# Assessment of sustainability competencies: a literature review and future pathways for ESD research and practice

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**Abstract:**

**Aim:** This paper aims at reviewing existing theoretical frameworks in sustainability competencies and identifying suitable evaluation strategies and instruments for sustainability competencies assessment in the context of Education for Sustainable Development.

**Design / Research methods:** To gain a comprehensive view of the evaluation and assessment processes of sustainability competencies a systematic literature review was conducted using a set of keywords. After a refining phase and selection of articles centred in evaluation processes a final sample of 43 articles was analysed.

**Conclusions / findings:** Little evidence exists on the development, outcomes and impact that courses introducing students to sustainability competencies have. Further empirical research is needed on the development and implementation of assessment tools for sustainability competencies.

**Originality / value of the article:** This paper outlines the state of the art of evaluation and assessment tools for sustainability competencies in higher education and suggests pathways for further research and practice based on a systematic literature review.

*Keywords: sustainability competencies, sustainability, higher education, assessment, evaluation*

*JEL: I20, I23, J24, Q01, Q56*

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## 1. Introduction

The past two decades have witnessed increasing recognition and political agreement over the role of education as a major agent to transform current society into a more sustainable, equitable and socially just one (UNESCO 2005; United Nations 2012). This has been reflected in international and national strategy and policy development, for example the Declaration of the United Nations Decade of Education for Sustainable Development (abbr. UNDESD, 2005-2014) in 2005, the United Nations Economic Commission for Europe (UNECE) Strategy for Education for Sustainable Development (ESD) in 2011 and the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, adopted by world leaders at the United Nations Sustainable Development Summit in 2015. The Declaration of the UNDESD in 2005 acted as a catalyst to the processes of integrating the principles of education for sustainable development (ESD) into all levels of education (UNESCO 2005). According to UNESCO (2009: 2) ESD is based on "values of justice, equity, tolerance, sufficiency and responsibility," with respect as its core. The existence of diverse views of sustainability and diverse ways to embed ESD are acknowledged as a positive element to ensure that new developments are culturally and locally relevant but with "consensus around a range of key principles covering the scope, purpose and practice" (Wals 2009: 25). In an expert review, Tilbury (2011) highlighted important ESD learning processes, such as collaboration, systems thinking, innovation, and active and participatory learning. Higher education (HE) is a principal agent for addressing the current sustainability challenge that society is facing, because of its key mission of knowledge generation and transfer through research and teaching (UNESCO 2005; United Nations 2012).

Sustainability in HE calls for interdisciplinary and innovative practice to promote sustainability in all its activities (Cotton, Winter 2010). Many academics in the field of sustainability in HE claim a paradigm shift – an epistemological change – is needed towards sustainability that is based on holism, critical subjectivity and systems-thinking (Sterling 2004). The curriculum, pedagogy, structure, organisation and ethos are shaping dimensions of education; therefore embedding sustainability implies a cultural change rather than an add-on to existing curricula and structures.

ESD can foster a sustainable social transformation, through the clarification and reassessment of values; it should be creative, innovative and constructive, culturally appropriate and action-orientated (Tilbury, Wortman 2004).

To date a number of universities worldwide have signed international declarations and have publicly committed to embed sustainability within their campus, outreach, education and research (Wright 2010). However, despite the declaration of good intentions and the development of policies and strategies at the national and international level, little has been achieved in terms of embedding sustainability holistically in the HE curriculum (Cebrián et al. 2015). Most of the research in the field has focussed on: environmental management and greening of university estates and operations; descriptive case studies and examples of good practice of universities; embedding sustainability in specific courses such as environmental sciences, business and engineering; theoretical developments on teaching and learning approaches towards sustainability; university and policy analysis (Barth, Rieckmann 2016; Cotton et al. 2009; Fien 2002; Wright 2010). The lack of theorisation of research conducted in the field has been criticised for often leading to descriptive and non-theoretical accounts (Corcoran et al. 2004; Fien 2002). It could be argued that the focus has been on explaining part of the stories of transformation, as papers have concentrated on the achievements and positive experiences without paying sufficient attention to the barriers to progress and the process of change per se (Velazquez et al. 2005). The environmental management and greening of campus operations and estates has seen much more progress than curriculum development (Verhulst, Lambrechts 2015).

