ESD action competencies of future teachers: self-perception and competence profile analysis

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Abstract

Purpose – This study aims to analyse the self-perception of future secondary school teachers (FTs) of biology about their education for sustainable development (ESD) competencies and evaluate the competence profile they develop in their educational proposals.

Design/methodology/approach – A mixed methodological approach was used to analyse 162 FTs' ESD action competencies as proposed by UNECE. Firstly, a six-point Likert-type scale questionnaire is used to explore their self-perception of the level of acquisition of these competencies. Then, a rubric is applied to analyse the competence profile when designing educational proposals to address socio-environmental issues related to consumption and waste generation. Besides descriptive analysis, inferential statistics were used to assess the significance of the differences detected between the competencies.

Findings – FTs self-perceive a partial acquisition of ESD action competencies, in line with their competence profile. Where they recognise and show significant difficulties is in assessing learning outcomes in terms of changes and achievements. Similarly, their best perception and competence profile is achieved in the approach to contextualised situations in the students' lives. There are also some discrepancies between their perception and their profile. In particular, FTs regard themselves as very competent in considering different dimensions and perspectives of the issues, but this is precisely where they reveal a lower competence profile.

Originality/value – This study applies a fully replicable rubric for the assessment of teachers' ESD competencies when designing proposals to address socio-environmental issues. This assessment allows one to approach the sustainability competencies that they will promote in their classrooms.

Keywords Secondary school, Competence profile, Educational proposals, ESD action competencies, Future teachers

Paper type Research paper

1. Introduction

Education for sustainable development (ESD) plays a central role in advancing the paradigm shift towards more sustainable behaviours (Barth and Rieckmann, 2016; UNESCO, 2017). However, recent research has identified that the implications of ESD for education practitioners are unclear (Redman *et al.*, 2018). For Vare *et al.* (2019), the lack of competencies among educators appears to be the most important bottleneck facing the promotion of ESD.

Among teachers, positive attitudes towards ESD prevail during their initial training, but they are more pessimistic during their teaching work (Álvarez-García *et al.*, 2018). Therefore, it remains essential to prepare teachers for the challenge of implementing ESD in school

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settings by encouraging them to acquire ESD competencies to create appropriate classroom learning situations (Rieckmann, 2018; Ferguson *et al.*, 2021). Although most studies on ESD in the professional sphere of future teachers use measurement instruments on behaviours, attitudes, beliefs towards sustainability or perceptions about their preparation (Andersson *et al.*, 2013; Van Petegem *et al.*, 2007; Vega-Marcote *et al.*, 2015), very few use a competence framework for their assessment (García *et al.*, 2017; Vare *et al.*, 2019). Hence, according to Cebrián and Junyent (2015), further research is needed on the levels of achievement in the acquisition of ESD competencies by teachers and future teachers.

Indeed, some authors noted that there are very few precise formulations of competencies that translate into models or measurement tools (Waltner *et al.*, 2019), and they point out that operationalising these competencies into observable performances might be a solution. In support of this, García *et al.* (2017) designed a rubric for assessing ESD competencies using the framework developed by the United Nations Economic Commission for Europe (UNECE, 2013) as a reference. They considered their research as a methodological contribution and a starting point for future studies on the assessment of the ESD competencies of education professionals. This work aims to continue in this direction and to delve deeper into the projection of these competencies in their work as teachers, based on what they propose as appropriate teaching–learning contexts (Ferguson *et al.*, 2021).

2. Theoretical framework

2.1 Sustainability and education for sustainable development competencies

ESD should enable citizens to reflect on their own actions, considering the current and future socio-ecological effects of said actions from a local and global perspective (Rieckmann, 2018). However, the authors consider that substantial progress is not necessarily being made towards achieving more sustainable behaviours in citizens (Barth, 2015). Some research agrees that the lack of clarification of the basic concepts behind ESD may be contributing to slow progress towards ESD goals and assessment (Shephard *et al.*, 2019; Waltner *et al.*, 2020).

The competencies approach to education was popularised at the beginning of this century, with initiatives such as "Definition and Selection of Competencies (DeSeCo)" (Rychen and Salganik, 2000). In sustainability education, it seems that it took several years to gain popularity, although, for Barth (2015), its adoption has increased since then. Nevertheless, more recent literature on sustainability competencies reveals a certain degree of conceptual ambiguity because the term competence "is associated with skills, abilities, capabilities, capacities, qualifications, and other concepts" (Vare *et al.*, 2019, p. 2). Thus, it seems possible to associate the term competencies with a sea of labels, which can lead to terminological confusion (Sterling *et al.*, 2017). In this regard, Shephard *et al.* (2019) discuss the use of the terms "competence" and "capability" in relation to learning outcomes in ESD. As a result, they point to substantial internal inconsistencies between students' capabilities and their willingness to put them into practice. For Waltner *et al.* (2020), this debate represents a major challenge for both ESD goal setting and assessment.

Further, in line with Vare *et al.* (2019), avoiding confusion between competencies for sustainable development and ESD competencies is essential. Often, teachers only focus on the competencies that students need to develop but not on the competencies that they themselves, as educators, need to acquire. However, it should be highlighted that this demarcation is not so precise, as there is a clear relationship between competencies for sustainability and ESD competencies, firstly, because the latter, developed in the teacher, aim to work on and develop the former in the students (UNESCO, 2017), and, secondly,

because the teacher, besides ESD competencies, also needs general sustainability competencies (Rieckmann, 2018).

Different authors have coincided in delimiting and describing these general sustainability competencies (Barth *et al.*, 2007; Lambrechts *et al.*, 2013; Rieckmann, 2012; Wiek *et al.*, 2011). Among all of them, Redman and Wiek (2021) updated the previous work of Wiek *et al.* (2011), where they redefine what they call *key competencies in sustainability*. These authors identify eight key competencies, described as capacities, that are considered indispensable for a critical citizenship that participates in a responsible and informed way in the decision-making required by current socio-ecological challenges. These competencies are systems thinking, futures thinking, values thinking and strategies thinking and implementation, interpersonal, intrapersonal and integration competencies.

In terms of competencies for ESD, different frameworks have been studied and proposed. Bertschy *et al.* (2013) focus their competence model on the teacher as a professional working on sustainability in early childhood and primary classrooms. While others, such as the CSST framework (Sleurs, 2008) and the KOM-BINE model (Rauch and Steiner, 2013), describe the competencies needed in three areas of teacher performance. Both papers are focused on the competencies that enable teachers to promote sustainable development as individuals, as agents in educational institutions and as members of a given society.

However, this research is aligned with the UNECE (2013) competence framework that requires teachers to contribute to ESD from within their professional sphere, focusing on what Delors *et al.* (1996) consider to be the four "pillars of knowledge" (p. 95): knowing, doing, being and living together. Thus, UNECE (2013) establishes ESD teacher competencies as what teachers need to understand, to do, to be and how they need to live and work with others, and groups these competencies around three characteristics of ESD: a holistic approach, envisioning change and achieving transformation (Figure 1).

