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RECEIVED 15 April 2024

ACCEPTED 25 June 2024

PUBLISHED 10 July 2024

CITATION

Annelin A and Boström G-O (2024)
Interdisciplinary perspectives on sustainability
in higher education: a sustainability
competence support model.
Front. Sustain. 5:1416498.
doi: 10.3389/frsus.2024.1416498

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Interdisciplinary perspectives on sustainability in higher education: a sustainability competence support model

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After several decades of work toward elevating sustainability education, many have called for a transformation of the education system to create timely action. Teachers, students, organizational leaders, and many other stakeholders have voiced their dissatisfaction with their experience of sustainability education. Some say we can do more to create real action for sustainable futures. We investigate what, how and why lectures across disciplines at universities in different countries work with sustainability education. We conduct interviews and dialogs with teachers across disciplines to uncover interdisciplinary perspectives on sustainability education and how to move forward. The emerging reflections provide insights about transformations in the strategies and systems, and how to implement sustainability education. There is also a call for reuniting diverse intrapersonal and values thinking between stakeholders to support transformations in sustainability education. Furthermore, participants imagined the future as a creative space where collaboration across disciplines facilitates a student-centred transdisciplinary experience with real-world practice. This study provides insights into the mindset of teachers across disciplines and countries. A sustainability competence-based support model about the current sustainability education discourse is developed.

KEYWORDS

sustainability in higher education, sustainability competence, transformative learning theory, didactics, interview, interdisciplinary

1 Introduction

In 2015, under the guidance of UN, 273 countries agreed on 17 sustainable development goals (SDGs). The SDGs have created a helpful pathway to guide organisations, such as universities, through their own targets and goals for a sustainable future. UNESCO (2017) have recognized an important relationship between education for sustainable development (ESD), the key sustainability competencies (KSC) described in Wiek et al.'s (2011) framework and the ability to attain the 17 SDGs. There is a call for action in education to develop students' competencies to work with the sustainability problems we face now.

Internationally, universities have been working to integrate sustainability not just in their education but across campus developing learning labs (Hald, 2010) and a whole school approach (Mogren et al., 2019). The demand for ESD has been placed on the general education community to integrate ESD into ongoing present modules, courses and programs across disciplines. The reasons for why teachers must deliver ESD is clearly outspoken by several stakeholders, for example institutions such as UNESCO and state education authorities

(Swedish Council for Higher Education, 2021), teachers, students and university leaders (Leal Filho et al., 2020). Teachers have been given the freedom to identify what and how sustainability should be taught. In order to do this work cooperation and exchange of ideas and resources is needed.

Space for creativity in sustainability education (SE) has been discussed (Hart et al., 2009; Clark and Button, 2011; McCrory et al., 2020), and a call for less add-on lectures about sustainability (Wals and Benavot, 2017; Barth et al., 2023) since it puts little emphasis on the importance of the transdisciplinary knowledge that SE embodies. Transdisciplinary knowledge (Scholz and Steiner, 2015) includes interdisciplinary knowledge and practical knowledge in the process of inquiry of sustainability challenges; and interdisciplinary knowledge is derived from different disciplinary science that provide different perspectives and understanding of the knowledge. To be able to help students to delve deeper into the sustainability challenges faced, students need to build capacity in sustainability competency through richer transdisciplinary activities (Backman et al., 2019; Alm et al., 2021). Community learning labs (Hald, 2010; Macintyre et al., 2020; Holmén et al., 2022) are one example of how universities have been working to enable richer engaging activities that can apply transdisciplinary approaches to sustainability education. Such learning spaces provide scientific and practical knowledge experiences for several stakeholders.

Many advocate for a student-centred experiential learning approach (Ely, 2018; Backman et al., 2019; Öhman and Sund, 2021). Experiential learning provides a space to prepare students for real-world problems and is not a new approach at many universities, however real-world problems often require an interdisciplinary approach. This involves many higher education teachers reassessing how they have been practicing the art of SE, to transform the language of teachers toward an interdisciplinary language of sustainability science (Brundiers et al., 2020).

SE questions what we teach, why we teach and how we teach it, as a sustainability discourse (Seatter, 2017). To facilitate a transformation in the SE discourse from a political position guided by the UN toward a position situated in knowledge of transdisciplinary sustainability science, it is time to support higher education teachers to share, learn and collaborate teaching experiences. We ask what has been experienced by teachers to teach sustainability, how do teachers practice sustainability education and imagine a future of SE, and why teachers implement SE.

In this article we investigate the findings from an action research project that has created and participated in different events across university campuses in higher education internationally. In the next section we discuss the theoretical background to the work conducted in the project. Section 3 provides insights from practicing higher education teachers and we conclude the article with a model about the sustainability education discourse across universities.

2 Transdisciplinary didactics for sustainability education: transformative learning theory

Transdisciplinary SE provides scientific and practical knowledge about complex sustainability challenges that require interdisciplinary scientific inquiry as well as practical understanding (Scholz and Steiner,

2015). Interdisciplinary SE includes the concepts and knowledge that combine different disciplinary perspectives to provide a more holistic scientific approach to the learning experience. Knowledge from practice also provides multiple and diverse stakeholder real-world perspectives on complex sustainability challenges. Together, science and practice provide a transdisciplinary sustainability learning space.

Didactic is a theory about what, how and why learners' build capacity to transform through the tools of knowledge and skills (Öhman and Sund, 2021; Mård and Hilli, 2022). As knowledge is taught about what sustainability concerns in each discipline, teachers are increasingly aware of a need to include interdisciplinary, multi-disciplinary and transdisciplinary (Barth et al., 2023) approaches to teach what sustainability is about from a scientific and practical perspective. How teachers teach sustainability can be quite diverse, using different pedagogical approaches (Lozano et al., 2017) within the disciplinary norms. Why teachers teach through sustainability or why they are resistant to the practice of SE could be due to our different feelings toward SE (Shephard and Furnari, 2013), which presents a diverse intrapersonal thinking toward sustainability science.

