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Sustainability Competence Vignette Questionnaire for Secondary Education Students: Design and Validation

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ABSTRACT

This study presents the design and validation of a vignette questionnaire for assessing sustainability competences in secondary school students, using the GreenComp competence framework as a theoretical basis. The questionnaire was administered to 389 students from seven secondary schools in the province of Tarragona, Spain. This article describes the processes of content validation by a group of experts, the assessment of questionnaire item quality, and the validation of the construct. As a result of the research, we obtained a final version of a vignette questionnaire with adequate psychometric properties and an expected a posteriori (EAP) reliability index = 0.804. This questionnaire is suitable for the assessment of the overall sustainability competence of secondary school students. The study results highlight the need to continue developing the design, validation, and implementation of tools for assessing sustainability competences in future research to contribute to the operationalization of existing competence frameworks in secondary education.

1 | Introduction

The role of sustainability has gained international recognition as a path toward the change and transformation necessary for improving our quality of life, fairness between generations, and for protecting the environment (European Commission 2024; UNESCO 2017, 2020; United Nations 2015). In the school context, sustainability involves reorienting the contents, competences, envisaged results, and purposes of education (Sterling et al. 2017; Cebrián et al. 2020). To promote these curricular improvements, it is necessary to define the sustainability competences that will enable students to critically reflect on their own actions and make informed decisions to address challenges that will inevitably affect their daily lives (Mulà et al. 2022). The competence-based approach facilitates bridging the gap between knowledge and action to transform competences into real

sustainable actions based on the individual's values and motivations (Rieckmann 2018).

Sustainability competencies are understood as the blend of cognitive, practical skills, attitudes, and ethical values that enable individuals and communities to contribute to sustainability (Bianchi et al. 2022; Brundiers et al. 2021). Within the concept of competence, the sub-constructs of knowledge, attitudes, and behaviors regarding sustainability stand out, as they help to gauge their environmental awareness and willingness to protect the environment (Powell et al. 2019). Beyond environmental awareness, other sustainability competencies can be developed, such as systems thinking, which encompasses students' everyday lives and enables them to understand the links among ecological, social, and economic systems (Clark et al. 2017; Li et al. 2018; Vesterinen and Ratinen 2024), and

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critical thinking, which motivates students to argue and reflect so they can make informed, consensus-based decisions (Bianchi et al. 2022; Domènech-Casal 2018). Action competence is also key, as it fosters an active role in driving changes in individual and collective behaviors (Oinonen et al. 2023; Olsson et al. 2022), as is futures-thinking competence, which helps people make decisions while considering possible consequences for the community toward building more sustainable futures (Julien et al. 2018; Levrini 2021). Furthermore, numerous generic sustainability competence frameworks covering different competences such as futures literacy, systems thinking, critical thinking, and acting for sustainability have been proposed (Bianchi et al. 2022; Brundiers et al. 2021; UNESCO 2017; Wiek et al. 2011). Increasing numbers of studies are researching how to define sustainability competences; however, the research on developing effective strategies and tools for assessing these competences is still in a premature stage (Cebrián et al. 2020; Redman and Wiek 2021; Toma et al. 2024). At the practical level, there is research based on designing and validating tools for assessing specific competences, such as acting for sustainability (Olsson et al. 2020; Sass et al. 2021), the three subconstructs of sustainability knowledge, attitudes, and behaviors (Varoglu et al. 2018; Berglund et al. 2019; Gericke et al. 2019) and the systems thinking competence (Li et al. 2018; van Harskamp et al. 2023). Other recent studies have designed tools for assessing sustainability competences by operationalizing generic competency frameworks such as GreenComp (Bianchi et al. 2022) in formal educational contexts such as primary education (Toma et al. 2024) or as the framework of the five competences of Wiek et al. (2011) in extracurricular university contexts (Xiao et al. 2024). Despite the emergence of research that aims to assess sustainability competences, currently there are very few studies that have made sustainability competence frameworks operational in secondary education, especially focused on evaluating more than one sustainability competence.

It is a great challenge to design a relevant tool to assess sustainability competences based on a multidimensional and generic conceptual framework (Ratinen et al. 2024). Thus, more research is necessary for designing and applying assessment questionnaires and scales to better understand the development of sustainability competences in different stages and educational contexts and how the different competences are related to each other (Planck et al. 2024). The GreenComp sustainability competence framework is a recent and evolving framework, and therefore there is currently very little research on it (Sourgiadaki and Karkalakos 2023). So far, in terms of studies that operationalize this framework by designing and validating tools for assessing sustainability competences, there is only one study involving an assessment tool for primary school students (Toma et al. 2024), and one study on training teachers' perceptions of the suitability of the GreenComp framework for promoting learning in sustainability (Sourgiadaki and Karkalakos 2023).

Therefore, this study aims to contribute to operationalizing the GreenComp competence framework in secondary education by designing and validating a sustainability competence assessment questionnaire based on vignettes for secondary school students, and by analyzing its structure and psychometric properties. GreenComp (Bianchi et al. 2022) is a lifelong learning framework that builds on existing sustainability

competence frameworks and has been validated by Education for Sustainable Development (ESD) experts. It currently needs to be operationalized and contextualized in the educational stage of secondary education. This study is based on the following research questions:

1. Does the designed assessment tool demonstrate content validity?
2. What is the dimensionality of the designed assessment tool?
3. Does the designed assessment tool meet the reliability criteria?

In this article, we firstly present a review of the literature related to the existing sustainability competence frameworks, as well as the tools designed to evaluate them in secondary education. Second, we explain the methodology and processes followed to develop the questionnaire as well as the validation process. Thirdly, we describe the process to conceptualize and implement the questionnaire, which includes the results of the content validation by experts, the analysis of the items, and the validation of the construct. Finally, we present the discussion, which is followed by the main conclusions of the study.

2 | Background

2.1 | Sustainability Competence Frameworks

There are several definitions of sustainability competence according to different authors; de Haan (2006) refers to the capacity to act and solve problems that endows the individual with the ability to actively participate and introduce changes in social, economic, and environmental behavior, aligned with sustainable development. According to Mulà et al. (2022) sustainability competence is the combination of knowledge, skills, attitudes, and ethical values necessary to solve sustainability challenges effectively. Bianchi et al. (2022) state that sustainability competences help students internalize sustainable values, understand complex systems to preserve the health of ecosystems, and promote justice, as well as helping them envisage sustainable futures. However, the existence of several definitions of sustainability competencies and agreement on its main components, the development of well-defined conceptual frameworks of sustainability that deploy clear competences and that can be used in different socio-cultural contexts and educational institutions, as well as at different educational levels is a persistent challenge (Brundiers et al. 2021; Mulà et al. 2022). During the last decades, various sustainability competence frameworks have been proposed, including generic competence frameworks (Wiek et al. 2011; Rieckmann 2012; UNESCO 2017), as well as more recent ones such as the European Commission's GreenComp sustainability competence framework (Bianchi et al. 2022). These frameworks highlight competences such as futures literacy, systems thinking, critical thinking, and acting for sustainability (Bianchi et al. 2022; Brundiers et al. 2021). However, in recent years, studies have emerged that focus on a specific competence, such as futures literacy (Julien et al. 2018) or acting for sustainability (Sass et al. 2021). There are also studies that have proposed sustainability competence frameworks for different

educational levels, including primary education (de Haan 2006), for teacher training (Cebrián and Junyent 2015; Rauch and Steiner 2013; Renta-Davids et al. 2020), for teachers or educators (Bertschy et al. 2013; Vare et al. 2019), and most frequently, for higher education (Brundiens et al. 2021; Rieckmann 2012; Wiek et al. 2011).