To promote sustainability in education, it is therefore essential that educators are competent in sustainability and ESD based on their own education and training (Rieckmann, 2018). The authors link the mobilisation of these competencies to their being carried out in the classroom and to their influence in the school context (Timm and Barth, 2020).

2.2 Education for sustainable development competencies of future teachers

It is our conviction that teachers are key actors in engaging and facilitating their students to develop the action competencies needed to achieve sustainability goals (Ferguson *et al.*, 2021; Varela-Losada *et al.*, 2021). They would have the capacity to reach a young population that has not yet set its habits and commitments, and in turn, they could also influence the intentions and decisions of their families and society at large (Goldman *et al.*, 2021; Kolbe, 2015).

Enhancing educators' capabilities to more effectively promote ESD is a priority area for action for UNESCO (2017). This would require incorporating into teacher education an ongoing commitment to the pursuit of more sustainable futures in their daily decisions (UNESCO, 2019; García *et al.*, 2017) and the development of pedagogical strategies for ESD practice in the classroom (Darling-Hammond *et al.*, 2017; Murphy *et al.*, 2021).

Nevertheless, it is rare to observe transformative practice among teachers with regard to the organising and undertaking of activities that could influence the behaviour of their students (Ferguson *et al.*, 2021; Rodríguez and Barth, 2020). Their proposals tend to be based on their own perceptions of sustainability, which can result in an education that is inconsistent with the intended purpose (Gustafsson *et al.*, 2015). Furthermore, although

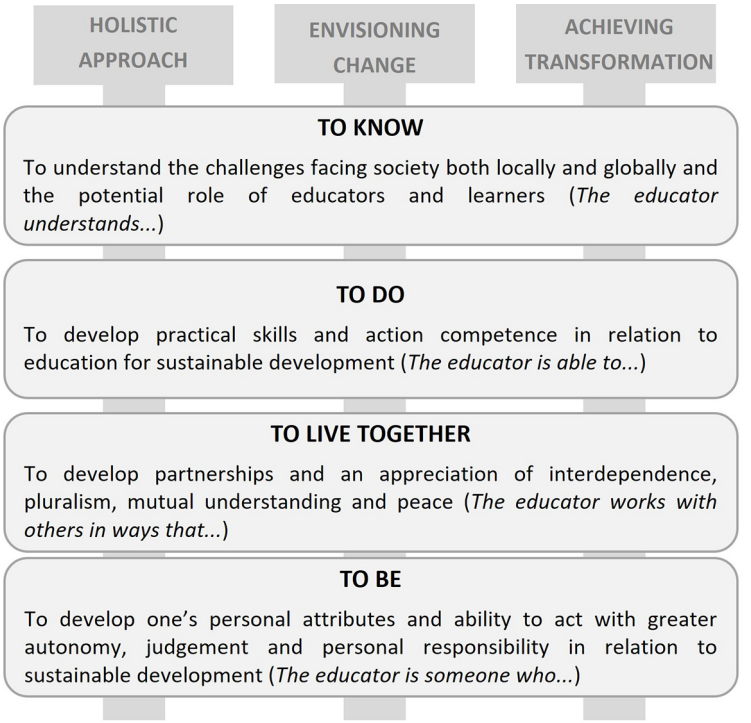


Figure 1.
Framework for ESD teacher competence

Source: Authors' own work adapted from UNECE (2013)

trainee teachers are often concerned and aware of the need to address socio-ecological issues in the classroom, many do not feel able to drive the necessary transformation to promote any solid commitments from the classroom (Martínez-Borreguero *et al.*, 2020; Redman and Redman, 2014; Varela-Losada *et al.*, 2021). Indeed, future teachers often question their own ability to adequately address sustainability issues and guide their students towards responsible decision-making (Dahl, 2019; Solís-Espallargas *et al.*, 2019). Thus, at the end of their training period, they point out the need for further training on how to work with these socio-ecological issues in their classrooms (Skarstein, 2020; Waltner *et al.*, 2020).

As a result, there is a tendency to adopt conventional practices in their classrooms rather than innovative educational approaches, widening the gap between the desire to integrate ESD in the classroom and its actual implementation (Redman *et al.*, 2021). For Pegalajar-Palomino *et al.* (2021), these shortcomings in adequately addressing sustainability issues in their professional practice support the need for research such as this oriented towards "to do" competencies. So, further emphasis can be placed on teacher training in this area (Álvarez-García *et al.*, 2018; Falkenberg and Babiuk, 2014).

3. Objectives

In this paper, two objectives in relation to the UNECE (2013) ESD action competencies or "to do" competencies are set out, which are those focusing on practical skills and action competencies:

- to analyse the self-perception of future secondary school teachers (FTs) regarding the degree of development of these competencies; and
- to assess the level of competence that FTs develop when designing an educational intervention aimed at secondary school students.

4. Methodological approach

The research design approach was mixed, integrating qualitative and quantitative methods of data collection and analysis, providing a better understanding of the research objective (Ivankova and Plano Clark, 2018).

4.1 Participants

The study was carried out over five academic years at the University of Murcia (Spain). It involved 162 FTs studying for a Master's degree in secondary education specialising in Biology, who represent the entire group each academic year. The groups of students were equivalent each year: between 30 and 40 students, whose average age was 26.4 years old (SD = 3.6). They were selected on a non-probabilistic basis and because of their ease of access. All of them had received training in science didactics before data collection.

4.2 Data collection and analysis

4.2.1 Tools for data collection. To analyse prospective teachers' self-perception of the degree of development of ESD teaching competencies, a six-point Likert-type scale questionnaire was used. This questionnaire consists of eight items, which correspond to the ESD competencies "to do" (UNECE, 2013), slightly adapted to the activity (Figure 2).

To assess the degree of development of these "to do" competencies in ESD, FTs were asked to design a teaching proposal on the issue of mass waste production. As suggested by Sinakou *et al.* (2023), the teaching material they design can be a suitable source of data collection for the evaluation of teaching practices in ESD.

The questionnaire and the design of the teaching proposals were completed by the 162 TFs individually in written form in the regular classroom at the end of the training block on educational innovation. The time invested in completing the questionnaire was approximately 12 min. They then carried out the design of the proposals, dedicating two 2-h sessions to it. It was an educational plan that included a description of classroom development as well as the elaboration of some of the necessary materials for the classroom.

Both instruments focus on the problem of waste production associated with overconsumption. This facilitates the analysis and comparison of the results and functions as stimulus material by using a real and contextualised situation about the controversies posed by the challenge of sustainability (Cebrián and Junyent, 2014; Redman and Redman, 2014).

4.2.2 Criteria for data analysis and data treatment. The answers to the self-perception questionnaire represent numerical values according to a response direction, ranging from 6 (totally acquired) to 1 (not acquired at all). Descriptive statistics were used to show the average values, with low scores indicating a lower self-assessment of the prospective teachers' competence development.

