hand, Zamora-Polo *et al.* have shown interest in finding out what level of information students have about the SDGs (Zamora-Polo *et al.*, 2019) as well as in the analysis of the impact of experiences linked to SDG awareness-raising. However, even though training for sustainability has been identified as a challenge in teacher education, it is not yet possible to identify the need for sustainability as a key issue (Vilches and Pérez, 2012), the number of studies focusing on teacher training on how to introduce cross-cutting SDG-oriented content in university degrees is very limited (Lee *et al.*, 2023; Arango-Uribe *et al.*, 2023). For this, projects that aim to integrate the SDGs into teacher training are necessary (Bernis Carro, 2019). The aim of this study was to assess the degree of perception of knowledge acquired by university professors after receiving virtual training course on the SDGs and their relationship with their teaching.

2. Materials and methods

This was a descriptive study developed following the completion of a questionnaire adapted from a previous study by Zamora-Polo *et al.* (2019). This study was supervised by the Bioethics Committee of the University of Extremadura, Spain, with ethics approval number 101/2021.

2.1 Sample description

A total of 60 university teachers belonging to the G9 group of Spanish universities voluntarily agreed to virtual training course. This group constitutes a university alliance that aims to develop university policies through common strategies. These include promoting joint teaching activities, stimulating the exchange of knowledge and collaboration with economic and social

agents. The choice of these universities was based on a previous study by the authors in which differences were found in teachers' motivations. The authors of the present study considered this issue of interest because of the representativeness of the study population.

In terms of ethical procedures, all participants gave informed consent and gave their consent to use their responses for our research for academic purposes. To maintain anonymity, all names were coded. This encouraged the teachers to freely express their opinions. Of the total number of teachers who accessed the virtual training (n = 60), those who met the following inclusion criteria participated in this study:

- Teachers (full- or part-time) from the G9 group of Spanish universities. This group is made up of the following public universities in Spain: Cantabria, Castilla La Mancha, Extremadura, Illes Balears, La Rioja, Navarra, Oviedo, Basque Country and Zaragoza.
- Teachers with a minimum of two full academic years of teaching experience in higher education.
- Teachers who had access to the Moodle platform of the G9 group of Spanish universities and carried out at least one activity from the Teacher Training Service during the 2017–2018, 2018–2019 and 2019–2020 academic years.

Those lecturers who did not respond to the questionnaire in the period were excluded, as were those who did not have a contractual/employment relationship with any of the universities during the recruitment period. Ultimately, the sample consisted of a total of 44 university teachers.

2.2 Data collection

The questionnaire had previously been used by at least 13 international higher education institutions. This questionnaire is presented in Appendix A (Supplementary material). The questionnaire collected sociological data from teachers and was structured in two sections. Section 1 contained questions (Q1–Q8) relating to their previous knowledge of the SDGs as well as the source of this knowledge. Questions Q1–Q4 provide information on knowledge of the SDGs and will be analyzed in sub-sections 3.1 and 3.2 as construct 1 (C1), questions Q5–Q8 provide information on the source of information on the SDGs, in sub-sections 3.1. and 3.2 they will be identified as construct 2 (C2). In Section 2, the professors were asked about the relationship between the SDGs and the content and competencies they teach in their undergraduate and/or master's degree courses at their universities (Section 2, Q9–Q25) (these questions were grouped in construct 3, C3). Subsequently, the adapted draft questionnaire was reviewed by two independent experts with more than 10 years of teaching and research experience in the field of educational sciences. They made some modifications to the wording of the questions. Teachers completed the form anonymously online as in previous studies (Zamora-Polo *et al.*, 2019), using the Google Form® tool (Google LLC, Mountain View, CA, USA), which was enabled for teachers who completed the tasks set by the course teachers in due time and form (both the initial tasks and the course completion tasks).

Finally, the questionnaire consisted of 25 items with Likert-type responses ranging from 0 (strongly disagree) to 5 (strongly agree). The time taken to complete the questionnaire was no more than 10 min.

