

Active methodologies and curricular sustainability in teacher training

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Abstract

Purpose – Changes in society, the economy and health require a response from higher education regarding the training of professionals, specifically, future teachers. In this sense, active methodologies constitute, in line with the 2030 Agenda for sustainable development, a key strategic element in teacher training, given the need to educate for sustainability and social responsibility (SR). This study aims to examine innovative teaching-learning experiences based on the use of active methodologies and the interaction with sustainability and SR on the part of university students in Education.

Design/methodology/approach – The methodology constitutes a systematic review of the qualitative, inductive and exploratory literature, on the basis of the PRISMA declaration principles. The sample is composed of research published between 2011 and 2021 in the world's most important scientific databases in the educational context (WoS, Scopus and Eric-ProQuest).

Findings – This study reveals the methodologies that are most commonly used in ecological literacy, their implications for the acquisition of competencies in terms of curriculum sustainability and their relationship with the UN Sustainable Development Goals and SR. Higher education must reflect and demonstrate awareness of its social mission and pedagogical effectiveness, to transform education, taking as a reference the sustainability and SR in the university student's curriculum.

Research limitations/implications – One of the main limitations of this study is the scarcity of research studies that include, jointly, the key descriptors analysed in this contribution such as teacher training, active methodologies, sustainability and SR. Another limitation to observe in this work is related to having considered as inclusion criteria solely research published in open access journals, since other research published in closed access journals is omitted.

Originality/value – This work demonstrates the usefulness of active methodologies in the training and professional development of future Education students in “sustainability”.

Keywords Sustainable development, Active methodologies, Teacher training, Higher education, Social responsibility

Paper type Literature review



Introduction

Teaching and learning practices in higher education have undergone a number of changes in recent years, with implications for the nature of student learning. The competency-based approach inherited from the European Higher Education Area, as well as the approach expressed by the United Nations World Organisation in the 2030 Agenda (UN, 2015) through the Sustainable Development Goals (SDGs), determine that universities should be involved in and committed to responding to new challenges and current social needs (Acosta and Queiruga, 2022) as open, inclusive and sustainable institutions committed to transparency and social responsibility (SR; CRUE, 2021; Garrote *et al.*, 2019; Payne, 2015; Roysen and Cruz, 2020; Triviño *et al.*, 2021).

In recent years, higher education has faced a dual challenge at a fundamental level. Firstly, the situation arising from the current COVID-19 pandemic. Secondly, that goal 4 of the 2030 Agenda, relating to education, expresses the need to ensure that students acquire the necessary skills to promote sustainable development (aim 4.7). This situation poses a challenge for the university community, specifically, because it has the responsibility to educate technologically and socially competent citizens.

Accordingly, higher education has to adapt its educational offer to guarantee the development of knowledge and competences linked to sustainable education (SDGs) and the promotion of a critical spirit among future graduates (CRUE, 2021). Thus, universities must develop their teaching and learning models to promote sustainability curricula through active methodologies that, according to Jucker and Mathar (2015) and Murga (2015), guarantee the commitment and SR of students in their training.

Sustainability and social responsibility: toward ecological literacy in initial teacher education

Quality university education promotes social transformation based on the involvement, enthusiasm, sustainability, commitment and criticism of students with respect to their socio-professional environment (Fernández *et al.*, 2015). These key aspects are proposed as a strategy for continuous improvement toward the effective fulfilment of its social mission based on four processes:

- (1) ethical and environmental management of the institution;
- (2) training of responsible and supportive citizens;
- (3) production and dissemination of socially relevant knowledge; and
- (4) finally, social participation in the promotion of development that is both more human and more sustainable (Mayorga *et al.*, 2021).

In addition, it is necessary to place particular emphasis on the attitudes, commitment and SR of students, through the application of the competences for sustainability established by UNESCO (2014) and the Conference of Rectors of Spanish Universities (CRUE, 2021, cit. in Albareda *et al.*, 2019), which include:

- critical contextualisation of knowledge, establishing interrelationships among social, economic and environmental, local and/or global problems;
- sustainable use of resources and prevention of negative impacts on the natural and social environment;
- participation in community processes that promote sustainability; and
- application of ethical principles related to sustainability values in personal and professional behaviour.

The above factors facilitate a multifaceted implementation of curriculum sustainability that channels social transformation, on the one hand, transgenerationally and, on the other hand, through awareness raising and sensitisation in our schools.