Emergent research in the field of sustainability in HE has explored the learning outcomes and competencies that educational programmes need to seek to develop in students for them to become change agents towards sustainability (Cebrián, Junyent 2015; Wiek et al. 2011). Despite the divergence in the usage of different concepts such as abilities, learning outcomes and competencies, and the existence of some criticisms around the usage of these terms, there is a need to define competencies in sustainability in order to foster curriculum developments and innovations. Developing sustainability competencies amongst graduates is particularly critical to the development of sustainability literacy and students becoming positive change

agents in their workplace and personal lives (Sipos et al. 2008). However, little evidence exists on the development, outcomes and impact that courses introducing students to these competencies have (Wiek et al. 2011). Further empirical research is needed on the development and implementation of assessment tools for sustainability competencies.

## 2. The Edinsost project

This paper presents a systematic literature review to identify the state of the art of evaluation and assessment tools for sustainability competencies in higher education, which served as the basis to guide the EDINSOST research project, "Education and social innovation for sustainability. Training in Spanish Universities of change agent graduates to meet challenges in society." In this project, funded by the Spanish Government, ten universities are working together with the goal of creating synergies and common frameworks and criteria to integrate sustainability competencies, learning processes and assessment tools. Project objectives are to: 1) Define the map of sustainability competencies of university degrees covered by the project and establish the framework to facilitate their integration in a holistic manner; 2) Validate teaching strategies for the acquisition of sustainability competencies, from a constructivist and community oriented pedagogical approach (Simulacion, Case studies, Service Learning, Problem Based Learning and Project oriented learning; 3) Diagnose the state of faculty sustainability training needs and develop and pilot training proposals; and 4) Diagnose the state of learning of sustainability competencies of higher education students and prepare and pilot training proposals. This paper outlines existing theoretical frameworks in sustainability competencies, presents a comprehensive systematic literature review of recent literature in sustainability competencies' assessment, and suggests suitable assessment strategies and tools, and pathways for further research and practice.

## 3. Research process

Systematic literature reviews are a commonly used in social and educational sciences to map the state of the art of specific fields of study. The aim is to conduct a systematic, replicable and transparent search and analysis process (Fink 2009). Recent studies have reported on systematic literature reviews in the area of sustainability in HE, which include quantitative and qualitative approaches (Barth, Rieckmann 2016). For example, Lozano et al. (2017) have used hermeneutics and grounded theory to create a framework to connect sustainability competencies and pedagogical approaches. Jim Wu and Shen (2016) used a mix-method approach to outline research topics that emerged during the UNDESD. Likewise, Figueiró and Rauffle (2015) conducted a systematic review to map and evaluate the status of sustainability in management education. In a Mindt and Rieckmann (2017) systematic literature review the state of the art concerning teaching-learning approaches and methods for sustainability-driven entrepreneurship in higher education was outlined. Finally, Barth and Rieckmann (2016) outline a bibliometric overview, which combines quantitative analysis with a qualitative analysis of content areas and research methodologies in the field of HE for sustainability.

Gaining a comprehensive overview of the evaluation and assessment processes of sustainability competencies in HE is essential to tackle the second objective of the Edinsost project, which is focused on validating teaching strategies for the development of sustainability competencies, from a constructivist and community oriented pedagogical approach. For this reason, a systematic review of existing research and practice focused on the design and development of sustainability competencies assessment strategies and tools has been conducted.

The data collection process consisted of a search in the 2 main databases: Web of Science and Scopus. These are the more relevant and comprehensive databases covering social and educational sciences. The literature search was conducted using the following keywords: ("higher education" OR "university" OR "universities" OR "tertiary education" OR "college") AND ("education for sustainability" OR "education for sustainable development") AND ("assessment" OR "evaluation"). This search produced a total of 80 hits in Web of Science and 121 in Scopus. A

second phase consisted of refining the sample, removing duplicates and selecting only articles that are peer-reviewed. In a third phase, articles focusing explicitly in the assessment process, including the design of assessment or evaluation tools and studies focusing on identifying students' knowledge, attitudes and/or competencies development were selected. This led to a final sample of 43 articles (figure 1). Going through the steps of (1) data collection, (2) data processing and coding and (3) data analysis, we produced an overview that combines quantitative and qualitative analysis of content areas and evaluation strategies and instruments used.