Generic competence frameworks cover an exhaustive list of competences and refer to the interconnections between them. The framework developed by Wiek et al. (2011) highlights five key competences: systems thinking, anticipatory, normative, strategic, and interpersonal competences. The framework developed by Brundiens et al. (2021) highlights the competences of strategic thinking, value thinking, future thinking, systems thinking, and implementation, through interconnection with inter- and intrapersonal competences and problem solving. There are also competence frameworks that integrate ethical and emotional aspects to be more specifically aligned with the definition of sustainability competence (Cebrián and Junyent 2015).

As a political action established in the European Green Deal, the European Commission has recently developed and published the European GreenComp framework for lifelong learning of key competences in sustainability (Bianchi et al. 2022). The objective of this framework is to help educators and teachers include these sustainability competences to enrich, guide, and improve curricula and educational programs to provide students with knowledge and attitudes that allow them to reflect, plan, and act for the well-being of the planet and public health (Bianchi et al. 2022). GreenComp has a solid theoretical base derived from reviewing other sustainability competence frameworks. These include the framework by Wiek et al. (2011, 2016), the framework by Brundiens et al. (2021), which adds two competences, intrapersonal and implementation, and the framework by Redman and Wiek (2021) based on the framework by Wiek et al. (2011). The GreenComp framework defines overall sustainability competence based on four competence areas that each include three interrelated competences: (1) Embodying sustainability values (*Valuing sustainability, Supporting fairness, Promoting nature*), which encourages students to reflect on their own personal values in relation to the principles of sustainability, to support equity and justice for current and future generations, and to acknowledge that human beings are part of nature; (2) embracing complexity in sustainability (*Systems thinking, Critical Thinking, Problem framing*), which prepares students to reflect using critical and systems thinking and to analyze real contexts related to sustainability; (3) Envisaging sustainable futures (*Futures literacy, Adaptability, Exploratory Thinking*), which enables students to visualize and imagine alternative future perspectives, to identify actions to achieve a sustainable future, to adapt to situations of uncertainty, and to explore new methods and processes through creativity; and (4) Acting for sustainability (*Political agency, Collective Action, Individual Initiative*), which encourages students to act at the individual and collective levels to achieve a sustainable future and to demand effective policies for sustainability from policy makers (Bianchi et al. 2022). Out of all the competence frameworks described, we chose GreenComp to develop a sustainability competence assessment tool for secondary education as it is a recent framework agreed upon by a group of 75 experts in ESD and lifelong learning of academic institutions with the

representation of young people, educators, and political representatives of EU Member States and NGOs. Thus, GreenComp is the result of a comprehensive expert review that involved a broad and diverse group to reach a consensus on an agreed competence framework. Additionally, the assessment tool developed and validated in this study aims to support the operationalization of this framework in secondary education, where research on applying the GreenComp and assessing its proposed competencies remains limited (European Commission; 2024; Laherto et al. 2023).

2.2 | Evaluation of Sustainability Competences and Assessment Tools

Assessment is a key aspect of education, as the evaluation of competencies plays an important role in improving learning processes and optimizing the effectiveness of educational systems (European Commission 2023; Leutner et al. 2017). The concept of assessment is polysemic and is classified into four types according to its purpose (Fuchs et al. 2003; Sanmartí 2010): (1) diagnostic assessment identifies students' prior knowledge to detect misconceptions that may hinder learning; (2) summative assessment verifies the level of knowledge acquired at the end of a learning stage; (3) formative assessment detects changes during the student's learning process to help them build knowledge in a targeted way; and (4) formative-instructional assessment identifies and analyzes students' errors in order to help them self-regulate their learning. In this study, the decision was made to assess competencies, as they go beyond attitudes and knowledge. While attitudes are stances taken in the face of different situations, and knowledge refers to theoretical concepts acquired during learning, competencies are developed through experience and practice in real and complex contexts, reflecting a combination of attitudes, knowledge, ethical values, and both cognitive and practical skills (Bianchi et al. 2022; Corraliza and Martín 2000). Assessing sustainability competencies in secondary education is essential, as at this educational stage, students' perceptions of sustainability may be influenced by age-specific characteristics (Olsson and Gericke 2016; Pol and Castrechini 2013). For this reason, it is crucial to evaluate sustainability competencies among adolescents, as this can help analyze their development and identify potential gaps in competencies related to collaboration, individual and collective action, and the use of critical and systems thinking, so that they are better equipped to address the complexity of everyday phenomena related to sustainability also informing curriculum design and development (Gil Pérez and Vilches 2019; UNESCO 2017).

In recent years, different tools have been developed to evaluate sustainability competences (Ratinen et al. 2024; Waltner et al. 2019). According to the literature review conducted by Redman et al. (2021), sustainability competence assessment tools are classified into three main groups: self-perception (scaled self-assessment, reflective writing, and focus groups/interviews); observation (performance observation, regular coursework, and conceptual mapping); and evidence-based approaches (case testing and conventional testing). Existing research on sustainability competencies' assessment has focused on formal contexts (Al-Rabaani and Al-Shuili 2020; Baldwin et al. 2022; Julien et al. 2018; Olsson et al. 2020; Sass et al. 2023;

Waltner et al. 2019), although recently these competences have also been studied in extracurricular contexts (Xiao et al. 2024). The sustainability competences that have been assessed so far in secondary education within formal educational contexts include the subconstructs of environmental awareness, knowledge, and attitudes (Jackson and Pang 2017; Waltner et al. 2019; Gericke et al. 2019; Ariza et al. 2021), action competence in sustainability (De Vreede et al. 2014; Olsson et al. 2020; Sass et al. 2021), systems thinking (Zoller 2015; Li et al. 2018; van Harskamp et al. 2023), critical thinking (Rudd et al. 2019), and futures literacy (Julien et al. 2018; Levrini 2021; Finnegan 2022).