For the analysis of the teaching proposals, a rubric adapted from García *et al.* (2017) was applied, which allows the competencies to be operationalised in observable actions (Waltner *et al.*, 2019). In this way, four profiles were established that represent the degree of development for each of the competencies (Figure 3).

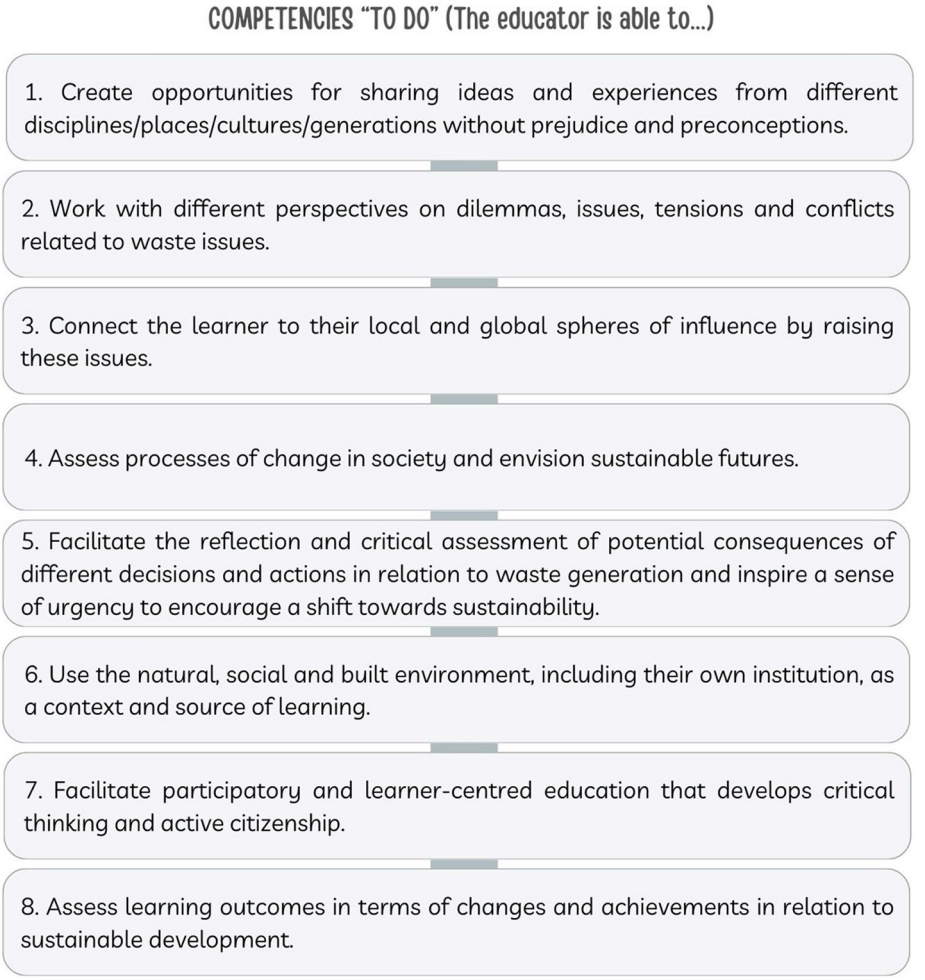


Figure 2.
Competencies "to do"

Source: Authors' own work adapted from UNECE (2013)

For the profile assignment, the first author analysed the teaching proposals and proposed the profile of the FTs for each competence. To validate the categories, a randomly selected sample of 41 proposals (25% subsample of the data) was reanalysed by the other two authors to receive inter-rater reliability statistics. The inter-rater Cohen's kappa coefficient was calculated, with a value between $\kappa = 0.71$ and $\kappa = 0.76$ for different competencies, reflecting "substantial" agreement in all of them, according to Landis and Koch (1977). Then, the frequency of the profiles was calculated for each competence. To ensure transparent categorisation, examples of these profiles (novice, beginner, advanced and expert) are included for each competence in the Appendix.

In addition to descriptive analyses, inferential statistics were also applied to both instruments. Specifically, the non-parametric Kruskal–Wallis test and its post hoc analysis using the Dunn's test were used, allowing us to assess the significance of the differences

Figure 3. Rubric to assess professional competencies in ESD

	NOVICE	BEGINNER	ADVANCED	EXPERT
C1	The teacher does not create spaces for dialogue or exchange of ideas. The work is done from an individual perspective.	The teacher creates spaces for sharing predetermined visions, with no room for dialogue and exchange of different disciplines, backgrounds, cultures and generations.	The teacher creates spaces for dialogue and exchange between different disciplines, origins, cultures and generations.	The teacher creates spaces for dialogue and exchange between different disciplines, backgrounds, cultures and generations. In which negotiation, understanding and cooperation are facilitated.
C2	The teacher is able to get students to work on the problem from a single perspective.	The teacher is able to get learners to work on issues from a variety of perspectives, but from tensions that are of little relevance.	The teacher is able to enable students to work on the issue from a variety of relevant perspectives and tensions.	The teacher is able to enable students to work on the issue from various relevant perspectives and tensions, involving various socio-ecological dimensions and issues.
C3	The teacher does not connect or get learners to work in their local or global sphere.	The teacher connects learners but does not get them to work actively either locally or globally.	The teacher connects learners and gets them to work actively, but only locally or globally.	The teacher connects learners and gets them to work actively both locally and globally.
C4	In his or her teaching, the teacher is not able to critically assess the processes of change in society or to envision sustainable futures.	In his or her teaching, the teacher assesses processes of change in society in a very superficial way and is not capable of envisioning sustainable futures.	In his or her teaching, the teacher is able to make a good critical assessment of the processes of change in society, but is not able to envision sustainable futures.	In his or her teaching, the teacher is able to critically assess the processes of change in society and envision sustainable futures.
C5	The teacher does not provide space for reflection between the individual's actions and the assumption of responsibility for SD.	The teacher facilitates spaces for reflection between individual actions and the assumption of responsibility for SD, but only occasionally.	The teacher facilitates spaces for reflection between individual actions and the assumption of their responsibility for SD.	The teacher facilitates spaces for reflection between individual actions and the assumption of their responsibility for SD, and promotes a sense of urgency and change towards SD.
C6	The teacher does not use environments as context, totally decontextualised.	The teacher uses unrealistic contexts that do not constitute a source of learning.	The teacher uses a natural, social and built environment, including its own institution as a context and source of learning.	The teacher uses a natural, social and built environment, including its own institution as a context and source of learning and allows working with a vision of change (present, past and future).
C7	The teacher does not facilitate participatory and learner-centred education.	The teacher facilitates participatory and learner-centred education, but does not promote the development of critical thinking and active citizenship.	The teacher facilitates participatory and learner-centred education, promotes the development of critical thinking, but not active citizenship.	The teacher facilitates participatory and learner-centred education, promotes the development of critical thinking, and the active citizenship.
C8	The teacher does not propose to assess these issues.	The teacher proposes to assess them only in terms of knowledge acquisition.	The teacher proposes to assess them in terms of knowledge acquisition and attitudes.	The teacher proposes to assess them, not only in terms of acquisition of knowledge and attitudes, but also behaviours.