The “sustainability” of initial teacher training is, therefore, key to the professional development of future teachers. Specifically, in the words of [Biasutti et al. \(2018\)](#), a transformative educational leadership is needed from the teacher to train responsible citizens committed to a sustainable environment. This new training model is endorsed by the report by the United Nations Economic Commission for Europe “Empowering educators for a sustainable future” ([UNECE, 2013](#)). This report includes a training proposal for teachers in Education for Sustainable Development (ESD) and it is organised around three fundamental aspects:

- (1) a holistic approach;
- (2) the vision of the future; and
- (3) concern for others.

Teacher training processes must implement a socially active methodology and a sustainable curriculum ([Albareda et al., 2019](#); [Danaher et al., 2021](#); [Yllana et al., 2021](#)). This implementation should include, according to [Biasutti \(2015\)](#), content and methodologies devised from “cooperative learning” and professional development perspectives. This methodological approach will improve professional competences and skills and promote the establishment of relationships between environmental, social and economic aspects of the curricula and their sustainable impact on the practical reality of schools ([Biasutti et al., 2016](#); [Tejedor et al., 2019](#); [Triviño et al., 2021](#)).

Active methodologies for the development of competencies in sustainability and social responsibility

An approach to teacher education that is based on sustainability competence and SR necessitates efforts within higher education to promote active learning experiences. Students should be at the centre of the process rather than being passive subjects within education ([Zamora and Sánchez, 2019](#)). Thus, the best way to implement the process of ecological literacy or education for sustainability is through the development of methodological strategies that are active, participatory and have social impact ([Igelmo and Quiroga, 2018](#); [Mayorga et al., 2021](#)).

In this way, training in sustainability and SR serves to challenge students in their commitment to the integral transformation of society, which includes educating toward the implementation of educational proposals based on experiential, cooperative, socioemotional and cognitive elements, facilitating students’ ethical, critical and analytical development ([Sánchez and Murga, 2019](#); [Crisol-Moya et al., 2020](#); [Lozano and Figueredo, 2021](#); [Pegalajar et al., 2022](#)).

Accordingly, universities must be committed to introducing active teaching methodologies. This is one of the key concepts used in this study. Active methodologies can be defined, under a competency-based approach, as those that place the student at the centre of the teaching model, as the main actor, allowing the creation of collaborative environments and providing the skills to solve real-life problems ([Crisol-Moya et al., 2020](#); [Gómez-Hurtado et al., 2020](#); [Salido-López, 2020](#)). In addition, by allowing students to provide feedback, these active methodologies help students to mobilise processes of self-assessment and self-regulation in their learning ([Dominguez et al., 2019](#)).

The context described above indicates that the optimal teaching model for teacher training would be centred on learning – specifically, interactive learning – in which sustainability and

SR constitute the backbone of the training process (Alonso and Berasategui, 2017; Garrote *et al.*, 2019; Mayor and Guillén, 2021; Payne, 2015; Roysen and Cruz, 2020; Triviño *et al.*, 2021). Such a model allows students to design their own learning pathways and to become actively and socially engaged in the process (Gómez and Gil, 2018), meaning that they share in the sustainability and SR of the organisation and in the transformation of knowledge.

In line with Zamora and Sánchez (2019), the most appropriate training strategies for sustainability and/or SR training are based on the use of active and participatory methodologies, classified into three main categories (Lozano and Figueredo, 2021):

- (1) *Universal*: Pedagogical approaches applicable in various subjects such as case studies, interdisciplinary teams, concept mapping and problem/project-based learning (PBL/PLO).
- (2) *Community and social justice*: These two concepts encompass various educational strategies, applied specifically to community development and social justice, such as service-learning, interconnected teams or participatory action research.
- (3) *Environmental education*: It brings together educational methods from environmental education, environmental science, situated environmental education, community and “eco-justice”, life cycle analysis and traditional ecological knowledge.

The literature, which focused on curriculum design and the development of innovative experiences for teacher training, revealed the large number of studies, extensive in nature, that deal with either the use of active methodologies (Tomas *et al.*, 2019; Rodríguez *et al.*, 2018) or with SR and/or sustainability (Pegalajar *et al.*, 2021; Tejedor *et al.*, 2019). However, the specific interest of this paper is to analyse active methodologies that are implemented during the initial teacher training process to contribute to ESD and SR and, thereby, respond to the requirements proposed in the 2030 Agenda.

Methodology

This research presents a systematic review. According to Torres and López (2014), a systematic review aims to analyse and discuss the most relevant and essential information on a topic of study, making a very exhaustive selection of scientific publications. The main objective of this work is to examine innovative teaching-learning experiences based on the use of active methodologies and interaction with sustainability and SR in the training of future teachers.