However, to date, there are few psychometric tools in the field of ESD research for assessing sustainability competences (Gericke et al. 2019; Olsson et al. 2020; Toma et al. 2024). The tools used to measure sustainability competencies have evolved over time, moving from the design and use of scales that only assess knowledge, attitudes, or behaviors, toward more holistic evaluations. This includes progress from Likert-type scales, which only measure environmental attitudes, to questionnaires such as the *Sustainability Consciousness Questionnaire (SCQ)*, which assesses attitudes, knowledge, and behaviors related to sustainability (Gericke et al. 2019). Furthermore, questionnaires have also advanced in their ability to evaluate other sustainability competencies. For example, action competence is assessed through the *Action Competence in Sustainable Development Questionnaire (ACiSD-Q)*, which takes into account variables such as knowledge, motivation to act, perceived ability, and anticipated outcomes regarding action in sustainability. Systems thinking is assessed using instruments like the *Systems Thinking Test regarding Ecological Issues (STTEI)*, which includes items related to ecological topics such as system organization, system behavior, system application, and system evaluation (Li and Li 2023; Sass et al. 2023). Other existing research has also used quantitative and qualitative tools for evaluating a specific sustainability competence, such as through drawings, scenarios, or role-playing for future-thinking competence (Julien et al. 2018), workshops for critical thinking, decision-making, and hope (Rudd et al. 2019) or classroom observations and semi-structured interviews for systems thinking (Zoller 2015), showing the value of using multiple assessment tools in combination.

In terms of assessment approaches, instrument design has also become more sophisticated. One example is the emergence of the use of vignettes, which offer a competency-based approach and address multifaceted and complex issues like sustainability by making the topics relatable to students' real-life experiences (Barnatt et al. 2007; Redman et al. 2021). This contrasts with traditional questionnaires, which measure self-perceptions (Bradbury-Jones et al. 2014; Sandri et al. 2016). Existing studies have used vignette questionnaires to assess sustainability learning or competences, although they are still limited and have been mainly applied in fields such as occupational therapy, psychology, social work, nursing, and education (Aguinis and Bradley 2014; Redman et al. 2021). Vignette questionnaires have been designed for assessing graduate sustainability learning outcomes (Sandri et al. 2016), and for assessing the competence of quality education awareness in student teachers (Renta-Davids et al. 2020). These questionnaires are considered a tool with great potential because they assess learning or competences based on real and contextualized situations,

which makes it possible to understand people's perceptions, values, and dispositions more completely (Barnatt et al. 2007; Finch 1987; Hughes and Huby 2002; Renta-Davids et al. 2020). In the case of competency-based instruments like vignettes, it is essential to ensure that the situations presented are short, simple, and recognizable for students to increase the likelihood that they can complete them (Sandri et al. 2016). Current assessment tools, however, share common challenges, such as a limited number of items, which hinders an in-depth exploration of students' knowledge and may lead to a disconnect between the assessed competency and actual behavior (Aminrad et al. 2013; Gericke et al. 2019; Sass et al. 2023). This reinforces the need to further develop and validate diverse sustainability competencies assessment approaches and tools in order to measure the level and development of sustainability competencies among secondary school students and to gain evidence on the effectiveness of specific ESD pedagogical approaches and educational programs (Mulà et al. 2022).

3 | Methodology

3.1 | Sample and Procedure

This research is part of the research project EDU4CLIM, which seeks to implement school climate assemblies in secondary education schools in the region of Tarragona (Spain) and determine the influence that these have in the development of sustainability competences among students through the design, validation, and implementation of an assessment tool based on vignettes. The design and validation of the vignette questionnaire was carried out during the 2023–24 academic year.

The vignette questionnaire was developed and validated in three phases: (1) Item development, which involved determining the items and validating the content; (2) scale development, which involved making a cognitive validation to formulate significant items and administering the vignette questionnaire; and (3) scale assessment, which involved testing dimensionality, reliability, and validity (Boateng et al. 2018; De Vellis 2003) (Figure 1).

In the item development phase, the initial questionnaire designed consisted of four vignettes and 12 questions, each related to a competence of the GreenComp framework (Bianchi et al. 2022). That was to include all the relevant aspects of the domain of sustainability competences, according to that framework. The answer format was closed with three options, one of them being the optimal answer. Subsequently, content validation was conducted by a panel of 12 experts in science education, sociology, social pedagogy, didactics and school organization, and education for sustainable development (ESD). This process added methodological rigor to the questionnaire, as the experts quantitatively evaluated the items in terms of their suitability, relevance, and clarity. Additionally, qualitative feedback was provided to refine and enhance the formulation of the items. Finally, the questionnaire was administered to 389 secondary school students in the Tarragona region, Spain.

In the scale development phase, a cognitive validation was carried out through a focus group with Grade 7 students (equivalent

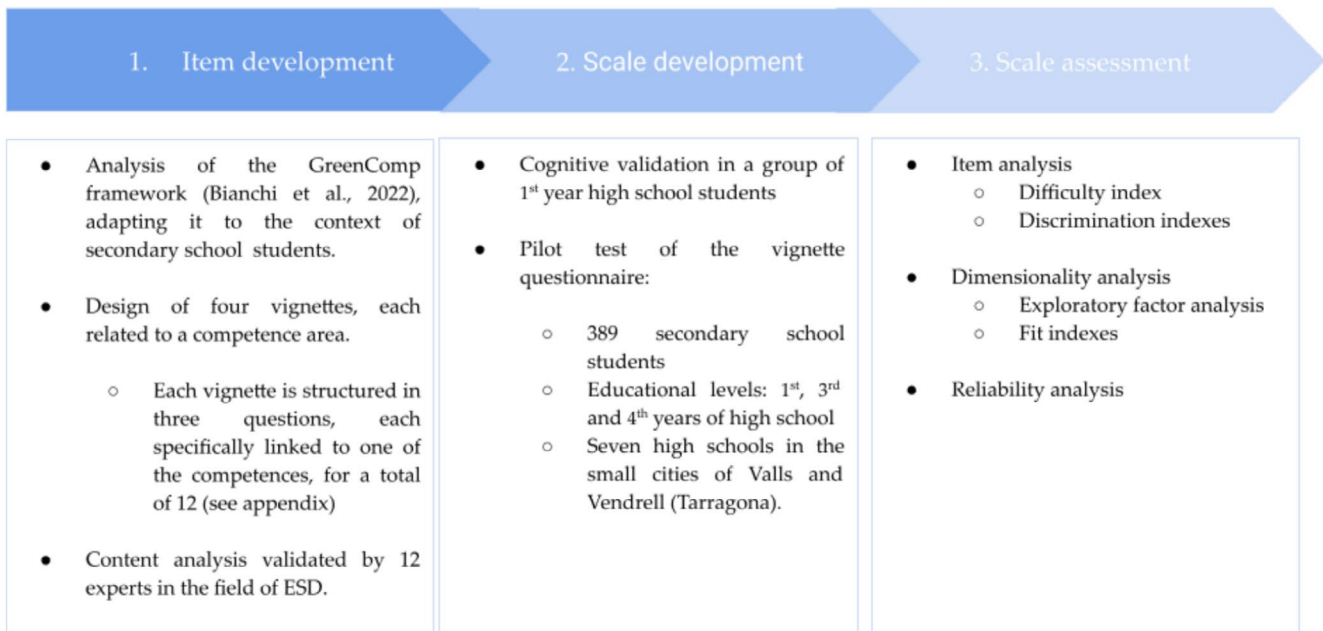


FIGURE 1 | Vignette questionnaire development and validation phases.

