Education for Sustainable Development as the Catalyst for Local Transitions Toward the Sustainable Development Goals

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Education for Sustainable Development (ESD) is hypothesized to enable the transition to a sustainable future as envisioned by the UN Sustainable Development Goals (SDGs). To demonstrate the potential of ESD to facilitate such a transition, research was carried out between 2018 and 2020, using a systems thinking approach to enable educational communities develop their own visions around the SDGs through a participatory process of localization of sustainability goals and targets and an alignment with formal educational outcomes. Three case studies implemented in a university and two schools in the UK were evaluated as to their capacity to facilitate these transitions through the development of sustainability competences in their learners. Findings from the application of the systemic framework for transitions toward the SDGs through ESD and assessment tools for sustainability competence attainment in learners are discussed in depth. Important barriers and enablers of the process are identified, as well as leverage points to increase the effectiveness of interventions. This work aims to inform education practitioners and community stakeholders about the potential of ESD and practices they can adapt to their own needs and circumstances.

Keywords: ESD, sustainability competence, SDGs, pedagogy, curriculum, assessment, sustainability transition, constructive alignment

INTRODUCTION

Education has a major role to play in dealing with the sustainability crisis, however its capacity to achieve positive outcomes has been criticized (Jickling and Wals, 2008). "It is the highly educated people who are causing the environmental destruction" (Orr, 1991), a statement that is often used to capture how unsuccessful education efforts have been so far in challenging the status quo, the values and perspectives that permeate the unsustainability of our times. Education for Sustainable Development (ESD) fits within the socially critical orientation of education, which assumes that it can challenge existing power structures and enable democratic and equal participation of all in society, with the other two being the vocational/neo-classical, which focuses on career goals and skills that are important for the labor market and the liberal/progressive, which focuses on personal development through experiential learning and integration of theory and practice, as the three main attitudes toward the educational curriculum, according to Wade (2008). The latter two have been

linked to ESD, as skills for sustainability are becoming increasingly important as well as experiential learning shows promise on changing mindsets. The former view however is transformational because it enables critical analysis of existing worldviews, values and structures and empowers learners to transform society. This critical view should be coupled with a systems or relational approach that recognizes that society operates within environmental boundaries as well as is built on social foundations of justice, equity and inclusion and examines the relationships among ESD, education, society and the biophysical environment through multiple spheres of interaction. Such approach can liberate people, make them question how things are done and experiment with different ways of doing them, to ultimate end up with doing better things (achieving visions) (Blake et al., 2013).

To harness education for a common future vision of the world that enables the planet and people to thrive, participatory approaches that allow all stakeholders to become involved, share their views and act, are also necessary (Bullock and Hitzhusen, 2015). Such approaches to education can focus local efforts and lead to regional and global actions. They enable people to connect to their local realities and link them with their communities to discuss, (dis)agree and discover common visions, values, ideas and experiments to try, complementing the socially critical orientation of education. Through a pragmatic lens, sustainability competence (or agency) is the ability to participate in collective decision-making, embrace the plurality of perspectives and engage in active experimentation and deliberation to reveal what works in specific problematic situations and contexts (Rojas, 2019). Education's role in this context is therefore to develop citizen's knowledge and skills in SD and cultivate an interest in participation in community.

The socioeconomic and environmental challenges our society faces today are complex and urgent (Rockström et al., 2009; Raworth, 2012; Griggs et al., 2013; Voulvoulis and Burgman, 2019). Thus, transformative pedagogy is a promising tool for ESD because it emphasizes learning that promotes action (Rose and Cachelin, 2013), enables learners to develop their own views, assess different perspectives, values and interests and develop their own observations, arguments and competences to deal with sustainability issues (Blake et al., 2013). This principle also supports active participation of students in community-driven decision-making to solve local problems (Medrick, 2013; Barnum and Illari, 2016). Within transformative pedagogies, project and problem-based pedagogies that encourage collaboration and active learning in ESD have been shown as effective for developing sustainability competences in learners. They expose students to real-world and authentic situations that require them to manage complexity, work closely with others and make decisions based on trade-offs (Brundiers et al., 2010; Segalàs et al., 2010; Wiek et al., 2011a; Aditomo et al., 2013). Lozano et al. (2017), using hermeneutics and grounded theory, showed project and problem-based learning to have the greatest potential in empowering learners with multiple sustainability competences.

Competence as a term in educational practice has been evolving. First, it related to professional standards and those

that prepare students for the labor market, often narrowing the perspective of education to merely the accumulation of skills that matter for the economy, such as the skills for the fourth industrial revolution (World Economic Forum, 2016). This view emerged as an opportunity to combat wide unemployment in Europe and overcome the obsolescence of lower order skills promoted by the widespread automation of work (Anderson-Levitt, 2017), and is apparent in early OECD (2005) documents. It evolved to cover whole personality development, one that aligns with personal fulfillment, freedom, active citizenship and participation in shaping all aspects of society, which increasingly aligns with the principles of ESD (Carm, 2013). The transformative view of competence requires active learning and transformative pedagogy; and requires students to develop cognitive, affective and behavioral competences, allowing them to construct their own knowledge, skills, values and emotions by active participation in learning, enabling in turn lasting transformation and commitment to action (Sipos et al., 2008). Learning increases through the interaction with others as well as self-reflection. Action increases by questioning accepted practices, values and norms and identifying areas that contradict people's experiences of the socio-economic and cultural context, ultimately altering them (Gokool-ramdoo and Rumjaun, 2016) and aligns with the socially critically view of ESD.

This view on competence in primary and secondary education, although widespread, is not global (Anderson-Levitt, 2017). Regions of the world that have implemented a competence-based approach to school education include most notably Europe, some countries in Africa, Latin America and regions in North America. There have been countries such as South Africa that implemented the model and abandoned it altogether due to resistance from local governments and some countries such as Japan and UK who are swinging between content-based and competence-based education. Using a broader interpretation of the concept, policy documents provide examples of some countries in Asia and America that are using the terms skills, capabilities, targets, goals and educational objectives interchangeably with the term competences (Wu and Shen, 2016).

The concept of competence is gaining a lot more ground in Higher Education (HE), with many universities worldwide shifting to a competence-based approach (Blanco-Portela et al., 2017). GreenComp, the European Sustainability Competence Framework was published recently, with a view to promoting learning for environmental sustainability in the European Union though a flexible set of competences that include empathy, responsibility, and care for our planet and for public health (Bianchi et al., 2022). The new ESD guidance for the UK HE sector (QAA, 2020) advocates for designing ESD into curricula, to transform students' ways of thinking and acting so that they become sustainability change makers. It also advises in favor of linking learning outcomes with ESD competences and designing learning environments that are interdisciplinary or transdisciplinary, learning approaches that are inclusive and accessible for all, policies that support holistic assessment and providing extra and co-curricular activities. All these require highly trained and motivated educators in all levels, educators

with the competences to achieve the transformation needed (UNESCO, 2020).

Another important ingredient to maximizing the effectiveness of ESD in enabling sustainability, is the need of for seeing things through a holistic lens, and the need for a systems approach in ESD programmes. Systems thinking as a promising approach for transforming ESD has been advocated for many times especially considering that sustainability is a complex concept with dynamically interactive dimensions, i.e., the natural, social and economic (UNESCO, 2014; Gokool-ramdoo and Rumjaun, 2016; Iyer-Raniga and Andamon, 2016; Pipere, 2016; Wilson, 2017; Schuler et al., 2018). It has further become particularly relevant, as the Sustainable Development Goals (SDGs) require an integrated approach to their implementation that avoids the fragmented approach of addressing them as separate priorities, which may be conflicting and undermine efforts to achieve them. Considering that sustainable development is a contested concept but is rooted in normativity, equity, integration and dynamism (Waas et al., 2011) and that the SDGs offer a blueprint for achieving a sustainable society by 2030, we developed a set of attributes for a society that would have achieved the SDGs in the future. These attributes are based on a systemic grouping of the SDGs and are: living well within planetary boundaries, maintaining inter and intra-generational equity and justice, engaging in resilient sustainable behaviors that dynamically adapt to context, safeguarding planetary and human health and wellbeing through alternative economic models, investing in collaboration based on empathy, tolerance and transdisciplinarity, promoting diversity and inclusion and transparent governance (Kioupi and Voulvoulis, 2019). They can offer education communities some clarity on what ESD is aiming to achieve through its efforts. Through this view, the SDGs offer the opportunity to view sustainability as strong, one that aligns with the environmental, living within earth's limits; social, the just operating space for humanity to thrive; economic, human activity that enhances nature and society; and institutional dimensions, transparent governance and public participation in decision-making needed for collaboratively achieving a sustainable, prosperous and peaceful future for the planet and its people.