Source: Authors' own work

detected between the competencies. The statistical power of these analyses was 81% and 83% for self-perception and teaching proposals, respectively, so the results of our study can be considered reliable (Maurandi López and González Vidal, 2022). For these inferential statistics, the significance level was established at a p value of <0.05 using SPSS 28.0 statistics software.

The data were treated in accordance with the Declaration of Helsinki, having received permission from the Ethics Committee on Humans of the University of Murcia (ID 2526/2019).

5. Results

5.1 Self-perception of competence acquisition

All competencies have an average of more than 3.5 without exceeding 4.5 points (Figure 4), which reflects that FTs perceive themselves as having a partial acquisition of competencies. Nevertheless, there are some differences that are interesting to note. For example, the competence to involve the pupils' environment as a context and source of learning (C6) is perceived by FTs as the one they have best acquired.

Meanwhile, the competencies they perceive to have least well acquired are those related to assessing learning outcomes in terms of change (C8) and in creating opportunities for sharing ideas and experiences (C1). These are the only two competencies with values below 4.

When analysing the significance of the averages obtained in the competencies, C8 stands out as it differs from all the others, with the sole exception of C1 (Table 1). This suggests that it is in the assessment of changes and achievements that FTs perceive their main limitations.

5.2 Development of competencies when designing proposals

When the competence profile developed in the design of the didactic proposals was analysed, it was possible to differentiate between two large groups of competencies

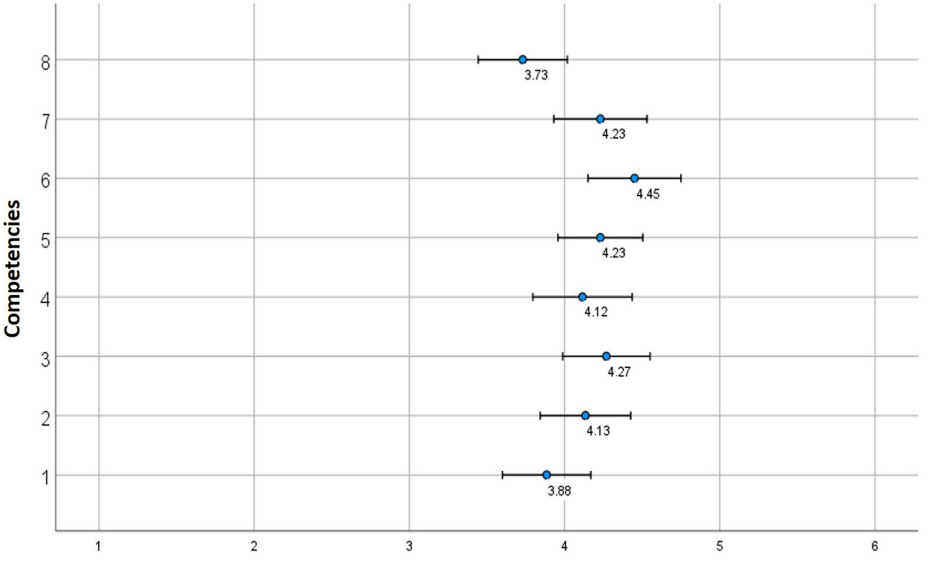


Figure 4.
Average value of each self-perceived competence

Source: Authors' own work

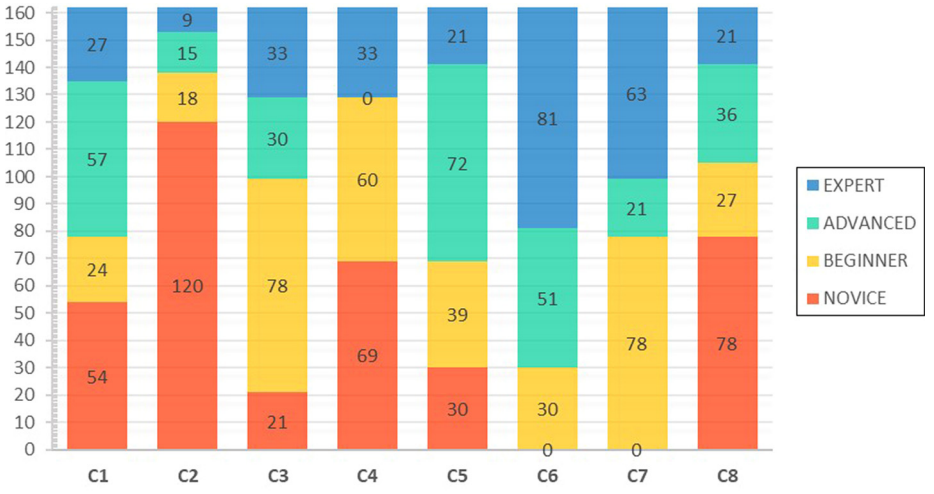
Competencies	C2	C3	C4	C5	C6	C7	C8
C1	$Z = -1.974$ $p = 1$	$Z = -3.040$ $p = 0.066$	$Z = -1.986$ $p = 1$	$Z = -2.618$ $p = 0.248$	$Z = -4.812$ $p < 0.001$*	$Z = -2.602$ $p = 0.260$	$Z = 1.656$ $p = 1$
C2		$Z = -1.066$ $p = 1$	$Z = -0.13$ $p = 1$	$Z = -0.644$ $p = 1$	$Z = -2.847$ $p = 0.123$	$Z = -0.628$ $p = 1$	$Z = 3.630$ $p = 0.008$*
C3			$Z = -1.053$ $p = 1$	$Z = 0.422$ $p = 1$	$Z = -1.787$ $p = 1$	$Z = 0.438$ $p = 1$	$Z = 4.696$ $p < 0.001$*
C4				$Z = -0.631$ $p = 1$	$Z = -2.835$ $p = 0.128$	$Z = -0.615$ $p = 1$	$Z = 3.642$ $p = 0.008$*
C5					$Z = -2.072$ $p = 0.766$	$Z = 0.16$ $p = 1$	$Z = 4.274$ $p = 0.001$*
C6						$Z = 2.223$ $p = 0.734$	$Z = 6.460$ $p < 0.001$*
C7							$Z = 4.258$ $p = 0.001$*

Source: Authors' own work

Table 1. Comparison between the level of self-perception of the acquisition of competencies

according to the frequency obtained from the profiles (Figure 5). The first group includes those competencies in which there is a greater proportion of FTs with novice and beginner profiles (C2, C3, C4 and C8) (Figure 3). The second group presents a predominance of FTs with advanced and expert profiles (C1, C5, C6 and C7) (see the Appendix).