**Figure 1. Diagram of the research process**
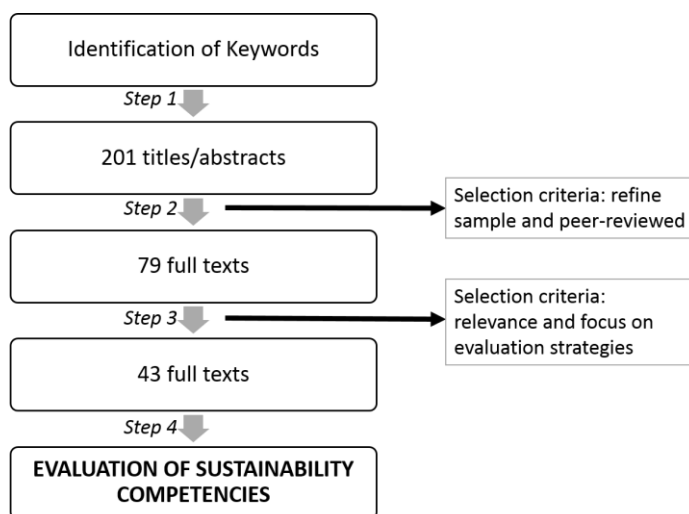


Source: Authors' own elaboration.

## 4. Results of the systematic literature review

In this section the results of the review are provided. First, existing theoretical frameworks of sustainability competencies. Second, the results in relation to evaluation and assessment processes of sustainability competencies, providing a general overview of publications by year and journal, are outlined. Third, the

content of the articles is characterised by the object and focus of the assessment, and the type of evaluation and assessment tools used. Forth, previous studies on students' perceptions, attitudes and behaviours in sustainability. Finally, assessment approaches of sustainability in university programmes and curriculum.

## 5. Sustainability competencies frameworks

Emergent research in the field of sustainability in HE has explored the learning outcomes and competencies that educational programmes need to seek to develop in students for them to become change agents towards sustainability (Mochizuki, Fadeeva 2010; Sipos et al. 2008; Svanström et al. Rowe 2008; Wiek et al. 2011). However, it is not possible to describe a mandatory set of competencies for sustainability because of the variety of the definitions of the terms sustainability and competence in educational settings (Mochizuki, Fadeeva 2010). Despite the divergence in the usage of different concepts such as abilities, learning outcomes and competencies, and the existence of some criticisms around the usage of these terms, there is a need to define competencies in sustainability in order to foster curriculum developments on ESD (Wiek et al. 2011). De Haan (2010) introduces the elements of the sustainability competence or *Gestaltungskompetenz*. It expresses the abilities and competencies of students in contexts of sustainability and can be defined as the ability to shape future scenarios by active participation in modelling and transforming society towards sustainable practices (Barth et al. 2007). According to De Haan (2010) the elements of sustainability competence are:

- Competence to think in a forward-looking manner, to deal with uncertainty, and with predictions, expectations and plans for the future.
- Competence to work in an interdisciplinary manner.
- Competence to achieve open-minded perception, transcultural understanding and cooperation.
- Participatory competence.
- Planning and implementation competence.
- Ability to feel empathy, sympathy and solidarity.

- Competence to motivate oneself and others.
- Competence to reflect in a distanced manner on individual and cultural concepts.

Rieckmann (2012) conducted a Delphi study in which sustainability key competencies were defined by experts from Europe and Latin American, where systemic thinking, anticipartory and critical thinking emerged as the most relevant ones. Moreover, in a recently conducted literature review and framework proposal (Lozano et al. 2017) a set of twelve sustainability competencies have been identified: systems thinking; interdisciplinary work; anticipatory thinking; justice responsibility and ethics; critical thinking and analysis; interpersonal relations and collaboration; empathy and change of perspective; communication and use of media; strategic action; personal involvement; assessment and evaluation; and tolerance for ambiguity and uncertainty.

Developing these competencies amongst graduates is particularly critical to the development of sustainability literacy (Stibbe 2009) and students becoming positive change agents in their workplace and personal lives (Sipos et al. 2008). The use of certain type of pedagogies, and teaching and learning approaches and strategies such as project-based learning, service learning and action learning (Bessant et al. 2013; Thomas 2009), foster the competencies or skills necessary to deal with sustainability, such as critical and creative thinking, problem-solving skills, action competence, collaboration, and futures thinking, therefore creating empowered and globally responsible citizens and professionals who can become active change agents (Wals 2010).