The questionnaire was completed together with other teacher training activities. The information reported using this questionnaire aimed to determine the degree of knowledge prior to completing the course, as well as the impact of the course on the acquisition of knowledge about the SDGs and their potential implementation in university teaching. This tool has been used by other researchers who have carried out similar studies exploring knowledge of the SDGs (Anderson *et al.*, 2024).

The questionnaire was provided online through the Moodle© virtual platform using a Google Forms link. This format has advantages, as it allows for almost automatic transcription, although it may have a lower response rate. Beforehand, the teachers were informed about the nature of this study and its objectives.

2.3 Virtual training course on sustainable development goals for university teachers

The tool used to train the teachers was a virtual training course entitled "Transversalisation of the University? Promoting professional ethics and sustainability through the inclusion of the Sustainable Development Goals". This training course was disseminated through an offer made by the guidance and teacher training services of the 9 Spanish public universities that make up the G9 group. This mixed-modality (asynchronous/synchronous) course was virtual and had a duration of 40 h. It was divided into four thematic axes with the following titles:

(1) basis of the course: awareness and motivation;

(2) teachers and students with ethics of commitment;

(3) promoting moral reasoning: a practical approach to university teaching; and

(4) development of transversal competences through the SDGs: applications in the classroom.

All of these axes were aligned with the role of university education in the sustainable human development of students and teachers. In all thematic axes of the training course, the SDGs were discussed as examples for the use of methodologies and teaching activities in different degrees. Each thematic axis had 10 identically distributed hours of virtual training:

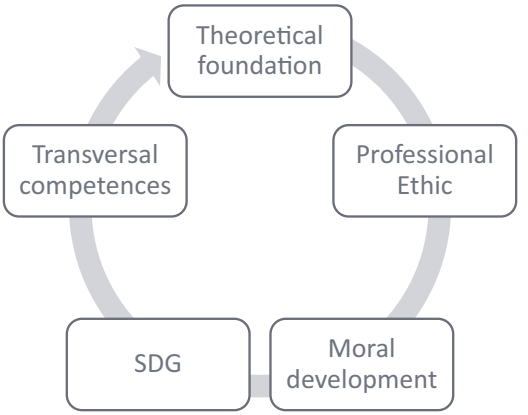
- Presentation of theoretical contents by the course lecturer (3 h): The course lecturer shared two video files (1.5 h each) with content on the thematic axis in question. These recordings were asynchronous, so the teachers receiving the training could consult them at any time.
- Reading and viewing digital documents in the virtual environment (2 h): each thematic axis had three documents (e.g. scientific articles) and a video that complemented the rationale of the thematic axis in question.
- Activities and tasks (3 h): The contents were developed with resources (forums, questionnaires, workshops, etc.) from the virtual environment. These tasks required individual and group participation, encouraging teachers to learn about practical applications of ethics in their degrees through the development of individual and collective critical thinking. The task(s) of each thematic axis had to be handed in before the beginning of the next thematic axis.
- Synchronous connection between trainer and trainee teachers (2 h): this section was intended to resolve doubts and was used to share the contents dealt with in each thematic axis.

There were four teacher trainers in total, and each of them was dedicated to one of the thematic axes established in the design of the course. At the end of the course, to pass the evaluation, all trained teachers had to meet the following criteria:

- deliver all activities/tasks of each thematic axis;
- attend at least 60% of section iv of each thematic axis; and
- fill in the satisfaction survey at the end of the course.

Figure 1 shows the main pillars of the training course.

The main goals pursued with this training course were as follows:



Source: Authors' own work

Figure 1. Fundamental pillars of the training experience analysed in this study

To raise teachers' awareness of the development of competences to produce ethically responsible students. To this end, participating teachers received training on the development of what some authors call "asymmetrical bilingualism".

To carry out teaching activities for the development of transversal competences in the bachelor's and master's degrees. To this end, teaching activities were proposed for application in the classroom for different fields of knowledge. The aim was to mainstream competences in university degrees through the challenges of the SDGs.