to the first year of lower secondary education in Spain), in which they were asked about the appropriateness of the questions according to their age and their understanding of them. Later, the questionnaire was administered to 389 students in Grade 7 (12–13 years old), Grade 9 (14–15 years old) and Grade 10 (15–16 years old) grades of high school, from seven secondary schools in the province of Tarragona (Catalonia, Spain). The participants' ages ranged from 12 to 17 ($M=13.38$, $SD=1.52$). The participants' gender identities were as follows: 48.6% identified themselves as female, 47.8% identified themselves as male, and 3.6% identified themselves with other gender identities. It should be noted that all participating schools are part of the Green Schools programme of the Autonomous Government of Catalonia that aims to incorporate environmental practices, education for sustainability, and curricular innovation into the education center (Espinet et al. 2015). The students answered the vignette questionnaires voluntarily within school hours in compulsory or optional subject sessions related to ESD. The questionnaire was administered by the research team, with the support of the teaching staff, who gave a brief explanation of the questionnaire and the approximate time to answer it. To minimize data loss, participants were supported with any questions that they had. The project received approval from the ethical committee CEIPSA-2023-PR-0008, obtained on May 2, 2023. The project information and informed consent forms were mailed to the participating centers and were distributed to the families and returned signed before the questionnaire was administered.

In the scale assessment phase, once the data had been collected, a series of analyses were carried out to determine the validity, dimensionality, and reliability of the questionnaire. To present the validation of the vignette questionnaire, we provide the data regarding the option that participants selected for each question. We also performed item analysis by calculating the difficulty and discrimination indices. The item difficulty index ranged from 0 to 1, with values closer to 1 indicating that the item is easier. The item discrimination index ranged from -1 to $+1$, and the

positive value represents the perfect discrimination. In the literature, values above 0.40 are considered very good items in terms of discrimination. Items with a discrimination index under 0.19 should be rejected and reviewed (Ebel and Frisbie 1986). To provide more insightful information about discrimination, we also calculated the point-biserial correlation between a continuous variable (the overall score in the vignettes) and a dichotomous variable (correct or incorrect answer).

We performed an exploratory factor analysis to determine the dimensionality of the vignette questionnaire. This was administered for the first time in a sample of adolescents, and therefore no previous assumptions can be made about its structure. Even though our vignette questionnaire is based on the GreenComp framework, this is a theoretical framework and not an empirical one, so evidence of its structure should be collected (Brown 2015; Ferrando and Lorenzo-Seva 2014). To determine the dimensions underlying our data, we carried out an optimal implementation of parallel analysis (PA) according to Timmerman and Lorenzo-Seva (2011). Due to the nature of our data, we used polychoric correlations and robust unweighted least squares as the extraction procedure with robust Promin for rotation (Lorenzo-Seva and Ferrando 2019). We carried out the Kaiser–Meyer–Olkin test, which assesses the adequacy of the sampling for the factorial analysis. In general, values above 0.70 can be considered adequate. To identify inappropriate items, we calculated the measure of sampling adequacy (MSA) as suggested by Lorenzo-Seva and Ferrando (2021). Values below 0.50 in the MSA suggest that the item does not measure the same domain as the other items in the questionnaire.

We also provide fit indices for our factorial solution. We provide information regarding the root mean square of residuals (RMSR), the non-normed fit index (NNFI), the comparative fit index (CFI), the goodness of fit index (GFI), and the adjusted goodness of fit index (AGFI). RMSR values lower than 0.08, NNFI and GFI values above 0.95, and CFI and AGFI values above 0.90 are

indicative of an acceptable fit (Steiger 2007; Kline 2005; Hu and Bentler 1999; Bentler 1990). We used IBM's SPSS and Microsoft's Excel to process our data and perform item analysis. FACTOR (Ferrando and Lorenzo-Seva 2017) was used to perform the dimensionality study of the vignette questionnaire.

3.2 | Design and Description of the Assessment Tool

The designed assessment tool used the experimental vignette methodology (EVM) for several reasons: they can be used to address multifaceted and complex issues (Bradbury-Jones et al. 2014), unlike questionnaires that focus exclusively on assessing knowledge, attitudes, and beliefs. Therefore, in this study, we have designed, applied, and validated a questionnaire that uses experimental vignettes (Hughes and Huby 2002). Vignettes were chosen as they can reduce the ambiguity of many concepts related to sustainability, as the details provided in the vignette offer sufficient context for students to make a reasonable judgment about the best action to take in a given situation (Sandri et al. 2016). EVM consists of presenting secondary school students with situations adjusted to their realities, described briefly and carefully through writing, images, videos, or other means, to evaluate dependent variables such as knowledge, attitudes, and behaviors (Hughes and Huby 2002; Sandri et al. 2016). The purpose of applying the vignette questionnaire is to explore sustainability competences that secondary school students would adopt in certain real-life situations.

The vignettes presented in this research describe hypothetical situations. The participants must select an answer from three options according to their legitimate interests, honestly answering what they think they would do or what should happen (Finch 1987). The contextualized situations have been constructed based on the competence areas and sustainability competences included in the GreenComp framework, being the competence understood as a set of knowledge, skills, and attitudes that enable students to embody sustainability values, understand complex systems, and envision sustainable futures, with the aim of taking action to preserve healthy ecosystems and enhance social justice (Bianchi et al. 2022). The tool designed includes four vignettes, one for each competence area (embodying sustainability values; embracing complexity in sustainability; envisaging sustainable futures and acting for sustainability). Each vignette comprises three questions related to each situation, which focus on a sustainability competence within the competence area. It is composed of a total of 12 questions, each linked to a sustainability competence. In the closed multiple-choice responses, there are three options, one of which is the most optimal or favorable (marked in bold) and the other two are distractors representing diminished or inappropriate behaviors (Cruz et al. 2021). In this sense, selecting the most optimal response indicates that the student demonstrates a higher level of sustainability competence compared to if they had chosen less optimal options.

The summary of the final assessment tool is presented in Table 1. The full version of the questionnaire is included as a [Supporting Information](#): Appendix. The vignettes aim to

challenge students to think about real situations such as sustainable food, responsible consumption of clothing, the ability to envisage possible future scenarios, and the willingness to act individually and collectively to address local problems that may involve them. Therefore, the students are provided with different relevant information so they can reflect before making a decision (AERA 2014).