Within the first group, it is working on different perspectives on the problem (C2) where they show a lower competence profile. In fact, this is the only competence in which the vast majority of FTs are at the novice level. This is the case of FT115, who proposes identifying containers for waste separation without addressing any dilemma or conflict related to the massive generation of such waste.



Source: Authors' own work

Figure 5. Competence profile developed by FTs

Further, in the competence relating to the assessment in terms of changes and achievements (C8), almost half of the FTs also present the novice profile, as they do not consider the assessment of these issues as being related to sustainability. Meanwhile, the FTs that are in the novice profile only address the assessment of knowledge. An example would be FT43, which proposes assessing the concepts involved in analysing the impacts of waste on ecosystems.

In the competence oriented towards critically assessing processes of change in society and envisioning sustainable futures (C4), there is a similar frequency among those who do not carry out this critique (novice profile) or propose it in a superficial way (beginner profile). An example of the first case is FT7, which deals with the presence of microplastics in clothing without proposing any critical analysis for her students on the changes needed to mitigate this problem. With regard to the beginner profile, the case of FT123 was found, who does assess the processes of change in society but only focuses on the need for the correct management of waste once it has been produced.

In terms of connecting students with their environments of influence (C3), unlike the previous ones, most FTs are at the beginner level. They manage to connect students with their environment, but they do not encourage them to actively work on issues at either a global or local level. For example, FT124 proposes a bibliographical consultation on the amount of waste produced on different scales (municipal, state and global). However, he does not use this consultation to delve into the matter beyond quantities, which limits the active participation of his students.

In the second group of competencies, it was found that both in creating spaces for the exchange of ideas (C1) and in facilitating the reflection and assessment of consequences (C5), the highest frequency of FTs is found in the advanced profile. For C1, for example, FT83 establishes a dialogue on the relationship between influencers and consumerism in different cultures. This provides an interesting opportunity for reflection but does not go so far as to encourage negotiation processes in this respect. As for C5, FT12 proposes an activity focused on students proposing and adopting measures to reduce plastic waste in their daily lives, although without emphasising the urgency of adopting these measures. Specifically, this FT proposes that students evaluate the effectiveness of these measures by calculating, using an app, their plastic footprint before and after adopting them.

Finally, facilitating participatory education (C7) and using the students' environment as a source of learning (C6) are the only two competencies where no FTs are in the novice profile, and more than a third are at expert level. With regard to C7, the example of FT32 was found, whose proposal revolves around students critically analysing their consumption habits at school so that, subsequently, they can take action by organising various actions, such as a second-hand charity market with items provided by the students themselves. In relation to C6, FT134 focuses the proposed activity on the clothing purchasing habits of his or her students, calculating the CO_2 and H_2O footprints of some of their clothes. In addition, he or she develops a vision of change by assessing the progression in clothing consumption patterns between generations, for example, with regard to the role played by fast fashion or changes in social values linked to the purchase of second-hand clothes.

When assessing the differences between competencies according to profile, C2 and C6 stand out, as they are the only ones that are significant with respect to all the others (Table 2). With regard to the former, the results suggest that, considering different perspectives on the problem, competence poses the greatest difficulties to FTs. The opposite seems to be true for C6. That is, these FTs make good use of the environment as a source of learning, enabling a vision of change (past,present and future) in the model of production and consumption of products.

Competencies	C2	C3	C4	C5	C6	C7	C8
C1	$Z = 7.254$ $p < 0.001$*	$Z = 2.266$ $p = 0.656$	$Z = 2.904$ $p = 0.103$	$Z = -1.531$ $p = 1$	$Z = -7.545$ $p < 0.001$*	$Z = -4.624$ $p < 0.001$*	$Z = 3.253$ $p = 0.032$*
C2		$Z = -4.988$ $p < 0.001$*	$Z = -4.350$ $p < 0.001$*	$Z = -8.786$ $p < 0.001$*	$Z = -14.800$ $p < 0.001$*	$Z = -11.879$ $p < 0.001$*	$Z = -4.001$ $p = 0.002$*
C3			$Z = 0.638$ $p = 1$	$Z = -3.798$ $p = 0.004$*	$Z = -9.812$ $p < 0.001$*	$Z = -6.891$ $p < 0.001$*	$Z = 0.987$ $p = 1$
C4				$Z = -4.435$ $p < 0.001$*	$Z = -10.450$ $p < 0.001$*	$Z = -7.529$ $p < 0.001$*	$Z = 0.349$ $p = 1$
C5					$Z = -6.014$ $p < 0.001$*	$Z = -3.093$ $p = 0.055$	$Z = 4.784$ $p < 0.001$*
C6						$Z = 2.921$ $p = 0.098$	$Z = 10.799$ $p < 0.001$*
C7							$Z = 7.878$ $p < 0.001$*

Source: Authors' own work

Table 2. Comparison between the level of real acquisition of competencies

6. Discussion

Sustainability-oriented training of future teachers is recognised as an essential strategy to achieve the necessary social transformation in the face of socio-ecological challenges (Ferguson *et al.*, 2021). In higher education, significant effort is being made to incorporate a framework of ESD teaching practices and competencies. Nonetheless, educational research has yet to analyse the effectiveness of these training programmes developed within the ESD competencies framework (Bourn *et al.*, 2023; Vega-Marcote *et al.*, 2015). The outcome of these analyses may provide guidance on how to engage teachers, from their initial training, to practice ESD in real classroom situations, which would contribute to learning-by-doing (Uitto and Saloranta, 2017). In addition, this would also foster confidence in future teachers to address these issues, a prerequisite for them to be able to empower their students in the field of sustainability (Dahl, 2019; Skarstein, 2020). For Sinakou *et al.* (2021), teachers' beliefs about transformative practices in ESD can support or hinder their implementation.

In this sense, the data obtained in this study should be interpreted with caution. On the one hand, because it is a case study, the number of participants limits the extrapolation of the results. On the other hand, because the analysis was carried out assessing the design of educational proposals, not their implementation in the classroom, this would provide more accurate results for the competencies analysed. Besides these limitations, it should also bear in mind the personal view of sustainability that each individual holds (Shephard *et al.*, 2019). Nevertheless, educational research seems consistent with the low perceived ability of teachers – both at the end of their initial and in-service training – to address sustainability challenges and actively engage their students (Dahl, 2019; Solís-Espallargas *et al.*, 2019; Waltner *et al.*, 2020).

In this paper, FTs perceive and show a partial level of acquisition of competencies, with considerable consistency with respect to those competencies with higher and lower levels of development. In this sense, Luján (2021) states that it seems that teachers' beliefs about their professional competencies might help predict their educational practice. However, there are also certain discrepancies that highlight the complexity of research in the competence

framework, and, as suggested by Fischer *et al.* (2022), there is a need for specific instruments to assess competence development. In this sense, the findings of our study show that the methodology based on the use of the rubric organised into different competence profiles is highly applicable. Indeed, this instrument makes it possible to explore the ESD competencies that future teachers mobilise when planning their educational action (García *et al.*, 2017). In this way, future research might focus on monitoring teachers' performance in promoting sustainability criteria in their classrooms. Thus, for educational research, the evaluation of teacher education programmes is essential because of their importance in realising the principles of lifelong learning and the competence-based approach to ESD (UNECE, 2013).