This study has been approached from a qualitative, exploratory, inductive and descriptive perspective, with the intention of understanding, examining and describing how curriculum sustainability is implemented in the initial teacher education process toward the achievement of the SDGs. However, the specific objectives of this study are:

- Examining the potential of active methodologies as methodological tools in the initial teacher training process, aimed at ecological literacy and social transformation of students in education.
- Analysing the implications of active methodologies for the development among future teachers of competences oriented toward education for sustainability and SR.
- Studying the contribution of “curriculum sustainability”, in the initial teacher education process, to the development of the SDGs, as well as to SR.

Following the indications of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and the work of Moher *et al.* (2014), this study searched for and selected scientific articles indexed in the highest quality category, for the field of education, on several reference databases: Web of Science (WOS by Clarivate Analytics), Scopus (Elsevier)

and Educational Resource Information Centre (ERIC-ProQuest). In addition, the period time has been limited to the last decade of scientific production (2011–2021). Curriculum sustainability and active methodologies are subjects which have seen a great impact since the entry of universities into the European Higher Education Area and, in addition, it has become important to understand student participation and responsibility in the teaching-learning process (Jiménez *et al.*, 2020).

In accordance with the above, the process followed for the selection of the articles, includes several stages:

1. *Identification.* This is a protocol that carries out database searches for primary studies using various descriptors related to the main concepts of the research. The latter have been written in English to ensure an international scope. The terms used can be found in the title, abstract and keywords of the research and their combination with the well-known Boolean Operators AND and OR allows the refinement of the search in respect of those articles most relevant for this study. Thus, the sequences followed are as follows:
 - Active methodology AND SR AND sustainability AND higher education AND teacher training.
 - Sustainability OR SR AND teacher AND active AND methodology.
 - Teacher training AND SR.
 - Active methodology AND teacher training AND sustainability.
 - Teacher training AND active learning AND sustainability.
 - Active methodology AND teacher training.
 - Active methodology AND SR OR sustainability AND higher education.
 - Teacher education AND SR AND active methodologies.
 - Active learning methods AND teacher training AND sustainability.
 - Active teaching methods AND teacher training AND SR AND higher education.
 - Active teaching methods OR teacher training AND sustainability.

The first search for publications in the selected databases, according to the previously described descriptors, has allowed us to locate a total of 462 publications (Figure 1):

2. *Screening and suitability:* After the first search had been carried out, additional inclusion and exclusion criteria were established to determine the relevance of the studies and to adjust the search to the research objective (Table 1).

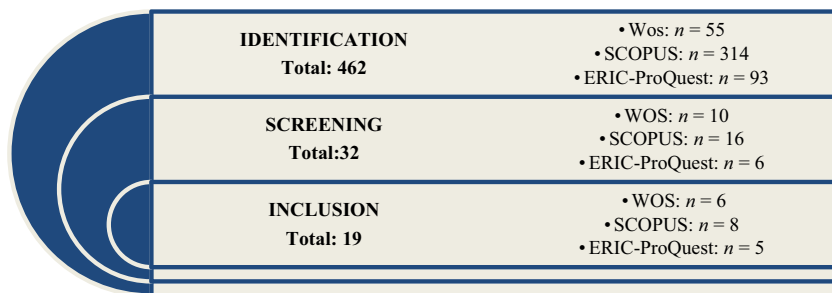


Figure 1.
Sample

The application of inclusion and exclusion criteria were based on the definition of four types of filters, as indicated in the study by [Hernández et al. \(2019; Table 2\)](#).

After reading the title, abstract and keywords of all publications, duplicate research items were eliminated. Thus, a total of 430 papers were excluded, with 32 publications selected as the initial sample:

3. *Inclusion*: After having applied the previous phases, articles were read in full to see if they met the research objectives and inclusion criteria. Accordingly, 13 scientific articles were eliminated; the final sample was composed of 19 scientific publications ([Figure 1](#)).

The final sample selection has information on each research study. This selection was reviewed in relation to authorship, research objectives, teaching strategy implemented for the development of sustainability competences (SDGs) and SR of the university student in Education and the limitations thereof. For this purpose, the bibliographic management programme was Mendeley, in addition to Microsoft Excel spreadsheets.

Results

Analysis of active methodologies for ecological literacy and social transformation in the initial teacher training process

The research aims to explore the integration of ESD, sustainability competences and sustainable consumption habits in students of various initial teacher training processes in different countries through the implementation of active and innovative methodologies in the university context. The projects have common objectives that focus on the impact caused by the application of active methodologies in the training of university students in the topic of study.