4 | Results

4.1 | Expert Validation

To obtain a robust, reliable, and valid version of the questionnaire, a panel of 12 experts was formed by researchers with extensive experience in Education for Sustainable Development. They evaluated the suitability, relevance, and clarity of writing of the items to assess the construction of the questionnaire and to exhaustively test the validity of the content (Table 2).

The experts' validation was favorable, evaluating the response options with a medium-high score for each item. We then reviewed all the items with scores below 5.3 and which obtained less than 88% for the content validity index. The experts' qualitative comments were also considered in order to rephrase the items. They suggested changes in the wording of some items to make them more understandable for the students, as well as simplifying them to avoid the possibility of confusion. A clear example of this is item 4.3. "I can't do anything. Families who come in their cars should try not to come at the same time as other cars or look for other ways to get to the high school other than by car" was replaced with "I can't do anything. It's not up to me what my family and the families who come by car to pick up their children do." Moreover, the experts proposed to incorporate a more holistic rather than reductionist view in some items to refer to sustainability instead of exclusively the environment. For example, in item 2.1, we replaced "I don't know, logically consuming more implies producing more, and consequently, producing more clothes could somehow affect the environment" with "I don't know. Maybe it depends on the amount of clothes they buy, but I'm not sure that this is related to sustainability." In addition, they highlighted that some options were too obvious, such as those in items 2.2 (*systems thinking*), 3.1 (*futures literacy*), and 3.3 (*exploratory thinking*). Table 3 includes the re-wording of all the items, offering a more complete view.

4.2 | Item Analysis

To determine the quality of the items, we measured the percentage and frequency of each optional answer (a, b, and c), aligned to each of the questions in the vignette questionnaire. The options marked in bold are linked to the optimal responses, most of which do not correspond to the highest percentages (Table 4).

Table 5 shows the difficulty and discrimination indices and also the results of the point-biserial correlation. The item difficulty ranges from 0.32 to 0.72 ($M=0.47$; $SD=0.11$). In general, the questionnaire's items have a medium difficulty of around 0.50. The discrimination index shows that most of the items have a

TABLE 1 | Simplified description of the assessment tool designed.

Summary of the vignette	Sustainability competence (description)	Item question	Answer options
<p>Vignette 1. Is consuming less meat a more sustainable lifestyle? A dialogue between friends (Lucia, Bilal and the student) who talk about reducing meat consumption and discuss topics such as animal rights, the impact of meat industries on the environment and the contribution they can make to a more sustainable lifestyle.</p>	<p>Promoting nature: To recognize that living beings are part of nature and respect the needs and rights of other species and nature itself in order to restore and regenerate healthy and resilient ecosystems.</p> <p>Valuing sustainability: To reflect on personal values; identify and explain how values vary among individuals and over time, critically assessing their alignment with sustainability values.</p> <p>Supporting fairness: To support equity and fairness for present and future generations and learn from previous generations for sustainability.</p>	<p>i1.1. What would you say to Lucia?</p> <p>i1.2. What would you say to Bilal?</p> <p>i1.3. What would you say to Bilal?</p>	<p>a. Industrial farms want to produce more meat so they can make more money, not because they don't care about the animals' welfare.</p> <p>b. Farm animals are part of our food chain and farms are responsible for raising them for us to eat.</p> <p>c. We should think about this. Farm animals, like humans, deserve to be treated well.</p> <p>a. We need to be aware of this issue and reduce the amount of meat we eat to reduce our impact on the environment.</p> <p>b. We need to be aware of this issue and tell our friends and family about it. I think that would be enough.</p> <p>c. We should keep eating like we've always done. I think reducing the amount of meat we eat wouldn't have as much impact on the environment as industrial farms do.</p> <p>a. Well, I don't know. I've never really thought about how meat production could affect future generations over time.</p> <p>b. If we contribute to reducing the number of industrial farms, we will reduce the negative impact on the environment, on living beings and on future generations.</p> <p>c. Industrial farms could end up negatively affecting future generations and they are the ones that will have to solve this problem.</p>

(Continues)

TABLE 1 | (Continued)

Summary of the vignette	Sustainability competence (description)	Item question	Answer options
<p>Vignette 2. Is fashion more important than human rights? Twins Blanca and Gabri love to wear new outfits every week that they buy online and share on social media. The ethics teacher asks them to do an activity related to the origin of their clothes, about the social, environmental and economic impact of textile industries and to reflect on ways to use clothes sustainably.</p>	<p>Problem framing: To formulate the current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, in order to identify appropriate approaches to anticipate and prevent problems, as well as to mitigate and adapt to those that already exist.</p> <p>Systems thinking: To approach a sustainability problem from all perspectives: consider time, space and context to understand how the elements interact within and between ecosystems.</p> <p>Critical thinking: To evaluate information and arguments, identify assumptions, question the status quo and reflect on how personal, social and cultural contexts influence thinking and conclusions.</p>	<p>i2.1. Do you think that Blanca's and Gabri's excessive clothing consumption could be related to sustainability?</p> <p>i2.2. What do you think Blanca means?</p> <p>i2.3. What would you recommend to Blanca and Gabri in relation to clothing consumption?</p>	<p>a. No, not at all. Buying clothes and sustainability have nothing to do with each other. They are completely different issues.</p> <p>b. I don't know. Maybe it depends on the amount of clothes they buy, but I'm not sure that this is related to sustainability.</p> <p>c. Yes, consuming more means producing more, and this production causes impacts such as water pollution from synthetic dyes in clothing.</p> <p>a. Clothing is cheap because Cambodia produces a lot of clothes, and they use cheap, low-quality fabric.</p> <p>b. Clothing is cheap because workers in Cambodia work longer hours than a normal working day and are paid very low wages.</p> <p>c. Clothing is cheap because Cambodia has a lot of clothing factories and so clothes are an abundant resource there.</p>
		<p>i2.3. What would you recommend to Blanca and Gabri in relation to clothing consumption?</p>	<p>a. Go on as always, the low prices make it possible to keep wearing different outfits and sharing them regularly on social media.</p> <p>b. They should try and use the clothes they already have, and give the clothes they don't wear to family, friends or social entities, so they can reduce the amount of clothes they buy as much as possible.</p> <p>c. There is no solution, even if they don't buy as many clothes, the problem will continue to exist no matter how much they worry about being sustainable.</p>

(Continues)

TABLE 1 | (Continued)