Here we present research that focuses on formal education settings. This is the model of education that has the potential to generate systemic change as it can shape the personalities and capacities of learners from early on in their lives through well into adulthood (Besson et al., 2014). Although the assessment of effectiveness of ESD can be conceptualized as teacher effectiveness, educational climate effectiveness and learning effectiveness from an education perspective (Stumbo and McWalters, 2010), when seen though a systemic lens for achieving sustainability it relates to the development of sustainability competences as educational outcomes. It is considered in terms of increasing student learning gain, i.e., capacity-building, that empowers learners with knowledge, skills, attitudes and behaviors to pursue sustainability (Pauw et al., 2015). Sustainability competences can be developed though primary, secondary and tertiary education, and through case studies at these levels, here, we present the findings from the application of a systemic framework for assessing their development.

MATERIALS AND METHODS

The Systemic Framework for Sustainability Transition Guided by the SDGs

Using a published systemic framework (**Figure 1**) for linking educational outcomes to the SDGs (Kioupi and Voulvoulis, 2019) as the conceptual framework, this study examines sustainability competence development in three case studies of formal education (Higher Education, primary and secondary school education). The power of the systems thinking approach is leveraged through this conceptual framework as it can be used as an overarching methodology to answer research questions around the complexity of SD, educational transformation toward sustainability, and in particular to set the research investigation. In addition, it can be used to provide the context and interconnections between sustainability, the role of education and measuring its effectiveness. Lastly and importantly, through its various tools, such as visioning, gap analysis, back casting and decision-making, it can enable the participatory approach necessary for including the perspectives of the education stakeholders involved in the transformation, actively engaging them in rethinking education, envisioning sustainability, making decisions and setting action plans for its realization (Blake et al., 2013; Palmberg et al., 2017). Two other approaches have already been used in ESD with limited success toward sustainability transformation. An instrumental approach has seen ESD as a tool for achieving sustainable development through education, criticized for being prescriptive and associated with the vocational/neoclassical view of education that puts the emphasis on skills for the market economy (Jickling and Wals, 2008). This is the same approach that has resulted in the sustainability challenges we face today that continues to fail to address current economic models as root causes of unsustainability. The other approach has been based on an emancipatory view and is more open-ended. It aligns with the liberal/progressive view of education that aims to transform the learner to an empowered individual capable of making their own choices through experiential pedagogy (Wals et al., 2008), but its success has also been limited due to its failure to account for the multiple societal influences on learner development and the importance of power relationships in enabling sustainability action.

The main steps of the systemic framework, applied in the case studies, include:

- Step 1 - brining the education stakeholders together in participatory visioning of what a sustainable future would look like for them if the SDGs had been fulfilled;
- Step 2 - identifying the enabling conditions that will allow the participatory vision to emerge;
- Step 3 - selecting the competences that target those enabling conditions and facilitate the sustainability transition;
- Step 4 – selecting pedagogies and assessments for enabling the required competence development and;
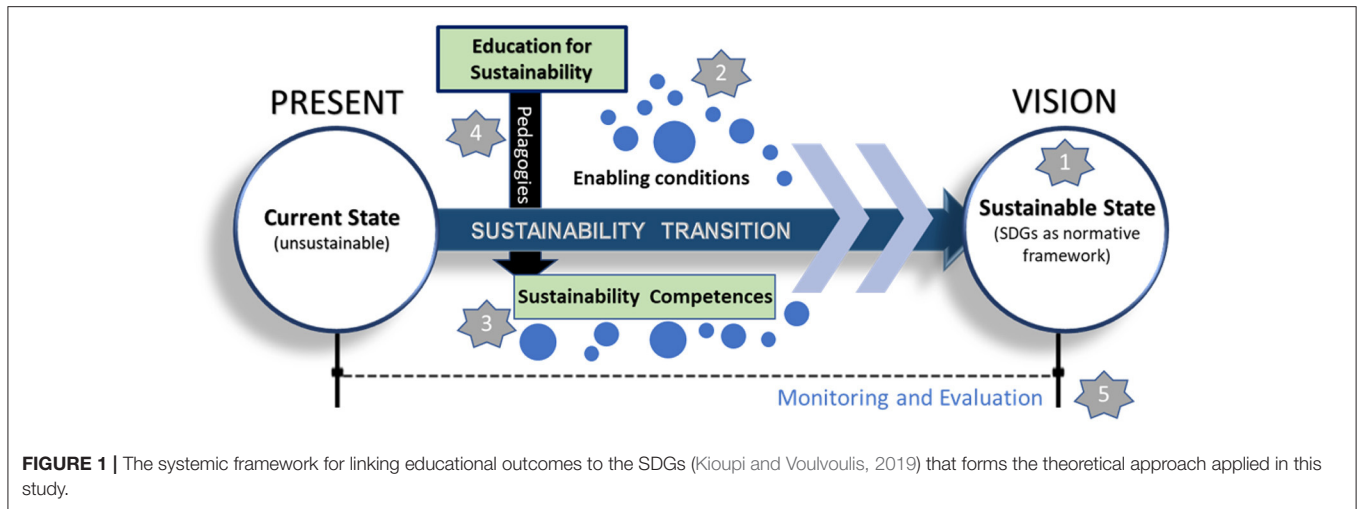
FIGURE 1 | The systemic framework for linking educational outcomes to the SDGs (Kioupi and Voulvoulis, 2019) that forms the theoretical approach applied in this study.

- Step 5 - monitoring and evaluation of progress toward the sustainable state.

The framework was intended to be used as guidance and inspiration by educational communities that seek to enable transformation toward sustainability and not seen as a prescriptive set of actions that they need to adapt to. Educational communities need to localize its steps in terms of the SDGs that are meaningful for them and will guide their vision as well as include the internal (educators, students, leadership of education communities) and external stakeholders (public and private organizations, citizens) to become involved in its realization. These stakeholders then through back-acting will devise a plan on how to achieve their vision. With regards to the enabling conditions for this vision to emerge, we have published a previous paper (Kioupi and Voulvoulis, 2020) on a generalized set of attributes of a sustainable society to emerge that can be used by Higher Education communities in particular and which we discussed in introduction and bring later into this paper as part of the application of the framework.

The selection of competences for sustainability by the educational community require transparent communications, participatory decision-making and inclusion of all stakeholders involved being mindful of the power imbalances that may skew the intended outcomes toward specific views. To formulate the competences needed the educational community should think about how the individual can lead a meaningful life not only for themselves but for their communities as well, and how they can take initiative, be adaptable and do the right things in the each complex situation (Lambrechts et al., 2018). To achieve that, educational communities should be mindful of how they enable all voices to be heard and to decide on values and ways of working that are inclusive and democratic prior to applying the steps of the framework. This view of competence is transformational and different to the traditional instrumental view of skills related with problem-solving of sustainability issues (Wiek et al., 2011a).

For step 4 the stakeholders should make sure that the pedagogies and assessments are constructively aligned to the competences selected (Casey and Sturgis, 2018) so they enable the lived experience of competence in their members and account for wider systemic factors that may influence it such as training of educators and whole institution approaches (Fischer et al., 2015). For the final step, which is monitoring and evaluation, they should keep in mind that change is unpredictable and thus an agile management approach of building capacity to tackle emerging challenges and seize opportunities as well as iteration of previous steps and adaptation of plans, practices as well as experimentation on new ways of being and doing would be beneficial (López-Alcarria et al., 2019). The flexibility of the framework presented is showcased in its adaptation for application in the different educational levels of the case studies examined in the next sections.

The framework applied in this study has some similarities with sustainability assessment frameworks that suggest ways by which integration of the SDGs into existing social and environmental impact assessments can help local communities make decisions about the effective management of resources, tackling inequalities and developing partnerships found in the literature (Morrison-Saunders et al., 2020), but should not be confused with these as it is a systemic framework for the transformation of the educational offer of communities with a view to achieving systemic change. For example, it shares similarities with the conceptual framework for sustainability assessment by Pope et al. (2017) in that it accounts for development goals, such as the SDGs, inclusion of multiple stakeholders and aims to generate a transition through targets for collaborative action but while the former outlines what is theoretically sound and practically possible, our framework includes a visioning part in which what is aspirational and desirable is decided to enable ownership of the transformation process and the commitment to action is built as capability in all stakeholders through engagement in back-casting. Lastly, regarding the view of sustainability assessment as decision making (Waas et al., 2014) process with structured approaches that enable the definition of sustainability based on the local context for the stakeholders, it being a learning process that transforms the stakeholders involved through the

operationalisation of sustainability and giving opportunity for measurable change based on the use of indicators and providing a systematic and stepwise approach to deal with its complexity, our framework has strong alignment. It is based on the same systems theory principles that to achieve transformation in a complex system, the current state needs to be known as well as the future stated should be envisioned and its attributes need to be identified for the selection of appropriate indicators to monitor progress to achieve it. In our case the indicators are the competences developed by the educational community and the process is guided by the proper pedagogies, assessments and whole systems approaches that enable competence development in learners.