In terms of learning outcomes, Sipos et al. (2008) developed the transformative sustainability learning (TSL) framework and conducted three case studies on courses related to sustainability and citizenship. They concluded that courses that were engaging students in a cognitive, psychomotor and effective sphere enhanced TSL (Sipos et al. 2008). Wiek et al. (2011) conducted a literature review on existing studies and frameworks on competencies on sustainability and developed an integrative framework on key sustainability research and problem solving competencies, namely *"systems-thinking competence, anticipatory competence, normative competence, strategic competence, and interpersonal competence"* (Wiek

et al. 2011: 205). Other research in the area has also developed competence frameworks for specific subject areas: engineering (Mulder et al. 2012), teacher education (Cebrián, Junyent 2015; Sleurs 2008), and educators at all levels of education (UNECE 2012). Research has also looked at the inclusion of sustainability competencies in the programme descriptors of undergraduate degrees (Cortés et al. 2010; Lambrechts et al. 2013; Segalàs et al. 2009). Thus the relevance of developing key competencies on sustainability has been acknowledged by international agencies such as UNESCO (2005; 2017), UNECE (2009) and for accreditation agencies (ABET 2017; Engineering Council 2013). UNESCO has recently published a set of learning objectives for each of the 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development (UNESCO 2017). Also, UNECE commissioned a group of ESD experts to develop a framework on ESD competencies for educators (UNECE 2012). The UNECE framework is based on Delors' four pillars of education (Delors 1996). Table 1 summarises the UNECE ESD competencies for educators framework.

**Table 1. UNECE framework on ESD competencies for educators**

| Domains | Brief description |
|---|---|
| **Knowledge** | Learning to know refers to understanding the challenges facing society both locally and globally and the potential role of educators and learners (The educator understands...); |
| **Interpersonal competency** | Learning to live together contributes to the development of partnerships and an appreciation of interdependence, pluralism, mutual understanding and peace (The educator works with others in ways that...); |
| **Ethics and values** | Learning to be addresses the development of one's personal attributes and ability to act with greater autonomy, judgement and personal responsibility in relation to sustainable development (The educator is someone who...). |
| **Practical skills** | Learning to do refers to developing practical skills and action competence in relation to education for sustainable development (The educator is able to...); |

Source: Adapted from UNECE (2012: 13-14).

However, as this is a relatively new and emerging area of research, little evidence exists on the development, outcomes and impact that courses introducing

students to these competencies have (Lozano et al. 2017; Wiek et al. 2011). Further empirical research is needed on the development and implementation of assessment tools for sustainability competencies (Cebrián, Junyent 2015; Sleurs 2008). There is still further research to be conducted to implement innovative and transformative teaching and learning approaches and transformative institutional strategies that lead to sustainability competencies (Barth, Rieckmann 2016; Sterling et al. 2017). Therefore, as stated by Wiek et al. (2016) the research agenda in the following years needs to focus on operationalising sustainability competencies, framing the different levels of competence and measuring and evaluating students' competencies development.

A tendency exists to focus on developing competencies' frameworks without paying sufficient attention to the individual and cultural context, and the organisational change processes required to achieve embedding ESD (Mochizuki, Fadeeva 2010). Developing innovative courses that consider sustainability competencies can foster transformative learning amongst students but also engage stakeholders and the community, and in turn contribute to generate organisational change in the context of HE by opening up innovative programme designs (Mochizuki, Fadeeva 2010).

## 6. General overview of publications focused on evaluation and assessment processes of sustainability competencies

The review shows that the 43 research articles identified, with focus on evaluation and assessment processes of sustainability competencies, were found between the period of 2005 and 2017. After 2005 there is an increasing tendency due to the catalyst or lever effect of the UN Decade on Education for Sustainable Development (UNESCO 2005), with a pick in 2015 coinciding with the end of the decade and with the hold of special issues in ESD of non-specific sustainability journals (figure 2). As stated in the previous sections, this a relatively new and emerging research area, so it is expected an increasing body of literature focused on the design and development of innovative teaching and learning methods, and assessment tools for sustainability competencies in the next years (Wiek et al. 2016).