Summary of the vignette	Sustainability competence (description)	Item question	Answer options
<p>Vignette 3. And you, how do you see the future?</p> <p>The student (protagonist of the story) is invited with his family to a meeting in the village to talk about the environmental future of the village. The student is asked different questions related to how he imagines the future of his village, whether he would be able to adapt to take measures for sustainability and whether he would be willing to commit himself to doing activities for sustainability at a local level.</p>	<p>Futures literacy: To project alternative sustainable futures by imagining and developing alternative scenarios and identifying the necessary steps to achieve a preferable sustainable future.</p>	<p>13.1. How would you answer this question?</p>	<p>a. I don't know, I've never really thought about the environmental future of my town and right now I can't imagine what it will be like in 2050 to be more sustainable, so I can't really say anything.</p> <p>b. I would propose different possible futures that I've imagined and think about how to improve the town's environmental situation so that it is more sustainable in 2050; for example, it would be good for the community to be able to access renewable energy.</p> <p>c. The possible environmental future that I imagine for 2050 is the foreseeable one, I mean, the one that you expect to happen depending on what is happening now, like, finding ways to save water to deal with drought.</p>
<p>Adaptability: To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk.</p>	<p>13.2. How would you adapt to this new situation?</p>	<p>a. It would be difficult for me to adapt to this new situation because it requires too much effort.</p> <p>b. I would try to adapt to this new situation as long as it didn't affect my daily life.</p> <p>c. I would look for ways to adapt to this change by thinking about improving the town's environmental situation.</p>	
<p>Exploratory thinking: To adopt a relational way of thinking when studying and linking different disciplines, using creativity and experimenting with ideas and new methods.</p>	<p>13.3. What would you say?</p>	<p>a. I commit to collaborating with the town's youth sector to develop and carry out extracurricular activities related to the environment that improve the town's environmental situation.</p> <p>b. I commit to collaborating with the youth sector of the town to brainstorm, research, develop, and implement extracurricular environmental activities, and to assess whether or not they are effective in the community.</p> <p>c. I prefer not to commit to any environmental activity in the town unless I'm really interested and can do it with my friends and with other young people from the town.</p>	

(Continues)

TABLE 1 | (Continued)

Summary of the vignette	Sustainability competence (description)	Item question	Answer options
<p>Vignette 4. An action is worth more than a thousand words</p> <p>When going to school by car (rush hour) there is lots of traffic, which generates a lot of pollution and even causes some accidents. The student is asked whether he/she would be interested and willing to help solve the problem at an individual and collective level, with people from the community, as well as whether he/she would be willing to ally him/herself with the political leaders to find a solution.</p>	<p>Political agency: To navigate the political system, identify political responsibility and accountability for unsustainable behavior, and demand effective policies for sustainability.</p>	<p>i4.1. What would you do to address this issue?</p>	<p>a. Nothing. The City Council should solve this problem. The school management team, teachers and families do not have the means to resolve this situation. The high school can't do anything.</p> <p>b. I agree that the transport situation must be changed because it affects all of us, but I can't think of anything at the moment. I wouldn't know where to start and I doubt that it's possible to do anything about it.</p> <p>c. I think we should present a letter to the City Council, together with the families, teachers and school management team, explaining the situation and proposing possible solutions such as promoting the use of bicycles.</p>
	<p>Collective action: To act in favour of change in collaboration with other agents.</p>	<p>i4.2. What would you do?</p>	<p>a. I would be interested in the initiative, and I would ask my family and friends to participate so that we can actively help together with other people.</p> <p>b. I think it's a good initiative, but I wouldn't participate because I prefer to meet with my friends or stay at home.</p> <p>c. I'm not interested in going to help the community for a common cause because I really wouldn't get anything out of it.</p>
	<p>Individual initiative: To identify one's own potential for sustainability and actively contribute to improving the prospects of the community and the planet.</p>	<p>i4.3. If it were up to you, what would you do to improve the situation and do your bit to help?</p>	<p>a. To improve the situation, I would try to get my family to take me to school by car outside of the rush hours so we wouldn't get caught in the traffic jam and wouldn't pollute so much.</p> <p>b. I can't do anything. It's not up to me what my family and the families who come by car to pick up their children do.</p> <p>c. I could go by bike or meet up with friends to walk to school together or try to use public transport that gets me as close as possible.</p>

TABLE 2 | Mean score of the validation process and content validity index.

Item	Suitability		Relevance		Clarity of wording		N experts
	M (SD)	CVI	M (SD)	CVI	M (SD)	CVI	
i1.1	5.33(0.88)	89%	5.31(0.74)	89%	5.47(0.70)	91%	12
i1.2	5.28(0.87)	88%	5.19(0.88)	87%	5.30(0.82)	88%	12
i1.3	4.45(1.24)	74%	4.56(1.38)	76%	5.36(0.72)	89%	11
i2.1	5.64(0.69)	94%	5.56(0.70)	93%	5.69(0.70)	95%	12
i2.2	5.17(0.84)	86%	5.20(0.88)	87%	5.17(0.84)	86%	10
i2.3	5.44(0.66)	91%	5.53(0.64)	92%	5.42(0.87)	90%	12
i3.1	5.36(0.83)	89%	5.56(0.72)	93%	5.22(1.08)	87%	12
i3.2	5.36(0.81)	89%	5.45(0.82)	91%	5.52(0.81)	92%	11
i3.3	5.03(1.23)	84%	5.12(1.27)	85%	4.88(1.42)	81%	11
i4.1	5.64(0.64)	94%	5.58(0.67)	93%	5.64(0.80)	94%	12
i4.2	5.58(0.77)	93%	5.50(0.77)	92%	5.67(0.65)	95%	12
i4.3	5.39(0.77)	90%	5.36(0.82)	89%	5.48(0.83)	91%	11

Abbreviations: CVI=content validation index, M=mean, SD=standard deviation.

TABLE 3 | Overview of rephrased items.

Original item	Rephrased item
i1.3a. I don't know, but even if we are aware of this problem, if we can't eat meat, the situation will not improve.	i1.3a. Well, I don't know. I've never really thought about how meat production could affect future generations over time.
i1.3b. Animal abuse is exaggerated. There is nothing wrong with animals living in a 1 m ² house for a period of time.	i1.3b. If we contribute to reducing the number of industrial farms, we will reduce the negative impact on the environment, on living beings and on future generations.
i1.3c. Industrial farms could end up negatively affecting future generations, but since I'm not in the area I'm not concerned.	i1.3c. Industrial farms could end up negatively affecting future generations and they are the ones that will have to solve this problem.
i2.1b. I don't know, logically consuming more implies producing more, and consequently, producing more meat could somehow affect the environment.	i2.1b. I don't know. Maybe it depends on the amount of clothes they buy, but I'm not sure that this is related to sustainability.
i2.2c. Clothes are cheap because the brand itself has decided to set this price so that they are affordable for everyone.	i2.2c. Clothing is cheap because Cambodia has a lot of clothing factories and so clothes are an abundant resource there.
i3.1a. I don't know, I have rarely thought about the environmental future of my village and right now I can't imagine what it will be like in 2050, so I won't say anything.	i3.1a. I don't know, I've never really thought about the environmental future of my town and right now I can't imagine what it will be like in 2050 to be more sustainable, so I can't really say anything.
i3.3a. I would take on a participatory role in the town, as long as I participate with my friends and occasionally in some activities related to the environment, to seek solutions in a creative and collective way.	i3.3a. I commit to collaborating with the town's youth sector to develop and carry out extracurricular activities related to the environment that improve the town's environmental situation.
i4.2c. I don't feel like going to help the community for a common cause, nor would I feel entirely comfortable.	i4.2c. I'm not interested in going to help the community for a common cause because I really wouldn't get anything out of it.
i4.3b. I can't do anything. The families who come with their cars should try not to coincide with the other cars or look for other ways to come to the school than by car.	i4.3b. I can't do anything. It's not up to me what my family and the families who come by car to pick up their children do.