The Case Study Approach as a Method for Applying the Systemic Framework

A case study approach was selected as the means to gain insights from applying the framework for each educational level (Moore et al., 2012), particularly through engaging with the stakeholders involved (mainly lecturers, curriculum coordinators, headmasters, teachers and students). Understanding the characteristics and needs of the different stakeholders as well as the barriers and opportunities they are faced with, is a crucial part of the case study approach that helped us strengthen the framework though its practical application. The three case studies of educational programmes already had some link with sustainability. Firstly, the university case study applied at a master's level programme in a London university had focus on environmental technology. Secondly, the secondary school case study applied at a London middle school in a programme related to the SDGs and thirdly the primary school case study took place in the outskirts of London in a school that implemented an innovative curriculum design with links among all subjects and sustainability.

The case study approach was selected as an opportunity for exploratory research in this emerging field of study as empirical evidence is missing (Rowley, 2002). It offered an opportunity to both demonstrate the application of the framework developed as well as the means for collecting evidence to support it. It also allowed its application to three different educational levels to evaluate its applicability as well as to enable a comparison between these levels. Such an approach compensates for the lack of rigor associated with case studies (Rowley, 2002) as it has a clear function and a positivist view by means of deciding the aim and research questions in advance of designing the data collection and analysis tools. The aim of this research was to assess the effectiveness of education in enabling the transition to a sustainable future guided by the SDGs through the application of a systemic framework for the development of sustainability competences in learners. The investigation was aided by the formulation of the following research questions:

1. Does the application of the developed framework in Higher Education (HE) provide evidence for its effectiveness in empowering learners with sustainability competences?
2. What are the important conditions/factors that influence its effectiveness when applied in a HE setting?

3. Does the application of the developed framework in School Education (SE) provide evidence for its effectiveness in empowering learners with sustainability competences?
4. What are the important conditions/factors that influence its effectiveness when applied in school settings?
5. Does the framework assist educational communities (HE, SE) to formalize their contributions to the SDGs/sustainability transformations?

The assumptions for this research were clarified early on as well and included:

1. The SDGs can provide a useful normative framework for educational communities to decide in a participatory way the sustainability competences they should develop in order to achieve their localized vision of sustainability
2. Learners can develop sustainability competences through educational programmes provided appropriate learning outcomes are defined and appropriate pedagogies and assessments are in place.
3. The evidence collected through the assessment of learner sustainability competences can aid decision making in curriculum, teaching methodology and pedagogy development and general transformation of education toward sustainability

The case study approach offered flexibility over the investigation (Rowley, 2002), which is considered a strength in accordance with the systemic framework produced, as a participatory approach in designing the data collection and analysis methods was desirable to fit the context of each educational community. A mix of methods for data collection that include both qualitative and quantitative tools was used and the participation of education stakeholders in shaping the research through discussions provided deep insights into the realities faced. Observations in classrooms, minutes from university and school meetings, official educational programme documents, websites, interviews and surveys were used to collect the data needed to fulfill the aim of this research. As for the methods of analysis, statistical analyses of quantitative data from surveys and questionnaires as well as qualitative text analyses to identify themes and generate insights were conducted using appropriate software (such as MS excel, SPSS, NVIVO). As generalization was not the aim of this research but instead evidence of the framework applicability and identification of factors/conditions that may influence the effectiveness of education in developing sustainability competences in the specific contexts, the findings can be of value to education practitioners when taking the framework forward in their institutions. In applying the framework, it was assumed that Step 1 "envisioning a sustainable future" had already taken place independently before the start of the research, as all three educational institutions had formulated their visions engaging their specific stakeholders involved in the three programmes of study. This was verified during discussions with educational institution representatives. Step 2 "identifying enabling conditions for sustainability to emerge" was only applied in the university case study referring to

important enabling conditions identified by the systemic grouping of the SDGs. These were based on a previous study around the attributes of a sustainable society elaborated earlier in the introduction and included, the Safe Operating Space (SOS), the Just Operating Space (JOS), Alternative Economic Models (AEM), Resilient Sustainable Behaviors (RSB), Health and Wellbeing (HW), Collaboration (COL), Diversity and Inclusion (DI) and Transparency and Governance (TG) (Kioupi and Voulvoulis, 2020). Those enabling conditions were used to assess the alignment of the master's programme's learning outcomes to sustainability. For the primary and secondary school programmes the learning outcomes where checked for alignment directly to the sustainability vision both had formulated.

For the selection of competences in the university case study (step 3), the competences were translated from the aligned learning outcomes to the enabling conditions for sustainability to emerge and complemented with more knowledge specific competences. Whereas, for the primary and secondary school case studies, the stakeholders according to their stated visions for sustainability and the specific curricular knowledge guidelines they were following, selected the intended competences. As far as the pedagogies selected are concerned (step 4), in the university and secondary school case studies the application of project and problem based pedagogies was deemed appropriate for the level of knowledge and skill the students already had and according to the transformative pedagogy principles of ESD (Seatter and Ceulemans, 2017; Tejedor et al., 2019). For the primary school case study, active learning approaches were followed that engaged the students in learning about the water, food and energy nexus such as interactive teaching sessions, field work, essays and opportunities to use their schools as test bed of sustainable practices (Burns et al., 2016).

Lastly and importantly, for the assessment of sustainability competences as indicators of achieving the sustainability vision (step 5) intended by the education stakeholders in the three case studies, a mix of existing assessments already used by the educators to cover their subject specific learning outcomes as well as additional self and team assessments and educator rubrics were used. This was done to enable the students and educators to receive and provide rich feedback and information about the performance of students. Competence models with criteria and levels of performance were also constructed for measurement purposes based on the cognitive, affective and behavioral dimensions of the selected competences for sustainability (Leutner et al., 2017).
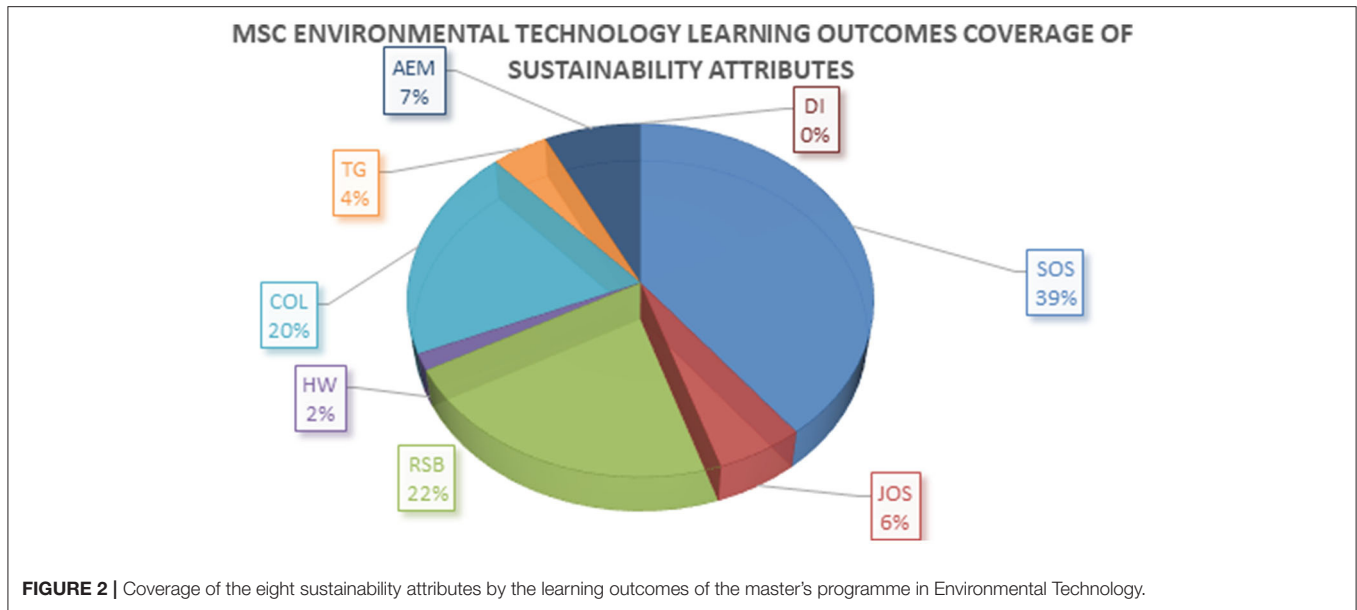
RESULTS

University Case Study

The university case study was at a master's course at a major UK university, focusing on two cohorts of students studying *water management, pollution management* and *environmental analysis and assessment,* as part of a programme in *Environmental Technology.* The course's sustainability vision was clarified in discussions with the director, teaching and research staff, curriculum developers, students and alumni as stakeholders. The vision included "the desire to prepare the next generation of sustainability professionals who can solve wicked problems, having a systemic and interdisciplinary understanding of their causes and effects as well as work collaboratively to provide solutions" (Centre for Environmental Policy, 2018). The analysis of the programme's learning outcomes (LOs) found problem solving for sustainability challenges to be of primary importance and related to analytical, research and critical thinking skills. Much attention overall was given to collaboration and communication in interdisciplinary contexts and the ability to understand and deal with complex socio-environmental systems. Decision-making and strategic thinking were deemed crucial for assessing different options and deciding on a course of action. Self-awareness and regulation were thought as important abilities related to understanding the role one can play when engaging in sustainability issues and coping with the challenges faced. Future thinking and value thinking around alternative scenarios and perspectives were targeted through the course's learning modules on energy policy and urban sustainable environments. LOs around understanding of water management and environmental analysis and assessment concepts were also considered.