**Figure 2. Distribution of the research articles focusing on evaluation processes of sustainability competencies**
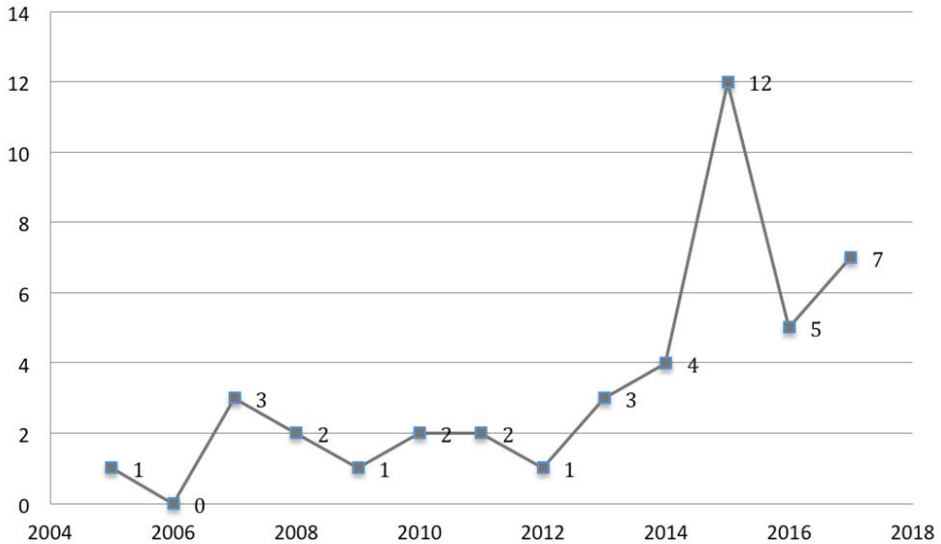


Source: Authors' own elaboration.

Regarding the distribution by journal (Figure 3), the "Journal of Cleaner Production and International Journal of Sustainability in Higher Education" emerged as the most numerous sources, with a 21% of the total publications each. The following largest source is Environmental Education Research with a 9% of the total of publications both. The scope of all these journals are to help advance understanding of environmental issues, sustainability and ESD through focusing on papers reporting research in the area. Also, the journal Assessment & Evaluation in Higher Education has a 9% of total publications, due to a Special Issue in assessment and evaluation of sustainable development in HE in 2015.

**Figure 3. Distribution of the research articles by journal**
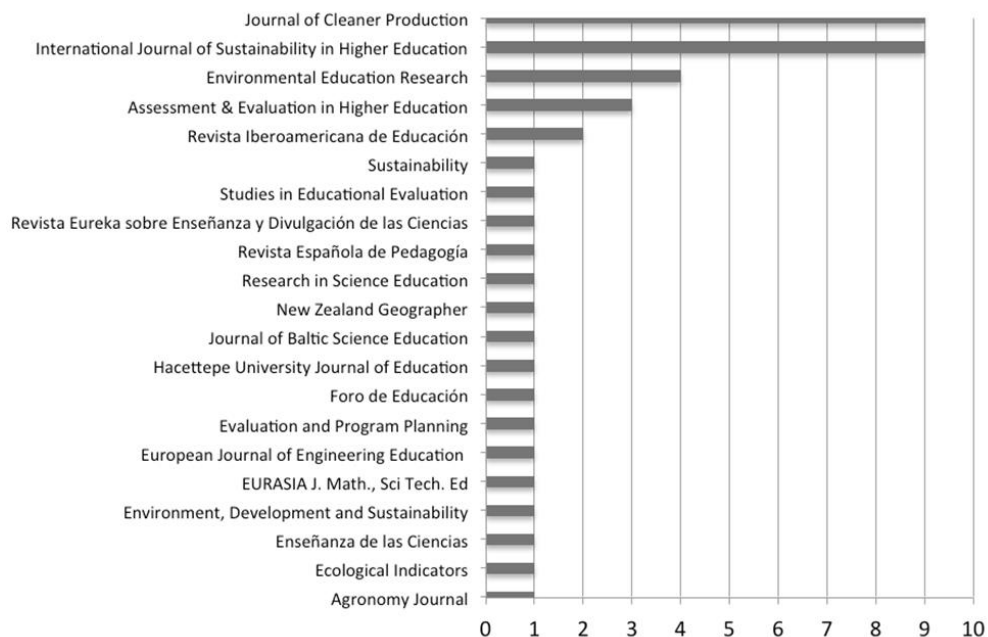
A word cloud of the keywords of the 43 papers was conducted, where the common keywords education, Education for Sustainability, Education for Sustainable Development, Sustainability and Sustainable Development were removed in order to provide a more detailed overview of relevant keywords. The word cloud shows a set of predominant keywords such as learning, assessing, curriculum, curricula, competences, campus and environmental (Figure 4). It also provides some insights into other commonly used words such as attitudes, values, outcomes, system, engineering and teacher amongst others. This shows the focus on engineering and teacher education studies, and attitudes, values and learning outcomes.