TABLE 4 | Descriptive statistics of the item scores.

Item	Option a %(fr)	Option b %(fr)	Option c %(fr)
i1.1	41.4(161)	41.1(160)	17.5(68)
i1.2	31.9(124)	31.6(123)	36.5(142)
i1.3	50.9(128)	27.2(106)	21.9(85)
i2.1	15.7(61)	72.2(281)	12.1(47)
i2.2	9(35)	36.5(142)	54.5(212)
i2.3	37.5(146)	42.2(164)	20.3(79)
i3.1	27.8 (108)	42.7(166)	29.6(115)
i3.2	18.0(70)	37.8(147)	44.2(172)
i3.3	35.7(139)	32.1(125)	32.1(125)
i4.1	16.5(64)	45.0(175)	38.6(150)
i4.2	47.6(185)	44.5(173)	8.0(31)
i4.3	21.6(84)	22.1(86)	56.3(219)

Note: Correct responses are indicated in bold. “fr” means frequency.

TABLE 5 | Difficulty index, discrimination index, and point-biserial correlation of the vignette questionnaire items.

Item	Difficulty index	Discrimination index	r_{pb}
i1.1	0.37	0.41	0.20
i1.2	0.51	0.61	0.39
i1.3	0.41	0.45	0.26
i2.1	0.55	0.62	0.39
i2.2	0.42	0.15	-0.01
i2.3	0.72	0.48	0.31
i3.1	0.43	0.11	-0.04
i3.2	0.44	0.54	0.31
i3.3	0.32	0.21	-0.03
i4.1	0.39	0.55	0.35
i4.2	0.48	0.59	0.35
i4.3	0.56	0.48	0.27

good discrimination, with values above 0.40. However, two of them (items 2.2 and 3.1) have values below 0.20, which suggests that these items should be removed from the questionnaire and reviewed. After calculating the point-biserial correlation between each item and the overall score in the vignettes, which is a stricter way to assess discrimination because it considers all the information and not only the extreme cases, we found that items 2.2 (*systems thinking*), 3.1 (*futures literacy*), and 3.3 (*exploratory thinking*) showed no correlation with the overall score. As this measure is stricter, all the values decreased compared to the previous criterion; however, the rest of the items continued to have acceptable values.

4.3 | Construct Validation

4.3.1 | Dimensionality Analysis

We performed an exploratory factor analysis on our sample and the 12 original items that comprised the vignettes. Our data were adequate for performing the factor analysis according to the Kaiser–Meyer–Olkin test ($KMO=0.81$). However, according to the Measure of Sampling Adequacy (MSA) a few items had values below 0.50; these were items 1.1 (*promoting nature*), 2.2 (*systems thinking*), 3.1 (*futures literacy*), and 3.3 (*exploratory thinking*).

The results of the parallel analysis suggest that a unidimensional structure is the best dimensional structure for our data, which is consistent with the fact that we propose a general sustainability competence. The factor loading matrix shows that items 2.2 (*systems thinking*), 3.1 (*futures literacy*), and 3.3 (*exploratory thinking*) also have a non-existent saturation in the proposed factor. This is consistent with the MSA index, which showed that these items were measuring a different dimension. We decided to eliminate items 2.2, 3.1, and 3.3. However, we chose to eliminate one item at a time and then perform a new exploratory factor analysis to be certain that the previous findings were consistent through several iterations of the analysis. After eliminating these items, there was a slight improvement in the Kaiser–Meyer–Olkin test ($KMO=0.84$). In addition, the MSA for item 1.1 showed an adequate value. Table 6 shows the loading matrix of the final version of the vignette questionnaire. As it can be seen, all the items load substantially in the proposed factor.

All the goodness of fit indices show adequate values: $RMSEA=0.028$; $NNFI=0.991$; $CFI=0.993$; $GFI=0.980$; $AGFI=0.973$. In addition, the expected a posteriori (EAP) reliability of the vignette questionnaire is also adequate, with an EAP reliability = 0.804.

4.4 | Scale Scores

After obtaining the final version of the vignettes questionnaire, we calculated the scores obtained by the participants. Scores can range from 0 to 9, depending on the items answered correctly.

TABLE 6 | Loading matrix of the items.

Item	F1
i1.1	0.40
i1.2	0.66
i1.3	0.44
i2.1	0.67
i2.3	0.58
i3.2	0.50
i4.1	0.60
i4.2	0.55
i4.3	0.45

For this sample, scores were as follows: $M=4.42$ and $SD=2.3$. Regarding the distribution, values around the mean were the most common. For example, 43.4% of participants scored between 3 and 5.

In addition, we performed a correlation analysis to test the relationship between age and the score in the vignette. We found a small, yet significant negative correlation ($r=-0.10$).

5 | Discussion

This research presents the design and validation of a vignette questionnaire for assessing sustainability competences in secondary school students. To respond to the first research question, (1) *Does the designed assessment tool demonstrate content validity?*, 12 experts in the field of ESD carried out an exhaustive content validation to determine the validity of the questionnaire's content and give it more rigor by evaluating the suitability, relevance, and clarity of the wording of each item.

In relation to the second research question, (2) *What is the dimensionality of the designed assessment tool?*, the factor analysis showed that all the competences of the GreenComp framework belong to one dimension, and therefore, to a single sustainability competence, and not to four competence areas or dimensions, as proposed by the GreenComp framework. Although the validated version of the questionnaire does not differentiate among competence areas and specific sustainability competencies, it serves as a suitable exploratory and diagnostic tool for assessing the overall level of sustainability competence in adolescent students. This challenge of distinguishing between individual sustainability competencies has also been noted in previous studies by Laherto et al. (2023) and Ratinen et al. (2024), who developed and validated sustainability competencies' assessment tools. They suggest that the difficulty arises because sustainability competencies are inherently interrelated, making it challenging to design items that accurately measure competence areas and each individual sustainability competence separately.