2.4 Data process

To carry out this research, the results generated by a specific training course for teachers whose central theme was the implementation of transversal competences in university teaching were analysed. The main parameters of the analysis were as follows:

- The teachers' concept of the relationship between their teaching and the SDGs.
- The ability to generate applications in the classroom in which the SDGs were included in a cross-cutting manner within their teaching fields.

The research software IBM SPSS Statistics 29.01.0 was used to carry out this analysis.

First, the internal consistency of the questionnaire was analysed using Cronbach's alpha coefficient (Oviedo and Arias, 2005). The law of science relating to this coefficient indicates that a set of items is part of the same reliable construct when the α index is ≥ 0.8. To complete the analysis, a factor analysis of the questionnaire was performed using the Kaiser–Meyer–Olkim (KMO) test and the Bartlett sphericity test to check and determine whether its structure was valid (Pizarro Romero and Martínez Mora, 2020). Once the reliability and validity of the questionnaire had been checked, to respond to the research objectives, a descriptive analysis was first carried out using a frequency table to determine the distribution of the sample based on demographic variables and academic characteristics. Subsequently, inferential analysis was carried out with a *t*-test to compare dependent samples and to determine whether the grouping variables showed significant changes before and after the training, following a Levene's test to assess the equality of

variances. The level of significance was $p < 0.05$. The results obtained through this quantitative analysis process are presented below in the Results section.

3. Results

3.1 Questionnaire validation

The elaborated questionnaire was designed to measure two different sections. The first of them is related to the teachers' perception of the knowledge and source information of SDGs (involving Q1–Q8). The second one is related to the relationship between the 17 SDGs and the subjects they teach (Q9–Q25). Section 1 was divided into two constructs (C1 and C2) to measure separately questions related to prior knowledge (Q1–Q4) and information sources (Q5–Q8). Section 2 is C3 (Q9–Q25). Table 1 shows the results obtained in the reliability and validity tests of the questionnaire, as well as for each of the sections. As can be seen, the results show a high level of internal consistency among all the items that make up each of the sections, since the value of the Alpha Cronbach test is higher as indicated by the scientific literature for an adequate analysis of internal consistency of the construct.

3.2 Description of the results

As can be seen, the analysis of the results can be done by linking two blocks, Section 1 presents two constructs (C1 and C2) and Section 2 presents C3. In this respect, Table 2 presents the quantitative results, demonstrating how the training received enhances the mean scores of the different constructs.

The distribution of the sample in the different categories such as academic figure, area of knowledge, experiences of knowledge about the SDGs and the sociodemographic variables gender and age are shown in Table 3. The percentage of women (62.3%) was higher than that

Table 1. Reliability and validity tests of the questionnaire

		Cronbach's alpha	KMO test	Bartlett test
Questionnaire	Section 1 + Section 2	0.912	0.600	< 0.001
Section 1	C1 + C2: (Q1–Q8)	0.908	0.867	< 0.001
Section 2	C3: (Q9–Q25)	0.914	0.754	< 0.001

Notes: C1 = Construct 1; C2 = Construct 2; C3 = Construct 3
Source: Authors' own work

Table 2. Mean of constructs

			Mean	DT	IC 95% (min–max)
Section 1	C1 + C2: (Q1–Q8)	Pre	23.41	7.91	21–25.81
		Post	30.57	6.35	28.54–32.60
	C1: Knowledge (Q1–Q4)	Pre	13.07	4.63	11.66–14.47
		Post	16.85	3.16	15.84–17.86
	C2: Access to information (Q5–Q8)	Pre	10.34	3.70	9.21–11.47
		Post	13.73	3.83	12.50–14.95
Section 2	C3:(Q9–Q25)	Pre	53.59	14.24	49.26–57.92
		Post	64.70	13.67	60.32–69.07

Notes: C1 = Construct 1; C2 = Construct 2; C3 = Construct 3
Source: Authors' own work

of men and the age range of 40–50 years (30.2%) was the predominant one in the sample. The years of teaching experience of the participants was 10.5 years.