**Figure 4. Word cloud of keywords**



Source: Authors' own elaboration.

## 7. Tools for the evaluation and assessment of sustainability performance amongst students

The articles were analysed in relation to the object of the evaluation or assessment (Figure 5), 33% of the articles focus on evaluation and assessment of sustainability competencies, skills and outcomes, 23% explore the perceptions, understandings, attitudes and behaviours of students and 21% have the goal of designing assessment tools for students' learning, programmes of study or the sustainability performance of universities. Finally, 14% of the papers found centered in the assessment of the inclusion of sustainability in specific university programmes or courses and only 9% in assessing students' knowledge and understandings of sustainability.

**Figure 5. Object of the evaluation and assessment publication**
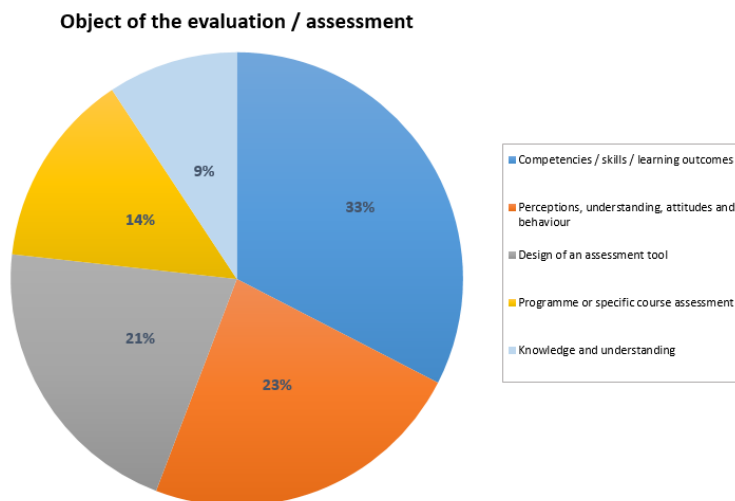


Source: Authors' own elaboration.

From the set of articles assessing competencies, skills or learning outcomes a diversity of contexts, subject areas and tools are found. For example, Cebrián and Junyent (2015) created an open-ended questionnaire to explore teacher students' perceived ESD competencies. Nikel (2007) used survey questionnaires, narrative tasks and an interview to study the perspectives of 30 student teachers about ESD competencies. Segalàs, Ferrer-Balas and Mulder (2008; 2010) undertook a 5-year research project to analyse how sustainability competencies were introduced into technological universities. Conceptual maps were used as assessment tools of sustainability competencies. Habron, Goralnik and Thorp (2012) assessed undergraduates' systems thinking competency through a short answer exam, online interactive small group dialogue exam, homework assignments, completion of an online community engagement tutorial, and completion of a final reflexive project (either in a group or individual). Mercer et al. (2017) used educational game design to foster design thinking and communication skills amongst students and assessed students' development using questionnaires and qualitative feedback. Moreover, Warr et al. (2017) designed and assessed the impact of a cross-disciplinary place-

based learning initiative on both the operational and student learning outcomes. Hegarty et al. (2011) evaluated student-learning outcomes in a stand-alone course on sustainability through critical analysis of articles, ecological footprint calculator and field-specific problem analysis (PBL). Rose, Ryan and Desha (2015) undertook a curriculum renewal to embed sustainability into a first year engineering curriculum and used "before and after surveys" to evaluate learning outcomes. Furthermore, Shephard et al. (2015) used a longitudinal mixed-effects repeat-measures statistical model to assess the development of affective outcomes related to sustainability. Pretorius, Lombard and Khotoo (2016) used evidence-based reflection to provide a narrative assessment of the experience gained with Inquiry-based in two undergraduate sustainability-focussed modules in open and distance learning at the University of South Africa. In recently published research, García, Junyent and Fonolleda (2017) have developed a rubric to assess professional competencies in ESD. Likewise, Sandri, Holdsworth and Thomas (2018) propose an assessment tool, based on a scenario/vignette question design, to capture data on sustainability graduate attributes in context and has the potential to be used across universities to enable comparative research.

Regarding the type of evaluation, there are only 25 cases that specify what type of evaluation is conducted. Of these, 19 correspond to summative evaluation and 6 to formative evaluation. Regarding the involvement of students in their own evaluation, only 6 cases out of 25 use self-assessment tools. When analysing the assessments tools, the most commonly used is the survey and questionnaire (used in 20 cases), followed by reflexive diary (used in 5 cases) and interviews (used in 4 cases) (Figure 6). One of the main reasons why questionnaires are used, is because it is less time-consuming, easy to distribute amongst a larger number of students and in turn it provides a larger amount of information. The challenge is that questionnaires do not allow obtaining other type of information regarding the process of learning itself.