Thus, when authors delve deeper into the profile achieved in each competence in ESD by future biology teachers, it was observed that one of the greatest difficulties lies in assessing learning outcomes in terms of changes and achievements (C8). These difficulties have been pointed out in previous studies (Bourn *et al.*, 2023; Olsson *et al.*, 2022). However, in ESD, the search for affective outcomes, understood as values, attitudes and behaviours, is essential (Shephard, 2008). For this author, the assessment of the affective component is very challenging for teachers, both because of the time required to achieve it, which may exceed that of the educational programme, and because of the practical difficulties of monitoring affective changes. Recently, some studies have attempted to offer specific strategies for the assessment of attitudes and behaviours. For example, Olsson *et al.* (2020) propose the SPACS-Q, aimed at measuring the development of three key elements of the affective component: knowledge of the possibilities for action, confidence in one's own influence and willingness to act. These elements can be monitored within an educational programme and, therefore, can be of great interest with regard to measuring the effectiveness of the programme in terms of the affective achievements generated among students.

In the face of difficulties in relation to assessment, competencies in which FTs self-perceive and demonstrate a high level of acquisition were found. This is the case of C6, related to the use of the environment as a source of learning. It seems that these FTs easily recognise contextualised situations in students' real lives, recognised as one of the key tools for promoting sustainability (Cebrián and Junyent, 2014; Cotgrave and Kokkarinen, 2010). In the specific case of waste issues, Alexandar and Poyyamoli (2014) highlight the interest in using scenarios familiar to students that are related to waste pollution, aimed at promoting its reduction. These types of real problems require the integration of different perspectives to solve them (Woo *et al.*, 2012). Then, in addition to contextualisation it is necessary for the proposals to be systemic in nature (Clark and Button, 2011). Nevertheless, regarding this aspect, significant difficulties were observed among the participating FTs. This is the case of C2 and C3 (Figures 2 and 3), where discrepancies are detected between their high self-perception and what they actually achieve in their educational proposals, mostly in novice and beginner profiles. Along these lines, Birdsall (2014) suggests that science students' and teachers' understanding of ESD is not systemic.

To be more precise, for Skarstein (2020), teacher training should emphasise the identification of society–environment interactions, particularly in relation to the production and consumption systems at different scales, local and global, favouring this systemic approach (UNEP, 2018). However, biology teachers tend to focus on environmental aspects related to the functioning of natural systems (Hofman-Bergholm, 2018). This prevents the complex interaction between cultural, social, economic, political and ecological dimensions from being contemplated. This is evidenced by Hagevik *et al.* (2015) and Bezeljak *et al.* (2020), as biology teachers deal with environmental aspects but are not familiar with the interconnections with other dimensions. This reductionist view of ESD, understood as

environmental education, is widespread among future teachers and university students (Evans *et al.*, 2012; Hagevik *et al.*, 2015; Cebrián and Junyent, 2014).

In this regard, different studies point to the interest of developing holistic and pluralistic approaches that are not mutually exclusive (Rudsberg and Öhman, 2010; Wolff *et al.*, 2017). The former approach tries to integrate the different dimensions of sustainability and their past, present and future implications. The latter approach recognises different points of view to discuss them and participate in democratic decision-making. Boeve-de Pauw *et al.* (2015) point out that neither approach is prevalent in the classroom and that both are conducive to sustainability awareness. While the former favours an increase in knowledge of the complexity of sustainability, the latter is more effective in promoting more sustainable student behaviour. However, to the extent that the former also has some positive effect on behaviour and that students have some difficulties in experiencing pluralism, it might be interesting for future teachers to be able to recognise and connect these two educational approaches during ESD planning.

7. Conclusions and educational implications

In general, there is good coherence between FTs' self-perceived level of competence acquisition and their profile. They perceived themselves to have a well-acquired level of competence to use the environment as a source of learning, and they developed an advanced profile, whereas FT recognised their own difficulties in assessing learning outcomes in terms of change and, actually, they developed a novice profile. Nevertheless, discrepancies were detected with respect to systems thinking competence, where FTs were self-overvalued, given that they show a basically environmental view.

The assessment of the ESD competence profile of future biology teachers can bring us closer to the sustainability competencies they will promote in their classrooms. In this sense, our results invite us to consider that using the environment as a context and source of learning could help students develop value-thinking competence (Redman and Wiek, 2021). This means that they can reflect on sustainability values, principles, goals and objectives within conflicting situations on the issue of massive waste generation. However, transferring and scaling the action plans or the decision-making is unlikely to be achieved because systemic thinking is not favoured, neither from a holistic nor a pluralistic approach (Wolff *et al.*, 2017). Therefore, it seems reasonable to assume a limited development of competencies in systems thinking but also collaborative, self-awareness and integrated conflict resolution (Redman and Wiek, 2021; Olsson *et al.*, 2022). This is confirmed when considering the assessment proposed by future teachers, which is more oriented towards monitoring the cognitive than the affective component (Bourn *et al.*, 2023). It would be interesting for future research to explore further these relationships between teachers' ESD competencies and students' competencies in sustainability.

For Weber (2012), the requirement to address attitudes and behavioural issues in the classroom requires competent teachers, and superficial training in teaching and assessment will not be sufficient. Explicit identification of affective learning outcomes will be key in ESD competence-based teacher education programmes (Bourn *et al.*, 2023). Establishing the changes in attitudes and behaviours that students are expected to develop when working on socio-ecological issues, such as those linked to overconsumption and massive waste generation, could help teachers clarify the implications of ESD (Redman *et al.*, 2018; Shephard *et al.*, 2019) and gain a holistic view (Lambrechts and Van Petegem, 2016). This vision could support their own acquisition of ESD competencies and, thus, the necessary promotion of action-oriented sustainability competencies (Vare *et al.*, 2019). The ultimate

aim of both ESD and sustainability competencies is to empower citizens and make more substantial progress towards sustainable behaviours (Barth, 2015).