The LOs were assessed against the sustainability attributes for enabling a sustainability vision guided by the SDGs to materialize through a word-code comparison (Kioupi and Voulvoulis, 2020). The outcome was that the master's programme while doing a good job in terms of specific enabling conditions for sustainability (SOS, AEM, COL, and RSB) related to its environmental, economic and institutional aspects, could benefit by increasing focus on others (JOS, HW. TG and DI) more related with its social aspects (**Figure 2**). The process informed the curriculum review that followed this study.

For conducting this research the students of the Water Management (WM), Environmental Analysis and Assessment (EAA) and Pollution Management (PM) options of the master's programme participated. Course pedagogies were also discussed with the academic staff, to understand the reasons behind the course's project/problem based approach; the students worked in projects simulating authentic consultancy work, helping water and waste management companies address complex sustainability challenges (Centre for Environmental Policy, 2020a,b). Assessments of competence were based on models with descriptors of behaviors the students would need to demonstrate, evaluated using educator rubrics (ER) as well as student self-assessments (SA) (Kioupi, 2021). The course's own assessment methods were explored to assess competence development in students. These included the project reports, project oral presentations and written exams to collect data on all the intended competences. The assessment found students to have developed the intended competences with combined scores ranging between 60 and 79% [intermediate (60–69%) to advanced (70–79%) performance] in all intended competences (**Figure 3**). The combined scores were derived

FIGURE 2 | Coverage of the eight sustainability attributes by the learning outcomes of the master's programme in Environmental Technology.

after integrating the ER and SA scores. A notable difference was that students perceived systems thinking, collaboration and research skills more challenging to attain according to their self-assessments scores.

It is evident from **Figure 3** that the students of WM performed better than the students of the EAA and PM options and achieved advanced performance in eight out of nine assessed competences. For the EAA and PM students, who achieved intermediate level in all nine competences, the combined scores were similar, but the PM students performed somewhat better that the EAA students in knowledge and understanding, systems thinking, future thinking and research skills.

Secondary School Case Study

The secondary school's vision was formulated by the school leadership, board of trustees, educators, students and parents. The vision was to "provide young people from all backgrounds with a life-changing education that equips and inspires them to make a positive impact on society and to excel in the wider world with sustainability being central to the kind of impact the students will have" (personal communication with head teacher). To apply the framework we collaborated with the coordinator, educators and Year 9 students of the Global Goals course. For this course, the coordinating educator and supporting teachers selected the following sustainability competences for their students to achieve the vision of becoming sustainability change agents:
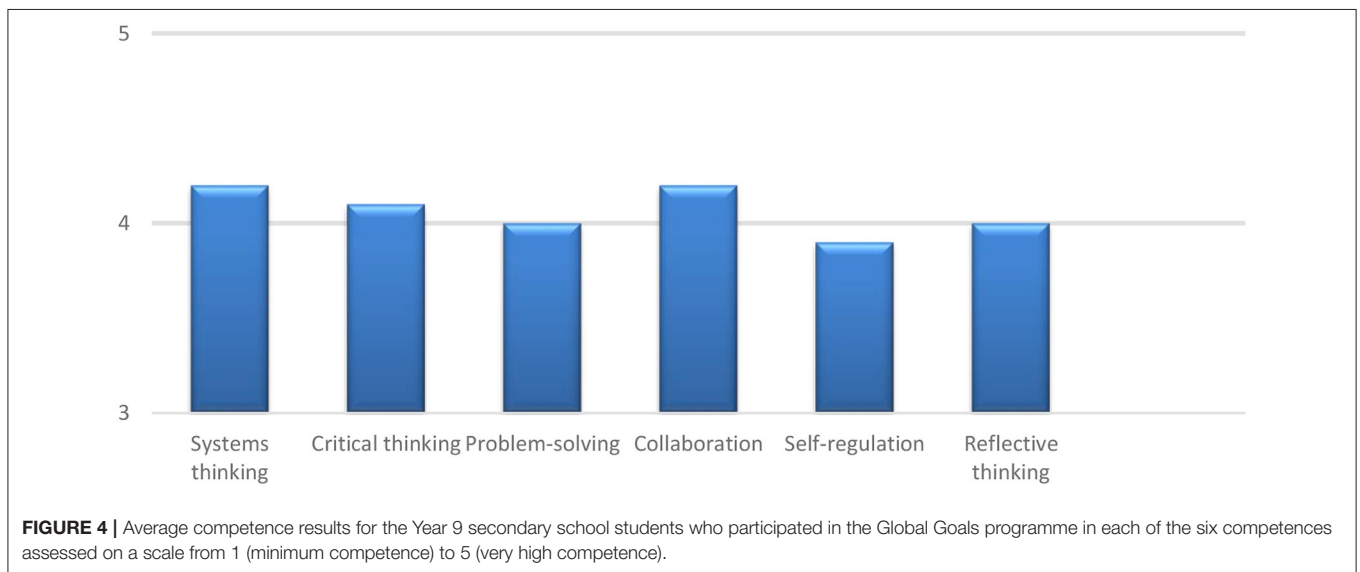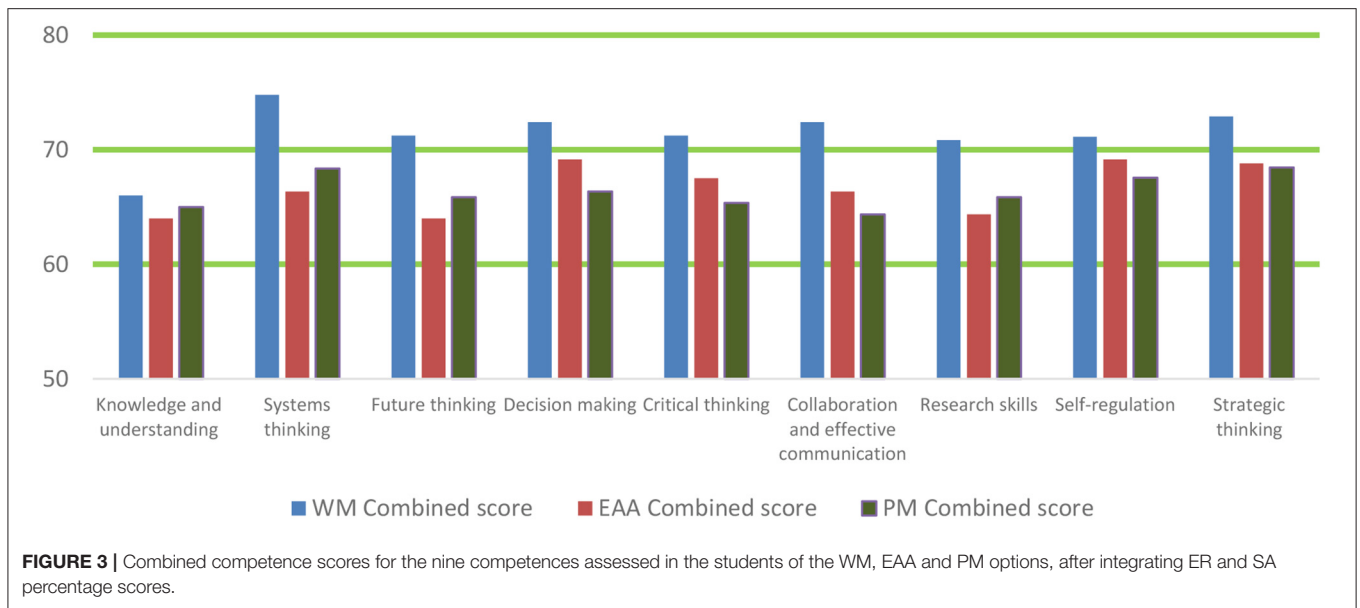
1. Systems thinking to allow students to understand the root causes of problems,
2. Reflective thinking to allow them to be independent learners,
3. Critical thinking to allow them to conduct valid research around the SDGs,
4. Self-regulation to allow them to cope with failure,

5. Collaboration to help them become team players and
6. Problem-solving and action to enable them develop creative and practical solutions and materialize them.