**Figure 6. Type of assessment tools used**
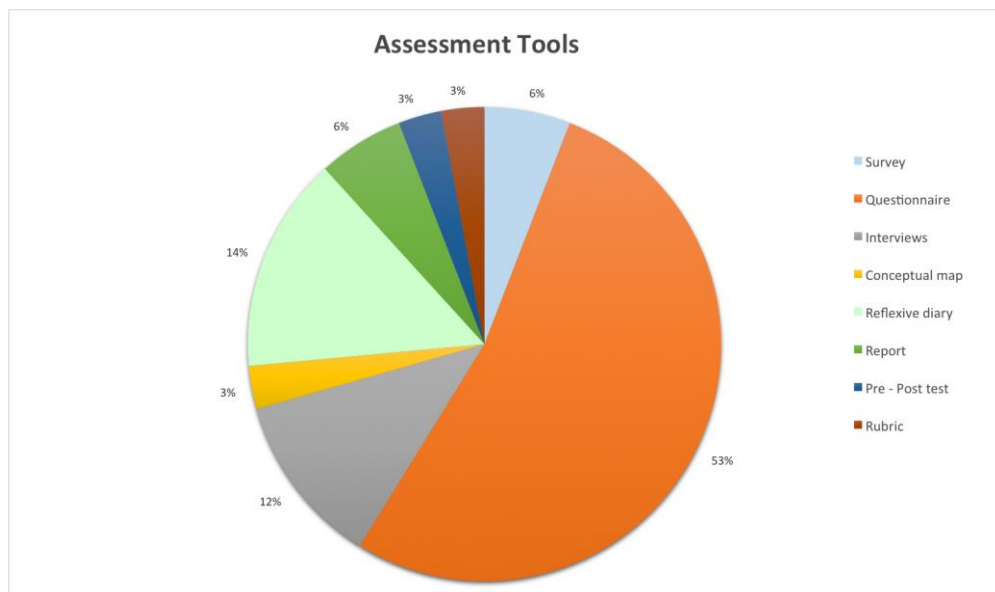


Source: Authors' own elaboration.

As the findings of the literature review show, a variety of tools are suggested and used to assess competencies and learning outcomes. Therefore, using a range of assessment tools can be positive to gain a more comprehensive overview of the development of sustainability competencies. However, this also mirrors the lack of a common framework of sustainability competencies and effective teaching and learning approaches that help students develop these competencies (Sterling et al. 2017). Further research is needed to design and validate instruments for assessing and monitoring students' sustainability performance (Barth, Rieckmann 2016).

## 8. Studies on students' perceptions, attitudes and behaviours in sustainability

Most of the studies exploring university students' perceptions, understanding, attitudes and behaviour have used questionnaires or surveys (Azapagic et al. 2005; Kagawa 2007; Murga-Mentoyo 2008). For example, Biasutti and Frate (2017) developed and validated a quantitative 20-item scale that measured Italian university

students' attitudes towards sustainable development. Mosher and Desrochers (2014) conducted a pretest posttest study to evaluate the impact of a sustainability workshop in changing students' behaviour. Moreover, Solís-Espallargas and Valderrama-Hernández (2015) explored the change of perception of teacher students due to a specific module on ESD through action-research and pre- post-questionnaires. In a study conducted in Australia a values approach was outlined to incorporate sustainability concepts into business courses (Sidiropoulos 2014). Student feedback showed how a values approach to ESD effectively produces changes in values, attitudes and behaviour over time, building graduate capability in sustainability.

Furthermore, other papers appeared in the search that focus on university educators' perceptions, knowledge or sustainability competencies. Aznar, Ull, Piñero and Martínez-Agut (2017) used an evaluative research based on a quantitative approach to assess the impact of the inclusion of sustainability within the teacher education curriculum. They used questionnaires and in-depth interviews with faculty to evaluate their knowledge, perception and attitude towards sustainability directly impacting on the training of future teachers. Cebrián (2015; 2017) conducted a collaborative action research with academic staff to foster critical reflection and action towards embedding ESD in teaching practice. Findings showed how action research enabled a change of vision and understanding of ESD and endorsed new teaching practices. Roberts and Roberts (2008) hosted a staff development event to provide a space for exchanging and sharing innovative practice in ESD in the university context.