3.3 Inferential analysis

To answer the objectives, Table 4 shows the statistics (mean, SD, 95% CI) of Section 1 of the questionnaire (Q1–Q8) where the knowledge and access to information of the sample before and after the training is collected. All questions underwent statistically significant changes before and after the course ($p < 0.05$).

The analysis of the measures for Section 2 (Q8–Q25) compares the responses linked to each of the SDGs, with all questions showing statistically significant changes except for Q12 and Q15 ($p = 0.474$ and $p = 0.096$) (Table 5). The results indicate a positive impact of the training provided through the course, thus showing the usefulness of the course.

3.4 Inferential analysis by groups

Considering the sections of the questionnaire, the inferential analysis led us to a comparison between the qualitative variables gender, age range, field of knowledge and teaching figure, grouping the sample into two groups according to the % of frequency. Gender did not show a statistically significant influence in any of the items. Age between 40 and 50 years was the most prevalent age in the sample. It was observed that age had a statistically significant influence on Q9 ($p = 0.020$), Q10 ($p = 0.004$) and Q16 ($p = 0.040$) of Section 2 of the pre-training questionnaire. Post-training, age had a statistically significant influence on question Q5 in Section 1 ($p = 0.040$) and in Section 2 for Q9 ($p = 0.030$), Q11 ($p = 0.010$), Q12 ($p = 0.005$), Q13 ($p = 0.010$) and Q18 ($p = 0.010$). In the area of knowledge, statistically significant differences were only observed in items Q1 and Q3 of Section 1 ($p = 0.040$ and $p = 0.042$) and Q10 ($p = 0.018$) of Section 2 prior to the start of training. This fact shows the existence of statistically significant associations at the beginning of teacher training, specifically for Q1 and

Table 3. Participants in the study in frequency percentage

Title	Category	Frequency (%)
Gender	Male	11 (20.8)
	Female	33 (62.3)
Age (years)	<30	7 (13.2)
	30–40	14 (26.4)
	40–50	16 (30.2)
	>50	7 (3.2)
Academic position	Lectures	18 (34)
	Reader	7 (13.2)
	Associate lecturer	7 (13.2)
	Professor	1 (1.9)
	Others	11 (20.8)
Field of knowledge	Technician	5 (9.4)
	Biosanitary	2 (3.8)
	Scientist	8 (15.1)
	Social	26 (49.1)
	Humanistic	3 (5.7)
Experiences with SDG	Yes	27 (50.9)
	No	17 (32.1)

Source: Authors' own work

Table 4. Mean differences in Section 1 of the questionnaire questions after training received

Items	Mean	Differences mean ± SD	IC 95% Min-Max	*p*-value
Q1. I know what the sustainable development goals are. *Baseline*	3.45	0.82 ± 1.19	0.44–1.20	<0.001**
Q1. I know what the sustainable development goals are. *After training*	4.27			
Q2. I am aware of the countries targeted by the sustainable development goals. *Baseline*	2.92	1.05 ± 1.08	0.70–1.39	<0.001**
Q2. I am aware of the countries targeted by the sustainable development goals. *After training*	3.97			
Q3. I am aware of the time horizon for which the SDGs are designed. *Baseline*	3.50	0.85 ± 1.12	0.49–1.20	<0.001**
Q3. I am aware of the time horizon for which the SDGs are designed. *After training*	4.35			
Q4. I know the number of SDGs and could indicate some of their targets. *Baseline*	3.17	1.07 ± 1.18	0.69–1.45	<0.001**
Q4. I know the number of SDGs and could indicate some of their targets. *After training*	4.25			
Q5. I have received information about the SDGs by e-mail and/or social media. *Baseline*	2.87	0.72 ± 1.43	0.26–1.18	0.003*
Q5. I have received information about the SDGs by email and/or social media. *After training*	3.60			
Q6. I have received information about the SDGs through traditional media (press, radio and/or television). *Baseline*	2.40	0.97 ± 1.14	0.60–1.34	<0.001**
Q6. I have received information about the SDGs through traditional media (press, radio and/or television). *After training*	3.37			
Q7. I have received information about the sustainable development goals from my university (Cooperation Office, ICE, Governing Board). *Baseline*	2.80	0.75 ± 1.05	0.41–1.08	<0.001**
Q7. I have received information about the sustainable development goals from my university (Cooperation Office, ICE, Governing Board). *After training*	3.55			
Q8. I have received information about the sustainable development goals in informal training (e.g. NGDO workshops). *Baseline*	2.25	0.95 ± 1.17	0.57–1.32	<0.001**
Q8. I have received information about the sustainable development goals in informal training (e.g. NGDO workshops). *After training*	3.20			