The pedagogies used as part of the application of the framework in the secondary school were project and problem-based learning. The students were practically asked to form teams and select the SDGs they felt they wanted to contribute toward and then identify a problem related to those and work to present a solution. The Global Goals programme was new and innovative, and did not have any established assessments. Self and team assessments were selected as they key instruments to collect data on the performance of the project teams and to help students understand their progress in discussions with the teaching staff (Kioupi, 2021). A final peer assessment for the projects the students submitted at the end of the school year with clear success criteria, was also developed to assess the quality of the project deliverables. The results demonstrated advanced competence (3.9–4.2 on a scale from 1 to 5) for the students of Year 9 who participated but highlighted some weaknesses in terms of coping with failure, self-regulation and working in teams based on the students' self and team assessments (**Figure 4**). The teachers considered these important findings, and ways to help those students have a positive impact in their societal roles.
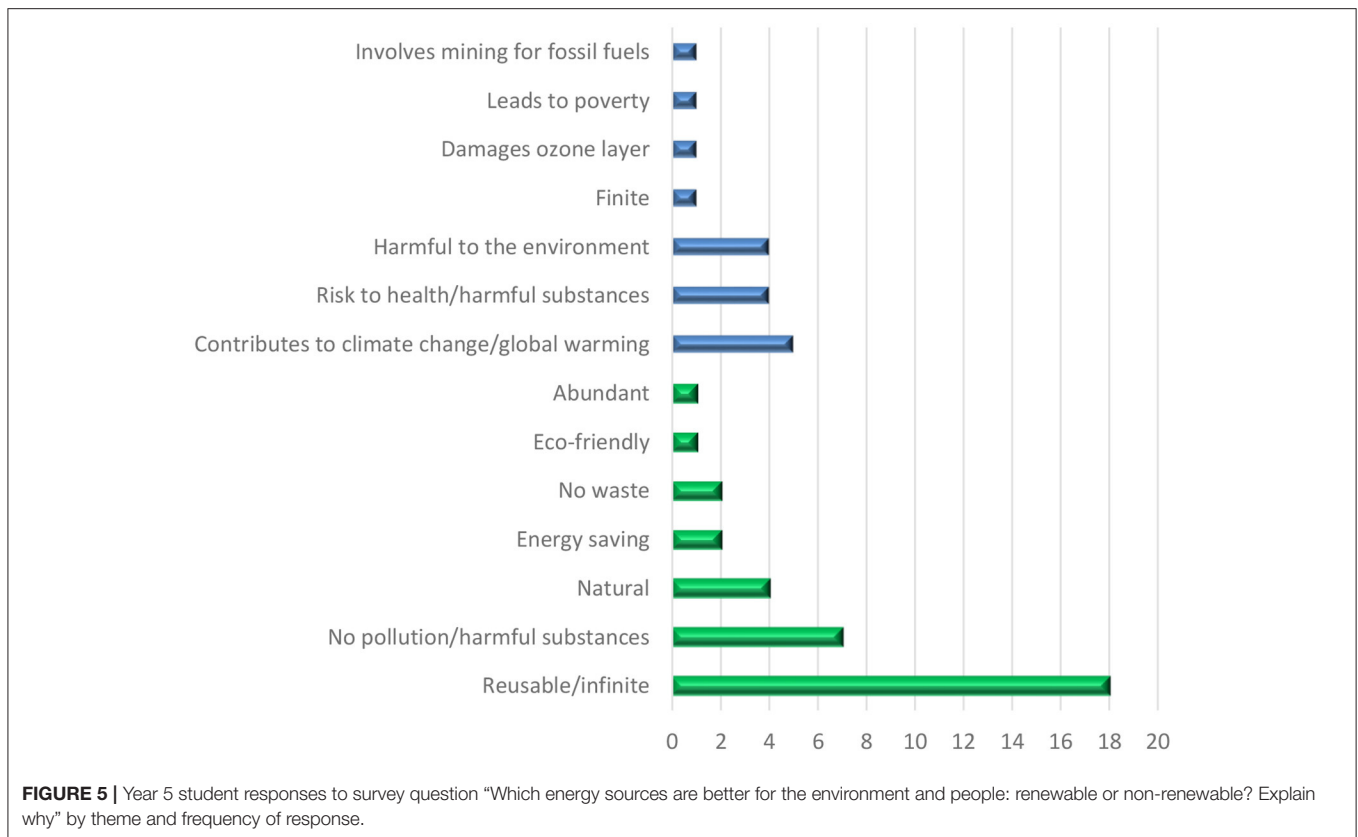
Primary School Case Study

The primary school's vision for sustainability was "to promote sustainable living and learning and develop energy and environmentally conscious individuals who care about the world around them and understand what is required to sustain individual, team and global well-being". The vision was formulated by the leadership of the school together with the teachers. The school was quite innovative in having developed a sustainability-linked curriculum that enabled students to

FIGURE 3 | Combined competence scores for the nine competences assessed in the students of the WM, EAA and PM options, after integrating ER and SA percentage scores.

FIGURE 4 | Average competence results for the Year 9 secondary school students who participated in the Global Goals programme in each of the six competences assessed on a scale from 1 (minimum competence) to 5 (very high competence).

experience sustainability values through enquiries of learning that linked all the subjects taught. The research was done with students of Years 4, 5 and 6 and their learning related to the water, energy and food nexus (Kioupi, 2021). Thus, the competences selected by the teachers to enable the school's vision were cognitive around knowledge and understanding of scientific problems related with food, energy and water, affective around values and emotions toward production and consumption of food, energy and water and behavioral in terms of making sustainable energy, water and food choices.

The pedagogies were based on active learning and included the whole school as a lab for practicing sustainability, supported by the nature of the school (an advanced eco-school). A questionnaire that checked the knowledge, skills and attitudes of students in topics around food, energy and water, observations of student work and informal interviews with them were used for assessment. The results demonstrated that the students although advanced in skills, values and behaviors for sustainability, lacked somewhat in scientific knowledge in environmental problems and were susceptible to framing issues around equating certain behaviors as good/sustainable and others as bad/unsustainable, such as conventional food and non-renewable energy always equates to unsustainable and thus "bad choice", while organic food and renewable energy always equates to sustainable and thus "good choice" (**Figures 5**, **6**). A more critical and holistic approach in dealing with sustainability issues would render them more capable to become conscious decision makers which is better aligned with the vision of the school (Starke, 2019; Kioupi, 2021). This was discussed with the teachers and headmaster of the school so that ways could be identified to remediate it.

FIGURE 5 | Year 5 student responses to survey question "Which energy sources are better for the environment and people: renewable or non-renewable? Explain why" by theme and frequency of response.
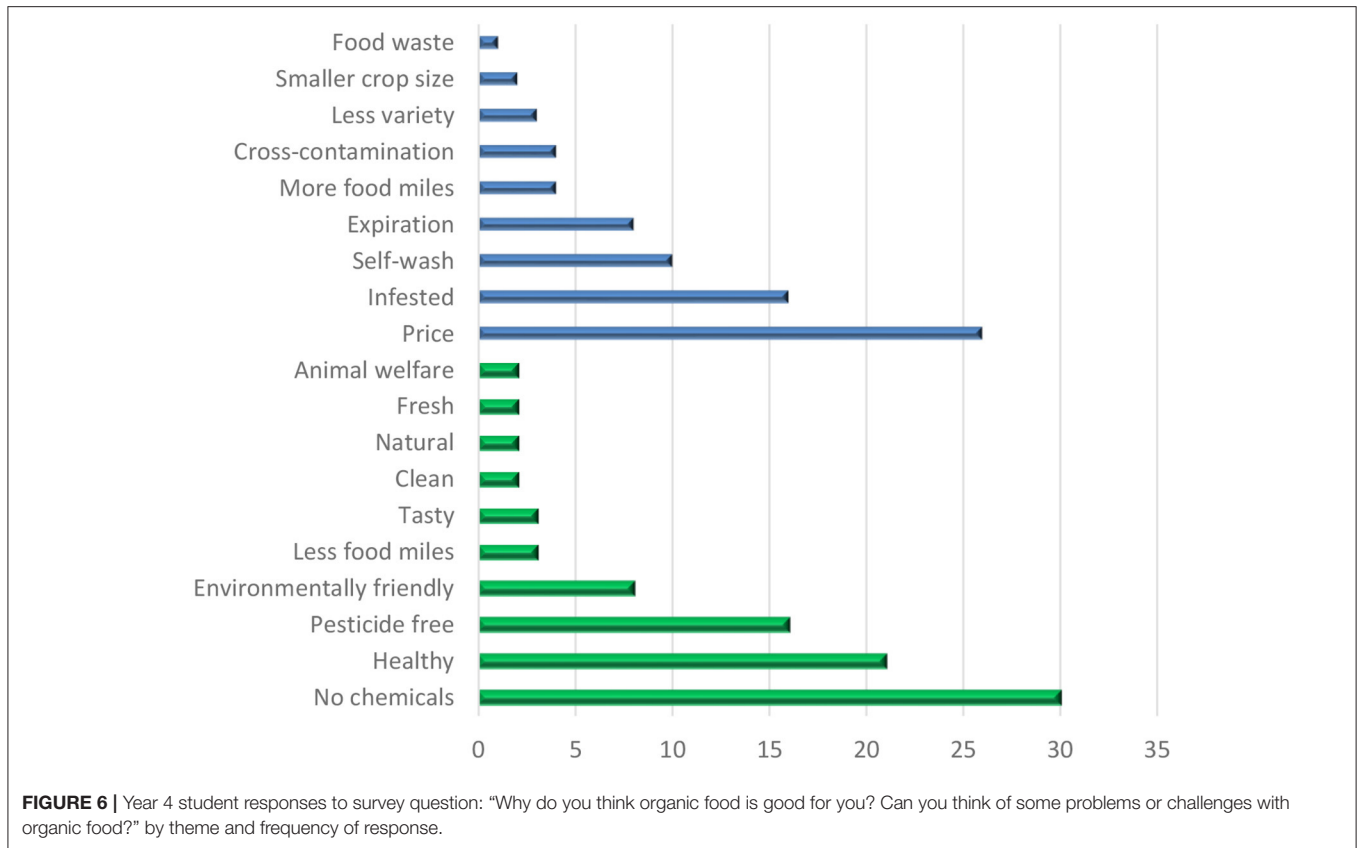
Results Across Educational Levels