## 9. Assessment of sustainability in university programmes and curriculum

Also research focused on the assessment of the inclusion of sustainability in university programmes and curriculum in different universities appeared in the review (Watson et al. 2013). Specific tools have been designed for this purpose, such as Sustainability Tool for Assessing University's Curricula Holistically (STAUNCH) (Glover et al. 2011). This was used across the Welsh higher education sector and emerged as a valuable tool for recognising what is being offered in the

curriculum about sustainability. However, it does not reflect the quality or effectiveness of the curriculum content (Glover et al. 2011). Other studies (Lambrechts et al. 2013) have evaluated the presence and integration of sustainability competencies in different programmes and curricula. Makrakis and Kostoulas-Makrakis (2016) conducted a sequential mixed methods evaluation in RUCAS programme "Reorientation of University Curricula to Address Sustainability (RUCAS): A European Commission Tempus-funded Programme." Using both qualitative and quantitative approaches in combination in an iterative evaluation process was found useful to enrich and produce more robust results. Sustainability assessment tools for sustainability programmes have been characterised, which include indicators and criteria for university performance in management, operations, estates, curriculum and outreach. For example, the INDICARE-model assesses participatory processes in HE's sustainability initiatives (Disterheft et al. 2016). As pointed out by Fischer, Jenssen and Tappeser (2015) in a comparative analysis of 12 assessment tools for sustainable universities, these have become more than instrumental facilitators of change. They have also established normative standards by framing what fields and issues should universities engage with.

## 10. Conclusions

As the findings of this review indicate a variety of frameworks of sustainability competencies and learning outcomes have been suggested (Wiek et al. 2011). This mirrors the lack of common definitions and frameworks, and the importance of defining common frameworks of sustainability competencies. This is a previous necessary step to create innovative teaching and learning, and transformative institutional approaches that can lead to sustainability competencies (Barth, Rieckmann 2016). So far little evidence exists on the development, outcomes and impact that courses introducing students to these competencies have (Lozano et al. 2017). The research efforts in the next years need to be put on operationalizing

sustainability competencies and developing tools to measure and evaluate students' competencies development (Cebrián, Junyent 2015).

From the articles analysed in this review, a divergence in the object and focus of the evaluation and assessment is observed, which includes competencies, skills, outcomes, perceptions, attitudes and behaviours of students. Also, different assessment approaches and tools are used, such as questionnaires, reflexive diaries, interviews, narrative tasks, scenario/vignette question design, conceptual maps and pre-post-test amongst others. The results indicate that most of the papers published centred in summative evaluation rather than formative or self-assessment. Using a range of assessment tools can be positive to gain a more comprehensive overview of the development of sustainability competencies. However, it is critical to develop effective teaching and learning approaches that help students develop these competencies (Sterling et al. 2017), jointly with the design and implementation of summative, formative and self-assessment tools.

Over the last years, there has been a rapid increase on the number of publications regarding the assessment of sustainability competencies. Also it is plausible an emergent diversification of the assessment tools used. Questionnaires have been commonly used to assess or explore students' knowledge, attitudes and behaviours towards sustainability. Other tools have been identified as suitable to assess sustainability competencies such as reflexive diaries, interviews, conceptual maps, rubrics and scenario/vignette visioning (Sandri et al. 2018). There is an emergent literature on qualitative assessment tools such as interviews and reflexive diaries or portfolios that facilitate the assessment of more normative sustainability competencies. However, still a lot of the articles focus on summative evaluation rather than formative or self-evaluation assessment. Thus developing formative and self-evaluation tools is needed in order to get a more comprehensive overview of students' learning process and sustainability competencies.

However the emergence of studies on the design of assessment tools, it is still necessary to conduct further developments and research in this area. Based on the review conducted, authors suggest the following pathways for future research and practice that will improve the assessment methodology and tools of sustainability competencies:

- Conduct longitudinal studies using summative, formative and self-assessment tools within HE and in the professional life of graduates, which can provide evidence of the development of sustainability competencies through higher education studies and in the posterior professional life.
- Carry out comparative analysis of different assessment tools against sustainability competencies. This would provide evidence on the effectiveness of different assessment tools.
- Design and test assessment tools in line with ESD principles such as critical thinking, collaboration, teamwork and systems thinking.
- Develop specific rubrics for each sustainability competence and adapt them to different programmes and contexts.

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