Notes: Data are reported as mean ± SD (standard deviation) and [95% confidence level]. * Indicates statistically significant intragroup differences ($p < 0.05$); ** Indicates statistically significant intragroup differences ($p < 0.001$)
Source: Authors' own work

Table 5. Mean differences in Section 2 of the questionnaire questions after training received

Item	Mean	Differences mean ± SD	IC 95% Min-Max	*p*-value
Q9 Poverty reduction baseline	2.72	0.70 ± 0.96	0.39–1.00	<0.001
Q9 Poverty reduction after training	3.42			
Q10 Hunger reduction baseline	2.35	0.95 ± 1.03	0.61–1.28	<0.001**
Q10 Hunger reduction after training	3.30			
Q11 Health care and wellbeing baseline	3.30	0.62 ± 1.12	0.26–0.98	0.001**
Q11 Health care and wellbeing after training	3.92			
Q12 Quality educ baseline	4.10	0.15 ± 1.31	0.26–0.56	0.474
Q12 Quality educ after training	4.25			
Q13 Gender equality baseline	3.47	0.52 ± 1.63	0.00–1.04	0.049*
Q13 Gender equality after training	4.00			
Q14 Clean water baseline	2.62	0.97 ± 1.25	0.57–1.37	<0.001**
Q14 Clean water after training	3.60			
Q15 Clean energy baseline	3.20	0.40 ± 1.48	0.07–0.87	0.096
Q15 Clean energy after training	3.60			
Q16 Economic growth baseline	3.17	0.55 ± 1.25	0.14–0.95	0.009*
Q16 Economic growth after training	3.72			
Q17 Industry and infrastructure baseline	3.00	0.67 ± 1.18	0.29–1.05	<0.001**
Q17 Industry and infrastructure after training	3.67			
Q18 Inequalities baseline	3.42	0.50 ± 1.03	0.16–0.83	0.004*
Q18 Inequalities after training	3.92			
Q19 Sustainability cities baseline	3.27	0.95 ± 1.28	0.54–1.35	<0.001**
Q19 Sustainability cities after training	4.22			
Q20 Responsible production baseline	3.40	0.70 ± 1.22	0.30–1.09	<0.001**
Q20 Responsible production after training	4.10			
Q21 Climate care baseline	3.35	0.55 ± 1.08	0.20–0.89	0.003*
Q21 Climate care after training	3.90			
Q22 Care for underwater life baseline	2.57	0.87 ± 1.62	0.35–1.39	0.001**
Q22 Care for underwater life after training	3.45			
Q23 Terrestrial ecosystems baseline	2.90	0.57 ± 1.59	0.63–1.08	0.029*
Q23Terrestrial ecosystems after training	3.47			
Q24 Corruption free institutions baseline	3.17	0.85 ± 1.09	0.49–1.20	<0.001**
Q24 Corruption free institutions after training	4.02			
Q25 Building alliances baseline	3.22	0.87 ± 1.09	0.52–1.22	<0.001**
Q25 Building alliances after training	4.10			

Notes: Data are reported as mean ± SD (standard deviation) and [95% confidence level].* Indicates statistically significant intragroup differences ($p < 0.05$); ** Indicates statistically significant intragroup differences ($p < 0.001$)
Source: Authors' own work

Q3 associated with the social knowledge domain. The absence of significant differences at the end of the training indicates that the impact of the competencies acquired in terms of SDGs homogenises the knowledge acquired by the sample regardless of the area of knowledge to which they belong. The teaching figure showed statistically significant influence in Q1 (p = 0.020), Q2 (p = 0.020), Q3 (p = 0.040), Q7 (p = 0.020) and Q8 (p = 0.010) of Section 1, with no significance observed in Section 2 of the questionnaire ($p > 0.05$) prior to the start of training nor in any of the sections after training.