The findings demonstrate the potential of all the approaches being successful in enabling students develop their intended sustainability competences but to different extent (Research questions 1 and 3). Starting early in primary school, students showed their capacity for basic systems thinking as they were able to link concepts such as food energy and water that do not have obvious connections in mainstream education approaches. This was further supported by the number of topics they could introduce to explain sustainability concepts and by being able in some cases to suggest pros and cons for some controversial issues. They were also found to uphold sustainability values, attitudes and behaviors around water, energy and food use/practices and preventing waste. These hold promise that ESD pedagogies can enable the development of complex competences in students from an early age (8–11 years old). This is in accordance with published studies (Assaraf and Orion, 2010; Ampuero et al., 2015) that support the proposition that transformative pedagogies have high potential to empower students with sustainability competences. The school students positively influenced their peers and families in favor of sustainability through discussions during and after the activities, as reported by their teachers. This could generate a ripple effect of transformation in the community on condition that the school employs a holistic and pluralistic approach to sustainability and avoids framing behaviors as "good/desirable" and "bad/undesirable".

Secondary school students, on the other hand, were found to be better able to integrate the environmental, social and economic dimensions of sustainability, and work independently to research and provide solutions to local sustainability problems during their engagement in the project-based learning activities. As they were adolescents, research supports the idea that they were more likely to develop sustainable behaviors through engaging in challenging active learning activities in the school and then transferring this to out of school settings (Uitto et al., 2015). They were also able to work collaboratively to develop their projects to a much higher capacity than primary school students were, but they needed support by their teachers in doing so. They showed high capacity for systems thinking, critical thinking, problem solving and reflective thinking, all of which are important for their personal learning growth and for addressing sustainability challenges. Such an assessment of sustainability competence in secondary school education addresses an important gap as there is limited research at this specific education level (Pauw et al., 2015). However, their ability to cope with failure and deal with feedback from peers and educators is something that requires attention and further development as it will define their future engagement with sustainability action.

Higher education students' ability to think systemically, strategically and critically empowers them to identify the root causes of problems, prioritize and implement targeted action as demonstrated in the study. Their capacity for future, normative

FIGURE 6 | Year 4 student responses to survey question: "Why do you think organic food is good for you? Can you think of some problems or challenges with organic food?" by theme and frequency of response.

thinking and self-regulation is something the universities must invest in as it will assist them in developing long-term solutions, balancing current and future needs and impacts and engaging in ethical inquiry with communities to prioritize ethical frameworks appropriate for enabling visions of sustainability to become reality (Minteer, 2012). Higher education learners are an important target of ESD efforts as they will be the leaders of tomorrow and have the capacity to apply their sustainability competences in various professional and societal roles (Weiss et al., 2021). University students are a great force for transformation as through their communities and networks they have the potential to mobilize local action and develop local sustainability solutions. Youth stakeholders are regarded as an important actor of the ESD for 2030 initiative for achieving the SDGs and their empowerment and mobilization is one of the five priority areas of this action plan (UNESCO, 2020). The focus of ESD at this level should be to enable university students to work collaboratively in transdisciplinary groups and show empathy and understanding toward diverse perspectives. This can happen if sustainability becomes part and parcel of teaching, research, community engagement and operations and appropriate sustainability competences are selected and integrated by the education institution stakeholders (Molderez and Ceulemans, 2018).

Regarding research questions 2 and 4 around the factors that influence the effectiveness of developing sustainability competences in learners, sustainability, as a concept is quite

complex and somehow vague across all the case studies, down to the interpretation of the local education stakeholders to clarify, define and pursue. Specifically in the HE case study the use of the tool to check the alignment of learning outcomes to the attributes of the sustainable society based on the systemic grouping of the SDGs helped the HE stakeholders articulate the contribution of the master's programme to sustainability by overcoming some of the confusion. Moreover, no programme was effectively compliant with constructive alignment principles among learning outcomes, pedagogies and assessments. Constructive alignment purports that to enable competence attainment in learners all the components of the curriculum and leaning and teaching process should be aligned (Casey and Sturgis, 2018) and is an influencing factor. Discussions with academic staff and school teachers on the importance of constructive alignment for enabling the students to develop the intended competences, aimed to facilitate changes to the curricula to support its principles. Improvements in the assessments of all programmes were made in terms of aligning pedagogies to selected competences and their evaluation.

An important research question of this project (research question 5) was around the capacity of the framework to enable educational communities initiate sustainability transformation. An important principle of effectiveness that resulted from this research is that education efforts around ESD should be pursued and implemented at all levels of education as they can provide unique benefits for the learners and increase their potential

for transformational change. The different levels of education, however, pursued different approaches in implementing ESD, with the primary school integrating sustainability as the connecting thread of all subjects taught, the secondary school including a unique course in its curriculum around the SDGs and the university offering a master's programme of study oriented toward sustainability. In secondary schools, the curriculum is much more fragmented than the primary school one, as the students are offered opportunities to develop their knowledge and skills in many different subjects. This may have some benefits in terms of improving subject-specific literacy but fails to develop the whole-personality of the student in a way aligned with ESD principles. ESD requires integration of different subjects, concepts and skills and should not be treated as an add-on to the curriculum. Rather, it should be integrated holistically giving the opportunity to students to be part of it throughout their secondary school studies so they can develop their critical thinking and action competence capacities. This is applicable to HE as well, opportunities to engage with sustainability should extend beyond a master's programme to all aspects of university life, campus operations, research, governance and community engagement to enable transformation.

DISCUSSION

Considering the systemic framework applied that provides the conceptual framework for this study and its steps, here we discuss our findings in terms of how the sustainability vision is defined, how competence is conceptualized and how pedagogy and assessment are enabling competence development in learners (research questions 1 and 3). Sustainable Development is not a well-defined concept and as a result Education for Sustainable Development has been criticized for vagueness and lack of tangible outcomes, often leading to disengagement of educators and learners (Kioupi and Voulvoulis, 2019). The SDGs have offered the opportunity for a new conceptualization of Sustainable Development as a systems state that our society is trying to achieve, and in this work, we looked at sustainability competences as the enabling conditions for transitioning to such a state. In other words, the aim of sustainability education is to empower learners with the competences needed to become the citizens of a sustainable world. This makes education crucial in driving sustainability transformation and the realization of the SDGs. Moreover, the sustainable state is not predefined, but one that needs to be envisioned by learners and the wider educational community inspired by the SDGs. All levels of education focused on the ideal learner as part of their sustainability vision, articulated its attributes or competences and were successful in developing them in their learners.

The concept of sustainability competence is also contested. It ranges from a narrow definition of knowledge for sustainability to problem-solving and generic lists of knowledge and skills prescribed for achieving sustainability integration in education (Wiek et al., 2011b; Brundiers et al., 2020).

According to our work, the selection of competences or LOs should not be based on generic lists that promise vague sustainability outcomes, but on the priorities of the educational institution and its sustainability vision. Similarly, the assessment of effectiveness in competence development by learners should be locally relevant, tailor made to their needs and their vision. Recent studies (Salovaara et al., 2020) support the uniform inclusion of a list of five suggested sustainability competences (systems thinking, anticipatory, strategic, interpersonal, and normative competencies) by Wiek et al. (2016) in all master's programmes for sustainability. However, master's programmes (and in general, university programmes) LOs need to reflect the diversity of perspectives of stakeholders that formulated them and the values they prioritize, and not prescribed lists of competences to achieve sustainability. Such competence lists should be viewed with caution, discussed by the HE community and aligned with a programme's specific aims about the type of graduates they want to develop based on their visions of sustainability.

Competences are enabled by pedagogies as per our framework. A study on the impact of ESD on student learning in 18 countries found that pedagogy is a better predictor of sustainability competence development than the introduction of sustainability content (Laurie et al., 2016). ESD pedagogies have some specific characteristics. These are active engagement of the learner (student-centered), enabling multiple voices to be heard and worldviews to be elaborated (pluralism), collaboration among peers and the educator to solve problems and tasks (collaborative problem solving), critical reflection on values, beliefs and actions (critical pedagogy) and planning and implementing action on real world cases (project based learning). All these require a shift from traditional teaching techniques in education such as lecturing or direct teaching (UNESCO, 2018). Authors (Wade, 2012) further suggest the importance of transdisciplinary communities of practice that generate new knowledge and transformative ESD practice, use physical and virtual learning environments and adapt their operations to the context. The teaching methods applied in the case studies followed some the principles of effective ESD pedagogies, however the framework can be enhanced by explicit reference to these to avoid the framing issues observed in primary education.