Operationalizing the GreenComp framework involves certain difficulties when competences are assessed independently due to their generic conceptualization, which makes it difficult to measure them accurately (Ploum et al. 2018; Ratinen et al. 2024). It is also important to note that sustainability competencies are not acquired in isolation. When analyzing a socio-environmental or sustainability issue, it is necessary to mobilize a set of interrelated competencies simultaneously, such as action competence, systems thinking, and futures thinking (Bianchi et al. 2022; Brundiers et al. 2021). Meaningful action cannot be achieved without first understanding the complex interconnections between society and the environment, and recognizing the inherent complexity of these socio-environmental challenges (Laherto et al. 2023; Ratinen et al. 2024). While the GreenComp framework provides a well-structured theoretical model and offers a promising approach to assessing sustainability competencies, it still requires further piloting and application in real-world educational contexts to be validated through empirical evidence (Ratinen et al. 2024).

More research is needed to design assessment tools and develop a valid competence measure that makes it possible to assess each of the sustainability competences and their interconnections as well as define competences according to the specific study context (Annelin and Boström 2024; Ploum et al. 2018). When these competences are measured, it is essential to differentiate them and that each of them provides different results, which demonstrates that they measure different aspects. Thus, the results of this research agree with previous studies (Ratinen et al. 2024; Toma et al. 2024) that have also concluded that the systematization of generic sustainability competence frameworks makes sense when sustainability competences are measured together rather than individually and exclusively.

Finally, referring to the third research question, (3) *Does the designed assessment tool meet the reliability criteria?*, we have tried to be consistent with the GreenComp framework in evaluating the items, since, due to their length (originally 12 items), it is most likely that a simple structure will be found. However, three items were discarded in the discrimination analysis and factorial saturation. The items were associated with the areas of *embracing complexity in sustainability* and *envisaging sustainable futures*. These items were removed for several reasons: (1) ambiguity in the response options, particularly in assessing systems thinking competence, as students might not connect environmental effects with social ones in topics such as clothing production and consumption; (2) social desirability bias, where students might feel inclined to provide socially acceptable answers rather than reflect their actual behaviors (Ortega-Quevedo et al. 2024); (3) lack of coverage of certain individual sustainability competencies in the classroom, such as futures thinking, including futures literacy and exploratory thinking competencies, which are addressed only at the secondary education level in specific subjects like experimental sciences, social studies, and geography, in contrast to primary education, where it is approached more transversally (European Commission 2024; Julien et al. 2018); and (4) level of abstraction, as the descriptor of the exploratory thinking competence in the GreenComp framework (Bianchi et al. 2022) is difficult to adapt into an item suitable for students, being more appropriate for teachers and less applicable to learners.

Therefore, we have obtained a final version of the vignette questionnaire with nine items according to the results of the factor analysis, with adequate psychometric properties, including the saturation of the items in the factor and their reliability. However, this study acknowledges certain limitations in relation to the construction of the tool designed following the criteria set by GreenComp (Bianchi et al. 2022), as three of its 12 sustainability competencies are not included in the final validated version, being necessary to continue working on the design, development, and validation of suitable assessment tools that allow measuring individual sustainability competencies and their interconnections (Annelin and Boström 2024; Waltner et al. 2019).

On one hand, it was not possible to gather evidence on the validity of the vignettes questionnaire by studying its relationship with other variables or comparing it with questionnaires that assess similar variables because there is a lack of tools to measure that construct in our context (European

Commission; 2024; Laherto et al. 2023). To minimize this issue, we followed the construction strategies of similar tools in other countries as explained above. In fact, studies that have administered tools to assess sustainability competences in high school students, such as those of Gericke et al. (2019), Olsson et al. (2020), Sass et al. (2021) and van Harskamp et al. (2023), and particularly those who have applied vignettes in university contexts (Sandri et al. 2016; Renta-Davids et al. 2020), have also encountered similar limitations to the ones found in this study such as the need to increase the sample, and the transferability and further application to other social and educational contexts in order to provide flexibility, reliability, and cross-cultural validation. On the other hand, the study sample was limited to 389 secondary school students from seven high schools in the province of Tarragona (Spain) at a given time, which represents a possible bias in the generalization of the results at the international level. This limitation has been identified in other studies that have also developed assessment tools exclusively in a specific sociocultural context and in small, difficult-to-replicate samples (Waltner et al. 2019; Sass et al. 2021, 2023; Verhelst et al. 2022; van Harskamp et al. 2023; Sourgiadaki and Karkalakos 2023; Toma et al. 2024).

6 | Concluding Remarks

Due to the lack of literature on operationalizing the GreenComp framework for the secondary education stage, a vignette-based questionnaire has been designed to assess the GreenComp sustainability competences (see [Supporting Information: Appendix](#)) in the Spanish educational context. Specifically, this questionnaire has been cognitively validated by a group of students, and the content has been validated by experts in the field of ESD. This has allowed us to operationalize a reliable questionnaire in accordance with theoretical and psychometric standards. While the vignette questionnaire validated presents some limitations in terms of assessing or measuring individual sustainability competencies, it can be a relevant tool for evaluating a general sustainability competence in secondary school students.

Thus, the validated version of the questionnaire represents a ready-to-use brief questionnaire that can be suitable as a diagnostic tool to assess the overall level of sustainability competence in adolescent students, based on the GreenComp framework. Unlike other existing instruments at this education level, it uses vignettes to create scenarios tailored to the secondary education students' age and context, offering a competency-based approach that is closely aligned with their realities. Furthermore, this assessment tool may be of particular interest to both researchers and educators, as it can facilitate a quick and straightforward evaluation of students' initial levels of global sustainability competence. This, in turn, can enable more informed and targeted classroom planning based on students' competence levels and specific needs. It can also be used in the evaluation of educational projects and programs that wish to incorporate a sustainability perspective.

Within the ESD framework, in recent decades there has been an increasing interest in offering and designing resources, activities, and educational interventions for promoting the development of competences from different perspectives, although

there is still a need for studies that focus on designing assessment tools that measure these competences efficiently (Cebrián et al. 2020; UNESCO 2017). This research provides several contributions to the educational and ESD research community. First, the tool designed in this study is short, easy to administer, and is designed to recreate real situations with the intention of making secondary school students question their beliefs. Secondly, although the instrument does not directly measure all the individual sustainability competencies present in the GreenComp framework, the validated questionnaire provides an overview of the students' overall sustainability competence, which can be valuable for informing the design, development, and evaluation of specific ESD programs and interventions.

In future research, it is necessary to design and implement multiple assessment approaches and tools that allow a more detailed evaluation of each of the individual sustainability competences and their interconnections, as well as tools contextualized to different educational levels and to socioeconomic and cultural contexts in order to improve their effectiveness and accuracy. In the case of the GreenComp framework itself, further empirical studies are needed that help operationalize this framework in real education contexts. Therefore, it is also necessary to find clearer distinctions between the sustainability areas and competences and contribute to a better understanding of the development of sustainability competences in different age groups (Ploum et al. 2018; Ratinen et al. 2024; Toma et al. 2024).

Conflicts of Interest

The authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.