The analysis of the teaching experiences ([Table 3](#)) reveals that the methodologies centred on PBL and PLO are the most widely used in the initial teacher training process ($n = 7$). This pedagogical approach enables students to work on certain real problems ([Albareda et al., 2019](#)),

Inclusion criteria	Exclusion criteria
1. Research that proposes educational experiences based on the use of active methodologies for sustainable development in education degrees	1. Duplicate investigations
2. Research published between 2011 and 2021	2. Research that describes teaching experiences developed at educational levels other than higher education
3. Papers published in English and Spanish	3. Theoretical or review studies
4. Open access publications	4. Proceedings of congresses, etc.
5. Results of research of education studies	

Table 1.
Inclusion and exclusion criteria

Filter	Description	Criterias applied	
		Inclusion	Exclusion
A	Research search according to protocol in selected databases	1, 2, 3, 4	–
B	Title, abstract and keywords of each publication	1, 5	2, 3, 4
C	Reject of duplicate studies	–	1
D	Read the full text of each publication	1, 5	2, 3

Table 2.
Strategy for the selection of publications

Reference	Methodological strategy	Qualification/Degree	Subject
Albareda <i>et al.</i> (2019)	PBL	Primary education	Science education and environmental education
Alonso and Berasategui (2017)	E-learning Interdisciplinary projects	Social education	Interdisciplinary activity module
Bugallo and Vega (2020)	PBL	Primary education	Teaching and learning of natural sciences II
Chiva <i>et al.</i> (2019)	Service-learning	Primary education	Didactics of corporal expression
Danaher <i>et al.</i> (2021)	Readings, discussion forums E-learning	Secondary education	Geography
Díaz <i>et al.</i> (2021)	Design thinking E-learning	Primary, early childhood and social education	School organisation Socio-educational projects for children and young people
Garrote <i>et al.</i> (2019)	Cooperative learning	Early childhood education	–
Guillén <i>et al.</i> (2020)	Cooperative learning	Early childhood and primary education	Educational innovation Didactics and organisation Tutorial action and childcare Didactics of matter and energy
Hernández <i>et al.</i> (2021)	PBL	Primary education	
López <i>et al.</i> (2021)	Service-learning	Early childhood and primary education	Vocational and citizenship training
Mayor and Guillén (2021)	Service-learning	Early childhood, primary, social education, teacher training master's	–
Payne (2015)	PBL	Pre-school and primary education	Curriculum theory and history
Roysen and Cruz (2020)	Cooperative learning PBL	Primary education	
Ruiz <i>et al.</i> (2019)	Service-learning	Primary education and physical activity and sport sciences	Evaluation of the teaching of Physical activity and sport planning and organisation of sport systems and activities
Santaolalla <i>et al.</i> (2020)	Interdisciplinary project PBL	Primary education	Didactics of mathematics Didactics of social sciences Educational innovation
Tejedor <i>et al.</i> (2019)	Service-learning PBL Gamification	–	–
Tomas <i>et al.</i> (2019)	Flipped classroom	Pre-school and primary school	Fundamentals of sustainability in education
Triviño <i>et al.</i> (2021)	Service-learning E-learning	Primary education	Didactics of social sciences
Yllana <i>et al.</i> (2021)	Flipped classroom gamification	Primary education	Knowledge of the natural environment in primary education

Table 3.
Teaching experiences in active methodologies for initial teacher education

as active researchers, change agents (Bugallo and Vega, 2020; Payne, 2015) and constructors of their own learning, capable of responding to certain challenges autonomously (Hernández *et al.*, 2021; Tejedor *et al.*, 2019). This teaching tool enhances transdisciplinarity in higher education and stimulates sustainability transitions (Roysen and Cruz, 2020).

Furthermore, we can highlight the development of teaching experiences based on service learning ($n = 6$). This is an experiential teaching-learning strategy that enables the development of competences in action (Chiva *et al.*, 2019; López, San-Eleuterio, and Andreu, 2021) through the implementation of projects that respond to the real needs of the environment; it integrates significant community service, as well as a commitment to a social justice-based curriculum (Tejedor *et al.*, 2019). In turn, it enables the opening of the educational institution to the environment and the establishment of a teaching-learning model in which society and students collaborate and reciprocally nurture each other to generate a formative exchange (Ruiz *et al.*, 2019). In this strategy, community needs are met with an appropriate service response, implementation and final reflection (Mayor and Guillén, 2021). This methodology helps students to take an active role in building their future. In addition, it facilitates their engagement and induces students to develop critical thinking (Triviño *et al.*, 2021).