As competence-based education is fast pervading university education, it requires methods to describe, model and assess competences. Competences are complex constructs and require special assessment as they reflect the multidimensional, integrated and action based nature of learner agency to enact sustainability and their assessment goes beyond testing knowledge and understanding, which is what traditional assessments do. Competence assessment in the case studies offered opportunities to educators to establish criteria and indicators of performance that include cognitive, affective and behavioral dimensions and examine holistically the areas that can be included in the LOs of their educational programmes. The students gained a more dynamic view of assessment as they were not only assessed by educators but could assess themselves and their peers in what can be a very educational experience that can sharpen their judgement (Ohland et al., 2012; Boud et al., 2015). In addition, a major importance of competence assessment is that it focuses not only on the outcomes of learning, but also on the

process and experiences that led to those outcomes (Hutchings et al., 2012) demonstrated by the fact that the learning and assessment activities used in the case studies prioritized the lived experience of competence. It further provides specific, targeted and actionable feedback to the educator and student on which they can work and improve (Casey and Sturgis, 2018).

Considering the factors that influence the effectiveness of education efforts to enable competence development in learners of universities and schools using the framework (research questions 2 and 4), it is absolutely crucial for educators to be trained. For all educators and especially those of HE institutions, this process poses difficulties as it requires them to develop skills in using new ways of teaching, which can be challenging and may generate resistance toward implementing ESD altogether (Lambrechts et al., 2010). Educator professional training that builds the capacities of educators to initiate education for the SDGs (UNESCO, 2020) is therefore needed to translate curricular guidelines into usable pedagogies. The need for educator training in social and environmental matters has been highlighted as a gap in the provision of skills for the fourth industrial revolution to learners in a study of public and private Technical Education Institutions (Srivastava et al., 2022). It would make sense to train the educators of every educational sector on how to use the framework we developed to define sustainability visions around the SDGs and select competences. Furthermore, the adaptation of the assessment tools for the alignment of LOs to the SDGs for use by educators and the development of relevant training material can empower them. The provision of training on the use of the assessment tool for the competences so that they can assess the attainment of sustainability competence in their learners can help educators align with QAA guidance on ESD (QAA, 2020).

Essential in implementing educator training is the why and how to do it. The main reason behind training educators in ESD is to enable them to start the process of sustainability transformation, but there are other desired outcomes as well. One very important outcome is to render teachers autonomous agents for sustainability education in schools (Kumaravadivelu, 2001). This way they will be able to challenge their own assumptions about teaching and learning, be critical about their practices, identify opportunities for transformation and know when to apply what and why. In addition, they will be better positioned to empathize with their learners, understand their background and perspectives and use it as material to enable constructive learning development for both the learner and the teacher.

Another important factor that influences the effectiveness of the framework in developing learner competences is the consideration of the educational environment and its interaction with the learner. Learners come to the educational setting having not only their own knowledge, skillset, worldviews, values and life experiences but also their own socio-political consciousness and educational history. This is alternatively called cultural capital and may enhance or inhibit learning especially if the learning environment is biased or not inclusive of the differences among learners (Cobern, 1996). The learner is influenced, according to Bronfenbrenner's ecological systems theory, by various spheres with which they interact (Crawford, 2020).

Immediate is the family, peers, educators, community members and the interactions among them. At an intermediate level, the learner is indirectly influenced by social, economic and governance structures, ideologies and attitudes of the culture. Lastly, at the outmost level, the learner is influenced by the environmental changes and transitions in larger time scales that influence the life events of a learner (Guy-Evans, 2020). It would be useful if educators were encouraged to develop holistic thinking, tolerance and acceptance with critical ability to use pedagogy that enables their students to explore their life experiences, accepted worldviews and values, spheres of influence and the very practice of sustainability and education and challenge them to come up with new conceptualisations (Kumaravadivelu, 2001). This would be particularly useful in avoiding framing as well as tackling uncertainty and complexity though developing self-regulation as highlighted in the problem and project based case study scenarios.

A useful way to enable effectiveness of the learning environment is to employ a constructivist view (McLeod, n.d.) in pedagogy design. As the implemented case studies show the learning environment should become dynamic and allow learners to express their own views, explain their thinking and in return, offer them opportunities to challenge those views and ways of thinking or reinforce them. This was obvious in the university case study, where students were challenged to understand an open-ended management problem with highly uncertain data and future implications, combine their views and navigate the complexities they faced to deliver a strategy for their clients. In the secondary school case study, the students selected the sustainability problem on which to focus on their own, but were given guidance and previous training in identifying and linking sustainability problems to the SDGs. They faced a lot of complexity and challenges with project realization, but at the same time managed to persevere either due to having selected the topic themselves and thus were committed or because the teachers/team mates encouraged them to do so. The primary school case study endeavored to challenge the students through linking concepts (such as water, food and energy) and exposing the connections between seemingly unrelated processes (e.g., growing food in other countries and consuming it in the UK results in virtual water transport) to offer them a holistic view of the food, energy, water nexus.

Constructivism also gives attention to students' emotions and attitudes as they condition, prepare or inhibit student learning (Huber and Seidel, 2018). This was more obvious in the design of the primary school case study as the questionnaire analysis showed the students had positive attitudes toward sustainability both prior to and after the learning activities. In the university case study, emotions were mainly related with how the students worked in teams and regulated conflict, while a similar approach was found in the secondary school with the students also focusing on recovering from failure. Because of the link between emotions, attitudes and behaviors that can lead to sustainability action (Sleurs, 2011), the learning environment should offer rich opportunities for learners to experience emotions and develop or change their attitudes toward learning and sustainability if appropriate, including through interacting with peers and

educators. The affective domain of learning should be considered by education practitioners and policy-makers in the field of school and university ESD as it can enable development of sustainability competences for the longer-term, and be given equal attention to the cognitive and behavioral domains.

The case studies helped identify some barriers that hinder the effectiveness of ESD. The concept of competence had not previously been used in primary school education in the integrated form used in the case study. In most cases competence is assessed as environmental knowledge gain or environmental attitudes' change (Legault and Pelletier, 2000; Kioupi and Arianoutsou, 2016) in students participating in environmental education programmes. The primary school decided to select cognitive, affective and behavioral learning outcomes around the environmental dimensions of the water, food and energy nexus because of its simpler form and due to time limitations. Thus, the environmental knowledge dimension of sustainability competence was more prominent in the primary school than holism and pluralism, which are integral parts of ESD. This lack of holism and pluralism could be related to the opinion of teachers that the developmental stage in which the primary school pupils were in their learning was premature and would pose difficulties for the students to grasp sustainability's interconnected nature.

School education practitioners are encouraged to focus on knowledge, emotional and behavioral gains around all three pillars of sustainability for school students participating in ESD programmes, engaging many perspectives on what can be sustainable and what not (Pauw et al., 2015). By contrast, the secondary school case study aimed to look at sustainability competences holistically and bring in multiple perspectives (environmental, social, economic, and psychological). This was apparent in the projects the students developed around the SDGs and in their self and team assessments. However, the ability of students to cope with failure and conflict was low, which shows that although secondary school students can engage in challenging sustainability projects as such, they need to be provided with tools on how to self-regulate and collaborate.

In the primary school, the lack of holism and pluralism was considered a barrier to truly empowering students with critical thinking in making informed decisions. In the secondary school, the lack of programme integration and continuity within the curriculum resulted in reduced student and teacher engagement with sustainability. These barriers have been identified by other authors who stress that the integration of sustainability across the programme of study is more difficult in secondary education than primary (Taylor et al., 2019). This is because of the rigid structure of the curriculum, but it is nevertheless worth investing in ESD being the central part of a school's work due to its benefits for student learning (Fredriksson et al., 2020). Policy-makers should therefore consider implementing changes at the secondary school level, as a siloed approach to different topics, whereby ESD is just another add-on in the curriculum, does not enhance learning. There is a strong movement in the UK specifically that advocates the need for a whole institution approach (WIA) that ensures all students engage in sustainability action (British Educational Research Association, 2021).

In the university case study, improving focus on sustainability attributes such as health and wellbeing, diversity and inclusion and the social dimensions of sustainability can result in wider approaches to teaching and learning that can support the holistic development of students as competent sustainability practitioners. Nevertheless, having a programme of study about sustainability is considered to be an isolated initiative especially if sustainability in other areas of the institution is rather low (operations, research, governance, outreach) and there is a lack of an integrative framework for guiding, supporting and linking activities at the institutional level (Weiss et al., 2021). Similarly to school education, at the university level, a WIA could lead to the ideal collaborative paradigm change toward sustainability that merges bottom-up and top-down approaches in all its dimensions (Weiss et al., 2021).