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Further reading

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Appendix

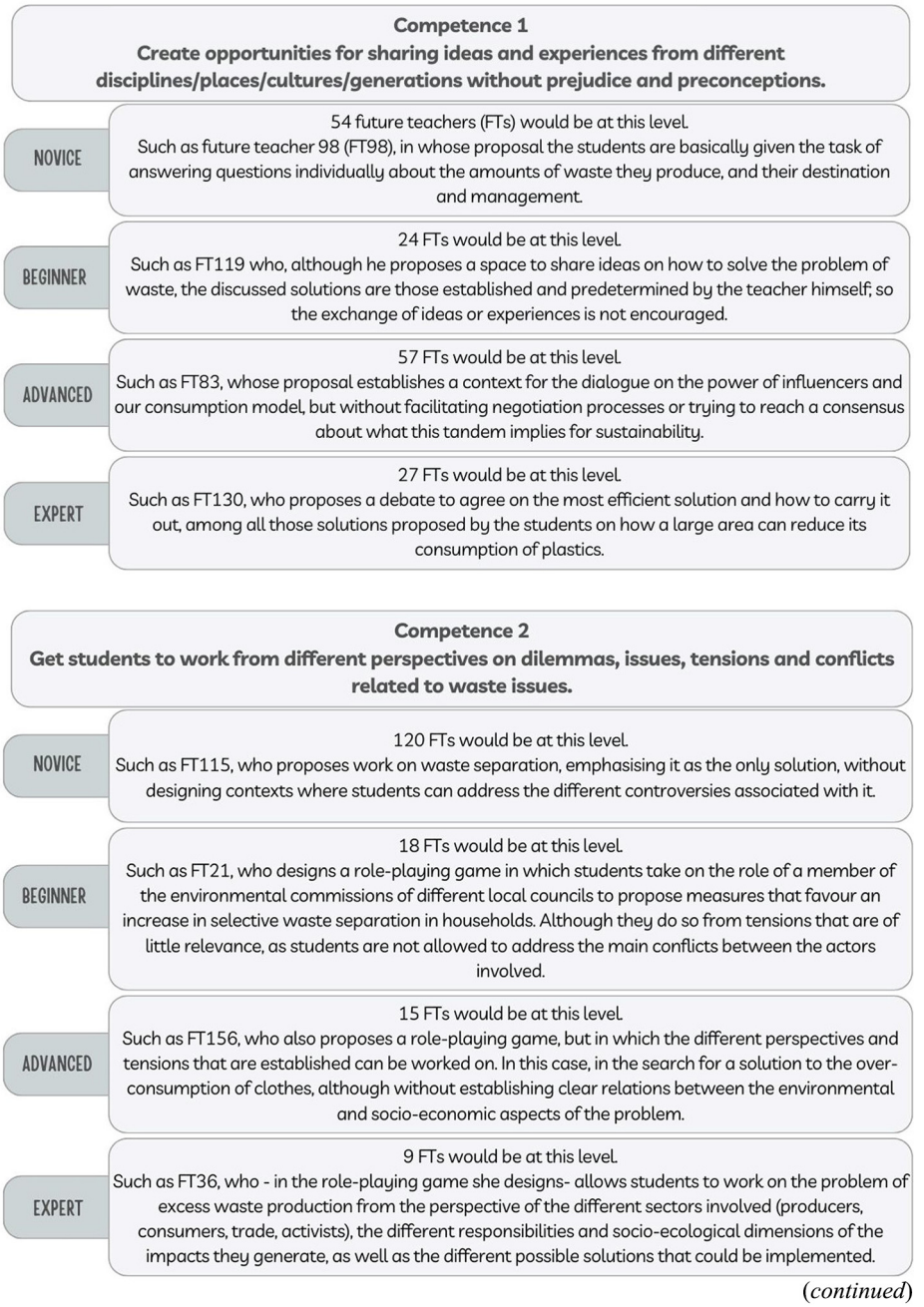

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Figure A1. Examples of the profiles for each competence

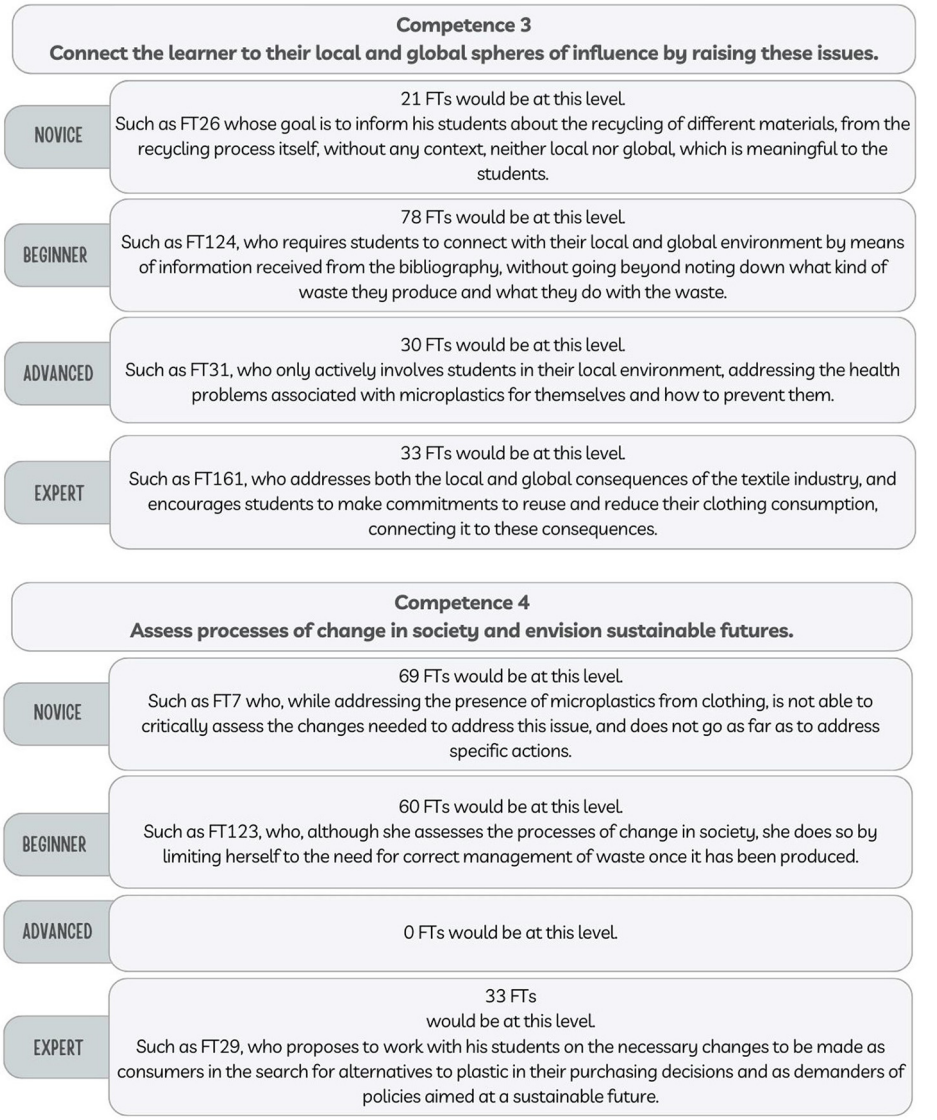
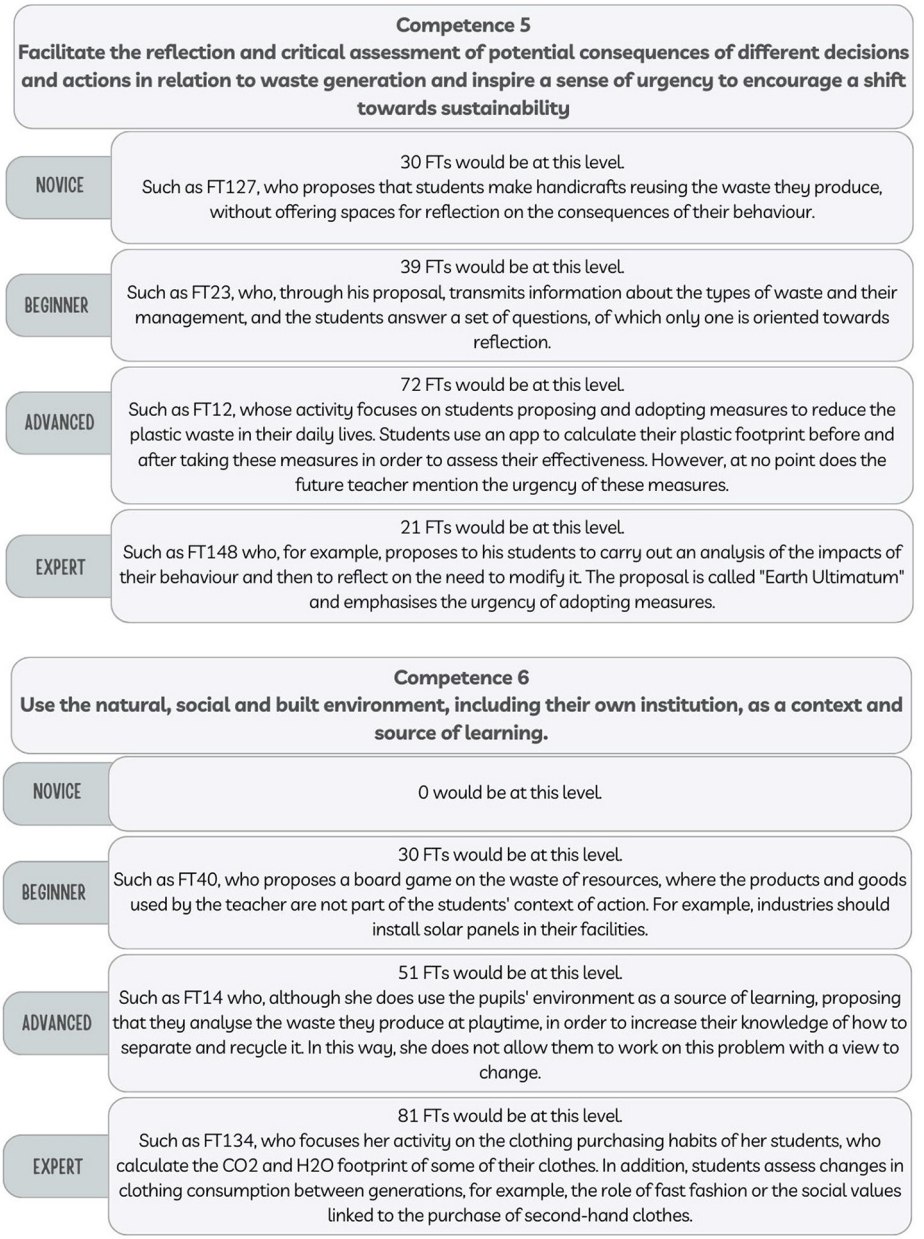