Other noteworthy training experiences among those considered are methodologies based on cooperative learning ($n = 3$) and gamification ($n = 3$). Cooperative learning seeks to achieve the acquisition of common objectives among the group in carrying out a specific task (Garrote *et al.*, 2019). In turn, it enables the implementation of skills relating to: positive interdependence among group members, individual responsibility, fostering interaction, development of social skills and asserting teamwork ideas, etc. (Guillén *et al.*, 2020). For its part, gamification promotes student satisfaction, qualification, collaboration and learning motivation through the use of basic game elements (Yllana *et al.*, 2021).

Furthermore, more specific, methodologies that stand out within the analysis include, on the one hand, the practice of interdisciplinary projects based on student collaboration, reflection and research, and, on the other hand, a methodology based on the “Flipped classroom” ($n = 2$) where those key elements play an important role in promoting competence-based learning (Alonso and Berasategui, 2017), fostering teaching collaboration and the development of communication skills among the agents involved (Santaolalla *et al.*, 2020). This methodology is a pedagogical option that favours the involvement and participation of students in the teaching-learning process (Tomas *et al.*, 2019). The analysis also revealed the implementation of the “E-learning” methodology ($n = 2$) that, based on the design of a teaching-learning platform, allows users to be in contact and to share content (Díaz *et al.*, 2021). Finally, the “Design Thinking” methodology stands out ($n = 1$): it is based on the creative and innovative capacity that we have to solve problems, focusing on the design of the process rather than the end product (Díaz *et al.*, 2021).

These teaching experiences have been developed in the teaching-learning process of university students in Education. The majority are aimed at students of Primary Education ($n = 15$) and Early Childhood Education Degree ($n = 7$), with the addition of active methodologies for students of Social Education ($n = 3$) and for Secondary Education teachers who are studying for a Master’s degree in their initial training process ($n = 2$).

Subjects implemented that are linked to the area of Science Didactics ($n = 8$) should be highlighted, specifically, those related to Experimental Sciences Didactics (Teaching and Learning of Natural Sciences, Matter and Energy, Science and Environmental Education Didactics, among others), Mathematics Didactics and Social Sciences Didactics. Furthermore, mention should be made of the active methodologies implemented in subjects belonging to the Pedagogy area ($n = 7$), such as School Organisation, Theory and History of

the Curriculum, Foundations of Sustainability in Education and Educational Innovation. Finally, other teaching experiences developed in subjects belonging to the Didactics of Musical, and Bodily Expression area ($n = 2$) are also noted.

Selected studies show that training in the above-mentioned active methodologies leads to significant sustainability-related learning among students along three main lines:

- (1) They learn through transformative educational activities, based on knowledge of sustainability, that promote a comprehensive training of the student through the development of academic, professional, ethical, civic and personal competences.
- (2) Students are brought into a greater involvement in different community projects.
- (3) The awareness and inner movement promoted through training leads them to act in a responsible way concerning sustainability and to continue to do so in their future professional practice.

Thus, learning through these active methodologies and innovative activities, in addition to technological upgrading of the classroom, leads to improvement in the quality of education. It is evident that when student learning comes directly from activities in which participation and engagement are promoted, learning is deeper and more lasting. This leads to an increase in student motivation and engagement in their subjects, as well as in their social and creative skills, which is transferable to other different and heterogeneous contexts.

A further aspect for analysis is the gaps or limitations of the selected sample, with the aim of demonstrating a direction for future research on this topic of study. These can be specified along several lines:

- Implementing pedagogical approaches in SDGs more generally and at different educational levels.
- Time, training and learning spaces are needed to facilitate the implementation of the abovementioned methodological strategies as a matter of course.
- It is not possible to know with exactitude whether the changes remain in the students over time.
- The necessary involvement of the scientific community in studies on this subject.
- Developing studies over longer periods of time and with more representative samples.
- Providing more spaces and circumstances for students to reflect on the SDGs; designating sustainability as a skill; aiming to achieve increasingly reliable results.

Implications of active methodologies for developing sustainability competences in initial teacher education

It is important to analyse the implications of implementing these innovative teaching experiences in the development of sustainability competences among university students of Education. For this purpose, the map of sustainability competences for Bachelor's Degrees in Education, approved by the Conference of Rectors for Spanish Universities, has been taken as a reference in this study (UNESCO, 2014; CRUE, 2021, cit. in Albareda *et al.*, 2019; Table 4).