4. Discussion

The main goal of this study was to analyze the degree of the perception of knowledge acquired by university professors regarding the application of the SDG in their courses in the academic context after receiving virtual training course.

The development of transversal competences is a major challenge in the current university context (Zamora-Polo *et al.*, 2019). Until now, previous studies have focused on the motivations of students and professors as key agents of university transformation.

The results of the present study showed a higher level of previous knowledge of the SDGs than that reported for university students Zamora-Polo *et al.* (2019). The higher prior knowledge of teachers than students may be justified by governmental efforts to promote the SDGs, other training actions, etc. However, the virtual training received by teachers statistically significantly improved the degree of knowledge and information on the application of the SDGs as a formative nexus in university cross-curricular competence (Table 4).

By the same token, a significant impact of teacher training on teachers' perception of the application of the SDGs in their subjects was obtained (Table 5). These changes were obtained in all SDG with the exception of quality education (Q12) and accessible and clean energy (Q15) (Table 5). These results can be explained by the following reasons:

- quality education is an SDG very related to university training: innovative methodologies, digital and linguistic transformation, etc.
- there is a high awareness among the university community of the role of renewable energies in climate change mitigation.

In view of this, authors such as Viera-Trevisan *et al.* (2024) refer to the need for more studies aimed at promoting education based on sustainable development. In this sense, some strategies, which can be used by educators and institutions to create transformative learning that can contribute to social change, have been exposed. Key aspects for this transformation of the educational ecosystem are collaboration, action-oriented learning, interdisciplinary approach, technology-based learning and continuous assessment (Viera-Trevisan *et al.*, 2024).

The results obtained in Section 2 of the questionnaire (Table 5) show the existing margin for improvement in the degree of applicability of the SDGs in teaching-learning processes. In view of this, it seems necessary for universities to promote initiatives that incorporate the SDGs into the training programs of teachers and students. According to Leal Filho (2020), it is important for universities to play a relevant role in this challenge, as there is a real danger of not achieving the challenges and goals described in the 2030 Agenda on time.

Previous studies have raised the need for greater involvement of university faculty for a real transformation of the university context (Zamora-Polo *et al.*, 2019; Dlouhá and Pospíšilová, 2018). Annan-Diab and Molinari (2017) have revealed limitations in the training of teachers accessing training on the SDGs. To address these shortcomings, they propose the creation of a common language and the establishment of governance to ensure the success of teaching-learning processes. Some alternatives for teacher training can be Massive Open Online Courses (MOOCs), these courses have been successfully applied to address assessment tools such as the rubric (Crespo *et al.*, 2017), as well as methodologies adapted to the development of sustainable competence (Albareda-Tiana *et al.*, 2018). In relation to this issue, Ribadeneira Pazmiño *et al.* (2022) point out in their systematic study on teacher professional development, that one of the most relevant issues at present is to introduce the SDGs into teaching-learning processes in the same vein, Zúñiga points out this task as a challenge for universities in Mexico (Zúñiga Sánchez, 2021). Leal Filho *et al.* (2019) highlight the importance of universities not lagging in the incorporation of sustainability as a backbone of teaching (Leal Filho *et al.*, 2019), and even more so after the effects caused by the Sars-CoV2 pandemic (Leal Filho *et al.*, 2021). At the

European level, Lozano and Barreiro-Gen (2019) highlight the importance of incorporating the teaching of the SDGs into the university system, and the possibilities offered by virtual education. For their part, Winter and colleagues analyse how this process is being carried out in Chinese universities (Winter *et al.*, 2022), concluding, as in the present study, the need to raise awareness among university faculty about the cross-cutting inclusion of sustainability issues. Studies of this type have also been carried out in Kazakhstan (Davletova, 2016), Australia (Danaher *et al.*, 2021; Shah *et al.*, 2022) and Spain (Delgado *et al.*, 2022), stressing the need to implement these contents and competences at university level.