Figure A1.

(*continued*)



(*continued*)

Figure A1.

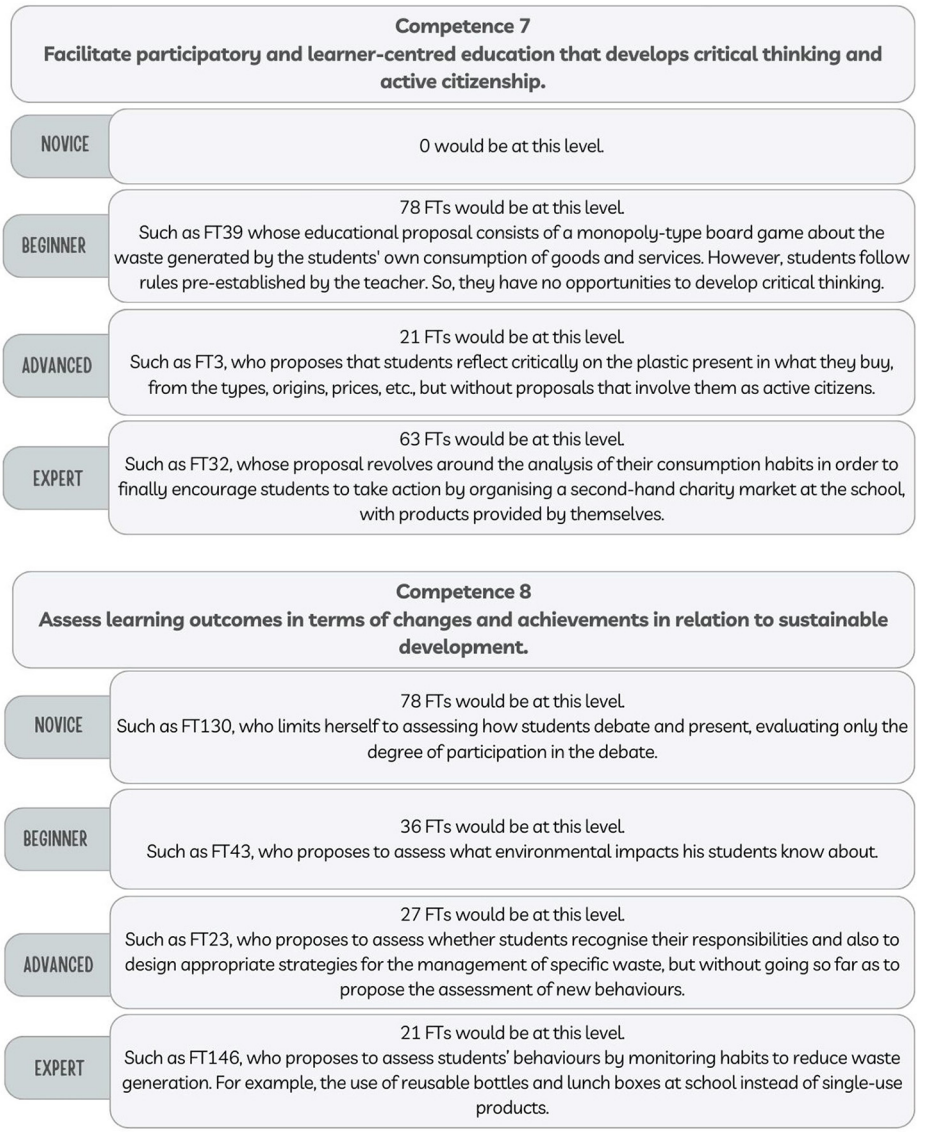


Figure A1. **Source:** Authors' own work

About the authors

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