Firstly, let us address Competence 1, "Critical contextualisation of knowledge, establishing interrelationships among social, economic, and environmental, local and/or global problems". Research reviewed reveals how these active methodologies enable students to engage with interdisciplinary teaching-learning processes (Santaolalla *et al.*,

Table 4.

Implications of active methodologies for the development of sustainability competences

Reference	Competence 1	Competence 2	Competence 3	Competence 4
Albareda <i>et al.</i> (2019)			X	X
Alonso and Berasategi (2017)	X			
Bugallo and Vega (2020)			X	X
Chiva <i>et al.</i> (2019)	X	X		
Danaher <i>et al.</i> (2021)	X			
Díaz <i>et al.</i> (2021)	X		X	
Garrote <i>et al.</i> (2019)			X	X
Guillén <i>et al.</i> (2020)			X	
Hernández <i>et al.</i> (2021)	X		X	X
López <i>et al.</i> (2021)		X	X	
Mayor and Guillén (2021)		X		X
Payne (2015)	X			
Roysen and Cruz (2020)	X			X
Ruiz <i>et al.</i> (2019)		X		X
Santaolalla <i>et al.</i> (2020)	X			
Tejedor <i>et al.</i> (2019)	X	X		
Tomas <i>et al.</i> (2019)				X
Triviño <i>et al.</i> (2021)	X			X
Yllana <i>et al.</i> (2021)				X

2020). These methodologies aim to develop critical judgement, establish social commitment and allow for making informed decisions and drawing up proposals for action, etc. (Alonso and Berasategui, 2017; Tejedor *et al.*, 2019). These tools motivate students to change by positing alternative ways of making decisions (Roysen and Cruz, 2020), while promoting a deeper understanding of subject content and the development of socio-sustainable behaviours and actions (Hernández *et al.*, 2021; Payne, 2015). At the same time, such methodologies have a commitment to the adjusted construction of reality on the part of students (Chiva *et al.*, 2019), based on sustainable and creative thinking (Danaher *et al.*, 2021; Díaz *et al.*, 2021; Triviño *et al.*, 2021).

For Competence 2, “Sustainable use of resources and prevention of negative impacts on the natural and social environment”, teaching experiences reviewed reveal how the active methodologies typically promote the student’s ability to solve problematic situations (Chiva *et al.*, 2019), connecting theoretical contents with practice (López *et al.*, 2021). These methodologies facilitate the transfer of contents to real-life situations (Mayor and Guillén, 2021; Ruiz *et al.*, 2019; Tejedor *et al.*, 2019).

In relation to Competence 3, “Participation in community processes that promote sustainability”, publications analysed express how the active methodologies used favour student interaction and participation in community projects (Albareda *et al.*, 2019) enabling collaboration in group tasks (Díaz *et al.*, 2021; Guillén *et al.*, 2020; López *et al.*, 2021). Furthermore, those experiences contribute to the improvement of social relations among students (Hernández *et al.*, 2021), transforming their behaviour towards sustainability (Bugallo and Vega, 2020).

Finally, in Competence 4, “Application of ethical principles related to sustainability values in personal and professional behaviour”, innovative teaching experiences propose active methodologies to modify consumption habits and transform student behaviour (Albareda *et al.*, 2019; Bugallo and Vega, 2020). For this reason, these tools grant a high level of social commitment to students (Garrote *et al.*, 2019; Tomas *et al.*, 2019; Triviño *et al.*, 2021), in addition to the development of the ethical and personal competences necessary for their

training and work (Garrote *et al.*, 2019; Ruiz *et al.*, 2019). This situation allows for an exchange of knowledge, feelings and affections between the agents involved (Roysen and Cruz, 2020), while improving positive emotions in students and reducing negative ones toward a science education that contributes to sustainable development (Hernández *et al.*, 2021; Mayor and Guillén, 2021; Yllana *et al.*, 2021).

Curriculum sustainability for the achievement of the sustainable development goals and social responsibility in initial teacher training

In reference to the achievement of the SDGs proposed in the Global Education Agenda 2030 (UN, 2015), the reviewed publications reveal the growing interest among the international scientific community in connecting new teaching methodologies implemented in the field of teacher training and ecological literacy. This situation responds to the principle problems affecting society today with regard to achieving a sustainable future.