The development of this study is aligned with proposals related to different thematic areas. Thus, in the field of business studies, Carey *et al.* (2021) affirm the need for sustainability education for future business leaders and point out that this is a fundamental task for universities (Carey *et al.*, 2021). In the area of educational sciences, there are numerous studies oriented towards educational transversality (Blanco-Portela *et al.*, 2020; Colás-Bravo *et al.*, 2021; Zizka and Varga, 2021). All this leads to the conclusion that sustainability is becoming a relevant issue in higher education today (Abo-Khalil, 2024).

5. Conclusions

To sum up, in this work the degree of the perception of knowledge acquired by university professors regarding the application of the SDG in their courses after receiving virtual training course is analyzed. For this purpose, a previously used questionnaire for university students has been used.

The role of universities in the challenge of transforming society through the 2030 Agenda as proposed by the UN is starting to consolidate. In this sense, the interest in education focused on sustainable development is increasing, generating a positive impact.

The professors participating in the initiative belonged to a total of 9 Spanish public universities that make up the G-9 group of universities. From the authors' point of view, the design of the present study is original and novel, because a formative proposal with possible repercussions on the curricular orientation to be carried out by professors in their courses was analyzed. The use of virtual training for university professors from different universities and fields of knowledge allowed to gain a deeper understanding of the interconnectedness of global issues and the curricular competencies that students develop in their courses. In addition, the study used an adapted, valid and reliable measuring instrument for the evaluation of the virtual training course based on other questionnaire proposed by Zamora-Polo *et al.* (2019).

Among the conclusions obtained in the present study, it would be highlighted that the results show that professors manifest a higher perception of knowledge acquired. Significant differences were found in most of the questions of the questionnaire with the exception of questions Q12 and Q15. The results shown here show the need for training of university professors, and on the other hand, the necessary sensitisation of these professors.

Regarding the existing differences by age, academic category and field of knowledge. Training reduces the difference between teachers in these variables. Thus, a greater homogenisation among the teaching staff is found.

The results presented are relevant to policymakers within the university context, promoting governance that drives change towards sustainable development. In this sense, the authors agree with Abo-Khalil (2024) that higher education institutions should continue to promote educational methodologies and the development of materials aligned with the promotion of the SDGs in the classroom, encouraging reward systems among teachers who access training on a voluntary basis.

5.1 Limitations and practical implications

The study analysed a population of university teachers belonging to the G9 group of Spanish public universities. It would be of interest to extend the sample by including universities in other countries. On the other hand, the access of the participating professors to the virtual training course in this study was voluntary. In this respect, formal training for all professors would be of interest.

In terms of practical implications, recent studies have shown the possibility of using telematic media to provide training on sustainability and/or SDGs, for example using MOOCs for future English teachers (Canaran and Bayram, 2024) or through Collaborative Online International Learning (Membrillo-Hernández *et al.*, 2022). The proposal analysed in this paper is consistent with the inter-university collaboration proposed by the initiatives. Moreover, the response rate to the questionnaire after the training (≥70%) was higher than that reported by previous studies (Lazzarini *et al.*, 2018; López-Zaldívar *et al.*, 2017).

In relation to the possibilities for policy makers to act in this regard, it is necessary to continue to promote the training of university teachers. In this article, the perspective of Sánchez Carracedo *et al.* (2022) is supported, emphasising that this training should focus on developing the competences of university teachers. Given the interest of higher education institutions in promoting the SDGs in their classrooms, they should reward teachers in their performance evaluations or promotion opportunities.

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Further reading

IBM corporation (2013), "IBM SPSS statistics for windows".

Supplementary material

Supplementary material for this article can be found online.

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