Linking effectiveness in developing sustainability competences in learners with enabling sustainability transformation through educational programmes (research question 5), it would be of interest to education practitioners, curriculum developers and policy makers to use the framework as strategizing tool when planning curriculum reviews, especially in the university sector. It would be beneficial for the aforementioned stakeholders to set clear targets for transformation based on data collected in advance of the review, such as how their programmes' LOs are aligning with sustainability attributes. However, it is crucial to start a curriculum review with envisioning alternative sustainable futures (through a participatory process) (Amsler, 2019), thinking on how these can be achieved and then reformulating LOs in order to align with them. Checking the completeness of LOs with respect to the sustainability visions generated can be done by applying the assessment tool provided to achieve holistic representation of sustainability attributes. This can inform the entire process of the review and become an opportunity to integrate sustainability holistically, as the education stakeholders can problematize on the eight sustainability attributes by discussions on, for example: What does living well within planetary boundaries mean? How can we achieve inter and intra generational equity and justice? How can we develop resilience as a community? What is transparent governance for us? How can we achieve inclusion and diversity? What are the important factors that contribute to our health and wellbeing? How can we achieve transdisciplinary collaboration? How can we change the current economic model of ecological destruction and injustice? This way the curriculum will have a solid foundation of visions, principles, and aligned LOs to which to link the teaching and assessment activities.

Research findings also demonstrated the importance of participation, experimentation and flexibility in achieving sustainability transformation. All educational institutions in our case studies (university, primary and secondary school) engaged various stakeholders, to a greater or lesser extent, in decisions regarding their visions, educational curricula, learning outcomes, activities and assessments. They were open to collaborating with the researchers to experiment during the research interventions with new ways of looking into their educational programmes. For example, the secondary school

teachers were open to implementing assessment of competences, although their programme was not formally marked, and experimenting with different types of assessments although they had no prior experience with these. They generated insights and knowledge around why they did things the way they did, such as the primary school teachers who wanted to instill a sustainability ethos in the students of the school that sometimes resulted in positive or negative framing of the concepts used. They also wanted to try other ways of teaching them, such as through inquiry that enables the students to investigate the concepts in focus. The university stakeholders saw the benefits of a competence-based approach in formulating LOs and the assessment of competence through the use of rubrics to evaluate the different performance levels, but at the same time recognized that the process can pose challenges for academic staff (unfamiliarity, inconsistency, time consuming assessment) as well as for the students (working toward performance levels and not marks, needing more support).

Overall, there is good evidence that a systems approach to the integration of the SDGs into education as shown by the application of our framework has the potential to transform education toward sustainability (research question 5). It can enable learners to develop sustainability competences through reorienting LOs toward sustainability, aligning curricula, learning and assessments. The SDGs as an element of intentional design in education can offer normative goals that can motivate intentions to act and bring about change (Caniglia et al., 2021). This can happen by explicitly selecting LOs aligned to the SDGs (such as those though our framework); leaving no one behind by tackling power asymmetries (such as those between the educator and the student, the head teacher and the teachers, the programme director, academic staff and students) and through providing equal participation opportunities for all groups (educators, students, directors etc.) to develop and exercise their agency.

Starting by integrating the SDGs through their translation into sustainability competences in educational offerings of all levels can incentivise and condition other internal and external stakeholders to do the same, as these are broad areas that can be used to transform all aspects of the educational institution. Having achieved that first stage, the transformation toward sustainability initiated in the educational communities would potentially diffuse into the local or regional communities through synergies among educational institutions and local stakeholders and by the graduates of those institutions working actively for and with those communities. The expected outcome would be progress toward achieving the UN 2030 SDGs and this can be quantified in the indicators selected by the global community (Costanza et al., 2016; Muff et al., 2018).

Sustainability transformations need to take place all around the world, and education can provide the ecosystem to foster them (Scoones et al., 2018). Higher system parameters such as cultural shifts and societal changes will need to help align such efforts toward sustainability to achieve natural and human wellbeing (Boyer et al., 2016). Such shifts will nurture diverse communities of practice, creating a mosaic of various ideas, perspectives and approaches. Education institutions can be the

hubs that generate the appropriate conditions for these shifts and enable the interactions among various stakeholders to reach a state that they all thrive. It is crucial that all educators and stakeholders who have been trained in the dominant paradigm of education get the support they need to open to new ideas (Wade, 2008). It is in the diversity of those interactions and openness to innovation that new ideas can be generated within communities. The ideas can be turned into actions and thus communities can provide sustainability services to society and an antidote to homogeneity. Regional Centres of Expertise (RCEs) on ESD, which are networks that are often organized around a university and bring multiple local stakeholders together to implement local and regional sustainability efforts coordinated by the United Nations University, can catalyze this effort. They can share best practices with other HE institutions, schools and other formal, non-formal and informal educational organizations and plan the transformation of education needed for sustainability to emerge (Wade, 2013; United Nations University Institute for the Advanced Study of Sustainability, 2021).

CONCLUDING THOUGHTS AND FUTURE RESEARCH OPPORTUNITIES

The application of the systemic framework for integrating the SDGs into educational outcomes and aforementioned assessment showed evidence of its effectiveness and the benefit various education levels can reap from engaging with these approaches. Based on the case study findings the steps of the framework can be enhanced and below is revised set of steps that could be implemented by educational communities:

- Step 1 - brining the education stakeholders together in participatory visioning of what a sustainable future would look like for them if the SDGs had been fulfilled; including the attributes of a sustainable society that has achieved the SDGs as an open framework on which the stakeholders can discuss their views so they have a base to develop their shared understanding of sustainability as well as the ideal learner. Discussions on including diverse voices as well as tackling power asymmetries are essential in this step.
- Step 2 - selecting the competences that target the sustainability attributes and facilitate the sustainability transition; checking the alignment of the selected competences to the attributes using the assessment tool developed to identify gaps and make adjustments if needed.
- Step 3 - identifying the enabling conditions that will allow competence development in learners such as constructive alignment among competences, pedagogies and assessments, educational environment design, educator professional development, implementation of curriculum reviews for sustainability integration and WIA approaches for enabling sustainability transformation.
- Step 4 – selecting pedagogies and assessments for enabling the required competence development based on the principles of ESD (holism, pluralism, critical analysis, collaboration, authenticity, real world application, lived experience, targeting cognitive, affective and behavioral aspects of competences).

- Step 5 - monitoring and evaluation of progress toward the sustainable state, collection of data through the assessment tools on learner competence to inform decision-making in an iterative process; crucial for its success is the participation of all stakeholders with interest and power; flexibility in adapting to new circumstances, experimenting with new ways of doing things (including teaching and assessing) and enhancing the contribution to the SDGs through forming partnerships with local, regional and international communities.

Future research could apply this framework to universities and schools from other geographies and orientations and comparisons could be made among diverse programmes of study on how they applied it in their communities and what were the benefits they experienced. It could also focus on the continuity of competence development through the different educational levels to identify developmental indicators of how knowledge, skill and behavior are actually evolving through the learner's educational journey. What is more, longitudinal studies that follow the graduates of ESD aligned programmes into their educational and societal roles and assess their application of sustainability competences in the service of community would verify the lasting effect those approaches can have on learners.

Other opportunities to take this research forward could focus on assessing the effectiveness of teacher empowerment with capacities for SDGs integration with the systemic framework and tools in teacher training sessions, how this reflects in their teaching practice, curriculum, pedagogy and assessment design and implementation, and how it affects student development of competence. Assessing the effectiveness of WIAs in terms of integrating SDGs vision in governance, operations, education, research and community engagement and outreach would show the added benefit of the assessment methods and allow for comparisons and lessons to be shared among educational institutions.

Finally, yet importantly, educational communities should engage in in depth discussions (or interviews and focus groups) about how by enabling their educators and learners develop sustainability competences and implementing a WIA, they are influencing the achievement of the SDGs at a local level. It would be helpful if the educational institutions would report on how they are impacting the realization of the SDGs locally through the use of the indicators of specific SDGs (United Nations, 2018) that are important for their communities. They could also use various existing tools such as the gap frame for monitoring and evaluation of their contributions (Muff et al., 2018).

This research took place in three educational settings that had the "institutional freedom" to develop their own curricula, LOs, teaching and learning and assessments following some official guidance. In cases where there are strict rules and curricula to be followed based on national guidelines for example the framework needs to be adapted. However, as further policy recommendation, granting freedom to education institutions to manage their vision, mission, curricula, learning outcomes,

pedagogies and assessments using participatory and systems approaches could help increase the flexibility and effectiveness of education. This can happen as a mix of a bottom-up (community-led approaches) and top-down method (formal education agencies' enabling policy). Another way to do this, would be to encourage diversity in learning outcomes as well as in practices used so that learners can be empowered to make critical and informed decisions around challenging sustainability issues and have the capacity for working in inter and transdisciplinary teams. The five-step framework and derived assessment tools can support educator and policy-maker training, with the main concepts covered in policy documents related to increasing the effectiveness of ESD. Sustainability needs to be an integral part of all education, incorporated in institutional agendas and practices of all countries as an enabling factor for achieving the SDGs. These changes will allow education to play a critical role for enabling the sustainability transformation our society urgently needs.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Imperial College London Research Ethics Committee. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

FUNDING

ACKNOWLEDGMENTS

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