As such, these findings highlight the relationship with SDG 4, which focuses on quality education and, more specifically, objective 4.7. This objective ensures that students fully enjoy the right to education as a catalyst for sustainable development. Therefore, teaching experiences implemented represent a unique learning opportunity for students, enabling them to raise their level of sustainability performance (Bugallo and Vega, 2020; Danaher *et al.*, 2021; Guillén *et al.*, 2020; Tejedor *et al.*, 2019; Tomas *et al.*, 2019).

These new teaching strategies seek to empower students as agents of change and social transformation based on the development of individual and social competences, which lead to knowledge of the rights, duties and freedoms of democratic society (Albareda *et al.*, 2019; Chiva *et al.*, 2019; Garrote *et al.*, 2019; Hernández *et al.*, 2021; López *et al.*, 2021; Roysen and Cruz, 2020; Ruiz *et al.*, 2019; Santaolalla *et al.*, 2020; Triviño *et al.*, 2021; Yllana *et al.*, 2021).

On the question of teachers' SR, analysis of publications reveals less interest among the scientific community in connecting the implementation of active methodologies in the initial teacher training process to improve the degree of SR. These methodologies have enabled the implementation of new teaching-learning processes for teacher training, focused on the reflective thinking of the education student (Albareda *et al.*, 2019; Alonso and Berasategui, 2017; Danaher *et al.*, 2021; Guillén *et al.*, 2020), in addition to constructive communication (Garrote *et al.*, 2019), to train professionals committed to change and SR (Bugallo and Vega, 2020; Díaz *et al.*, 2021; Hernández *et al.*, 2021; López *et al.*, 2021; Mayor and Guillén, 2021; Payne, 2015; Roysen and Cruz, 2020; Ruiz *et al.*, 2019; Santaolalla *et al.*, 2020; Triviño *et al.*, 2021).

Discussion

The review process developed in this work has determined a series of approaches and strategies to be followed based on active methodologies to address sustainability and SR among university students in Education.

In relation to the first objective of the research, which focused on exploring the potential of methodological strategies for ecological literacy among future teachers, it is worth highlighting the proliferation of teaching experiences based on PBL, PLO or service learning. These strategies enable the acquisition of significant learning from three areas. Firstly, learning would take place through transformative educational "activities" with sustainable knowledge as a reference that enables professional development for teachers through the integration of academic, professional, ethical, civic and personal competences. This learning would generate greater participation by the teacher in different community projects and, crucially, a level of awareness that allows them to act in a responsible and sustainable way in their future professional activity (Biasutti, 2015, 2018). These

methodological strategies are essential in the learning process of future teachers and in their professional development (Biasutti, 2016).

Such a context allows for feedback that, on the one hand, helps to promote reflection and self-regulation of the learning process based on the development of a series of cognitive skills and practical actions and, on the other hand, fosters autonomy and self-confidence in confronting complex problems and in generating effective and relevant responses (Dominguez *et al.*, 2019; Tejedor *et al.*, 2019; Bugallo and Vega, 2020; Acosta and Queiruga, 2022). In addition, in the teacher training process, methodologies should occupy an important place in students' education toward sustainability, with functional, cultural and critical purposes (Caride, 2017).

Concerning the second objective, the focus is on the significant incorporation of competences related to sustainability into different initiatives and training experiences for students in Education. Based on the implementation of active methodologies, the purpose is for future professionals in the field of education to be trained, on the one hand, from a social, global and competency-based vision and, on the other hand, from one of pedagogical effectiveness (Fumoto *et al.*, 2007); i.e. supplying the training process with instruments and effective knowledge to respond to the aforementioned sustainability problems (social, economic and environmental, local and/or global) and to those arising within schools and immediate environment (Danaher *et al.*, 2021; Diaz *et al.*, 2021; Santaolalla *et al.*, 2020; Triviño *et al.*, 2021). In addition, the aim is to provide students with skills for the development of actions linked to the sustainable and preventative use of resources in the natural and social environment. This is enhanced through the use of problem situations that include a scientific character (Chiva *et al.*, 2019), promoting the connection between theory and practice, i.e. the transferring of content to real-life situations (Castillo and Ladino, 2016).

Furthermore, these experiences encourage student participation in community processes promoting sustainability. According to Bugallo and Vega (2020), this leads to building more sustainable societies and enables future teachers to be aware of and sensitive to environmental and social issues (Hernández *et al.*, 2021). For its part, the development and application of an environmental ethic (based on personal and professional behaviour) constitutes an applied ethic that facilitates reflection on the duties and responsibilities of human beings toward nature, living beings and future generations (Murga, 2015). This approach involves principles based on SR for the care and protection of the environment (Danaher *et al.*, 2021), the principle of social justice (Lozano and Figueredo, 2021; Tejedor *et al.*, 2019) and the ethical-political concept of ecological citizenship as a foundation for a global society (Acosta and Queiruga, 2022; UNESCO, 2014).

The third objective of this research analyses the contribution of the sustainability curriculum in the teacher training process in respect of the SDGs and SR. This involves providing students with mechanisms for reflection from a social and environmental justice approach, permeating their conceptions and knowledge about society (Lozano and Figueredo, 2021; Escofet and Rubio, 2019; Tejedor *et al.*, 2019).

The professional training knowledge generated during professional practice can be transformed and modified into transversal and interdisciplinary content that enriches the competence training of teachers and their students in schools (Fernández *et al.*, 2015). Competence training consists, for example, of critically contextualising learning by establishing interrelationships with local and/or global social, curricular, economic and environmental problems in a committed and socially sustainable way (Santaolalla *et al.*, 2020; Escofet and Rubio, 2019). Another key competence, according to Chiva *et al.* (2019), is to use resources in a preventive and sustainable way to reduce the negative impact of a problematic natural and/or social situation. These two competences will not make sense, on

the one hand, if ethical principles related to sustainable values are not applied in teachers' personal and professional behaviour. Nor, on the other hand, if teachers' participation in socio-community processes is not encouraged, taking this "sustainable ethic" as a reference that allows, in the words of [Albareda et al. \(2019\)](#) and [Bugallo and Vega \(2020\)](#), for the transformation of students' "consumerist" interest and their socially irresponsible and unsustainable attitudes.

However, it is worth highlighting how SR has not managed to obtain a clear space for the implementation of active methodologies in the training process of future teachers. These methodologies have mainly focused on the development of a reflective and critical citizenship with the capacity for social transformation in which the Education student is the main agent of change ([Jucker and Mathar, 2015](#)).

Conclusions

The most important conclusion of this study determines that, on the one hand, higher education must reflect and become aware of its social mission and pedagogical effectiveness on the basis that this institution must generate social impacts, new commitments and functions that include the transmission of knowledge for training and the generation, dissemination, transfer and application of new knowledge. On the other hand, higher education must anticipate the transformation of education, in respect of the integration of elements such as innovation and entrepreneurship within sustainability and SR perspective.

One of the implications of this study is related to the idea that the "teaching" component, in the professional development of the future teacher, is key within sustainable educational transformation based on the use of active methodologies, defined as effective strategies that enable ecological literacy and social transformation of the student. This situation is achieved if there is a critical contextualisation of teaching knowledge, establishing connections with social, economic, environmental, local and/or global problems. Another interesting implication is expressed by the different practical training experiences analysed in this study. Taking the SDGs as a starting point, the purpose pursued is the development of competences aimed at education for sustainability to prevent negative impacts on the natural and social environment.

An important detail obtained from the analysis of the data carried out in this study is that SR plays a key role in teacher training in the field of curriculum sustainability, although the studies analysed in this work do not consider it in the same way.

One key recommendation is that it is necessary to design a curricular framework in which, on the one hand, methodologies focused on PBL and PLO are the basis of teacher training and, on the other hand, to include ethical principles related to sustainability values in personal and professional behaviours within teachers' professional development activity. This pedagogical approach makes it possible for the student to work on certain real problems as an active researcher and change agent, and it would ensure that trainee teachers experience the opportunity to develop ecological literacy values/attitudes in sustainability education.

In summary, this work strengthens and demonstrates the usefulness of active methodologies in the training and professional development of the future student of Education as regards "sustainability". As such, a key implication of this affirmation is to offer active methodologies to apply a certain type of knowledge and ethics and the values of sustainability within the socio-professional context. From this assertion, some questions also arise as to how to integrate or foster SR in the various fields of sustainability and how to connect with other life domains beyond the academic one.

One of the main limitations of this study is the scarcity of research studies that include, jointly, the key descriptors analysed in this contribution: teacher training, active methodologies, sustainability and SR. Another limitation to observe in this work is related to having considered as inclusion criteria solely research published in open access journals, since other research published in closed access journals is omitted.

Future lines of research will arise from the need to develop longitudinal and/or comparative studies that address the learning of content relating to the SDGs, and likewise, the use of active methodologies in training processes based on a perspective of commitment and SR within higher education. Other lines of research related to the initial training of Secondary Education teachers might also be considered, because it may be possible to find other, interesting experiences related to the implementation of active methodologies based on sustainable development.

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