Furthermore, transformative learning theory explains learning that transforms values through intra-personal self-awareness that creates an understanding of our ethical responsibility (Sterling, 2010). Transformations in SE include the need for a holistic integration and a built-in approach (Wals, 2014) of sustainability in higher education. For transformative learning to be successful, the institution must put in place the principles and policies that lead the teachers toward transforming sustainability education toward a transdisciplinary approach and teachers become facilitators of co-created learning.

Many universities have applied different principles and policies in line with aspects of the sustainability perspective or sustainable development in their education system, which reveals support through sustainability leadership (Leal Filho et al., 2020). Higher education transformations toward student-centred learning that can challenge traditional mindsets and promote creativity (Lozano, 2006; Barth et al., 2007; Baumber, 2022) requires adapting how teachers teach from the role as teacher to a role of learning with students – co-created transdisciplinary learning. The sustainability competence of teachers and students therefore build capacity to transform practices to be able to act on sustainability challenges (Brundiers et al., 2020; Redman and Wiek, 2021).

Students and teachers recognize and understand sustainability's wicked problems (Lönngrén and van Poeck, 2021). Transformative learning requests a space for students to consider life-long learning for sustainability. Facilitators engage with students through more active, inspiring and solution-based activities (Eka Putri et al., 2023). Interdisciplinary activities, such as anticipatory practices (Sharpe et al., 2016), and art in sustainability teaching (Clark and Button, 2011; Heinrich and Kørnø, 2021) are increasingly called for but not often applied. A transdisciplinary approach to sustainability learning can provide the knowledge and skills students and teachers need to transform SE (Scholz and Steiner, 2015; Baumber, 2022).

3 Method

We conducted interviews and facilitated dialogs with teachers to learn from their experience teaching sustainability in their different disciplines. Open question interviews were conducted among

participants to let information about higher education experience emerge (Alvesson, 2003). We identified several questions based in research (Cebrián, 2017) to design an interview guide (see Supplementary Appendix) that could help elicit information about the three main research questions: (1) what teachers experience to teach sustainability education, (2) how have teachers captured opportunities to build student capacity for sustainability, and (3) why teachers implement SE? Sub questions included probes into the teachers' understanding of sustainability and evaluation of SE work.

3.1 Participants

We sought out teachers that work at universities on an international scale that are responsible for courses on a program because we wanted to understand what might have changed over several years. The sample followed the snowball approach (Mweshi and Sakyi, 2020) through known contacts (seeds) at Umeå university and in the Baltic University program initiative that are directly involved in SE initiatives. We also began our search for participants with teachers who work in an environment where SE is emphasized but do not specifically teach on an SE named course or program. Those that were recommended by interviewees that had participated were then contacted, which included several universities in Sweden and Finland and then Germany and the UK and the Netherlands. This approach has led to a large international project that is taking part in several cooperations on an international scale. In total, emails were sent to 67 teachers that work across all faculties and several disciplines¹ in Sweden, Finland, Germany, Poland, Latvia, Greece, England, the Netherlands, Canada, the US and Australia. The experience of the teachers in higher education is a range of between 3 years to 40 years, and teacher roles ranged from PhD students to full professors, including adjunct professors, administrators, sustainability leaders and pedagogical development roles. The authors acknowledge that the snowball approach to sample selection has its limitations and can explain why the participants may present certain perspectives that differ compared to teachers based at universities in locations that are not represented in this study.

3.2 Data collection

We conducted the interviews and facilitated dialogs between 2020 and 2023, using Zoom and face to face, and each took between 60 min and 90 min long. The length of time was influenced by discretion of the researchers, pragmatic reasoning and the number of details being elicited (Alvesson, 2003; Creswell, 2006). There were 26 interviews that were recorded on Zoom, and transcribed using the software called Trint. Consent was given to record interviews and use the information for research. Other dialogs were documented by note taking. Interviews and dialogs were conducted in English, but sometimes in Swedish to

help participants in Sweden feel comfortable to talk freely. The authors are proficient in both languages. Both researchers participated in the data collection and reflected on the experience together.

3.3 Data analysis

The inductive and emergent thematic analysis follows recommendations in research (Alvesson, 2003; Denzin and Lincoln, 2011). First, we took notes during interviews which revealed emerging themes that were coded manually. Interviewer discussions after each interview helped to recognize patterns emerging (Alvesson, 2003). Second, listening to the recorded interviews helped to confirm and reveal new themes (Rowley, 2012; Leedy and Ormrod, 2013) that were manually coded. Third, the software called NVivo was used to upload transcripts and organize the codes by the emerging themes.

We applied the cluster analysis in NVivo and found that “knowledge” and “time” is needed to “teach students sustainability” [themes of support and lack resources] and “to teach something different” and through “good research” [themes of knowledge-based sustainability science, didactics and practice]. Also, to “change business” we “need to question what we know” and teachers “want” to integrate “sustainability well in a course to actually be a part and mean” something and emphasize that it is “important people discuss courses and meaning” in SE [themes of facilitation support, transformation through action and sustainability science, shared collaboration].

The themes that emerged and confirmed by participants and the cluster analysis were then established as “support” and the “lack of resources,” especially time that we frame as strategy and systems thinking; also, themes of “didactics in practice” that we frame as implementation thinking, teacher “attitudes” revealed intrapersonal and values thinking and “collaboration” as interpersonal and future thinking, to create interventions for a sustainability science transformative education system. The coding scheme was confirmed by a line by line reading of the transcripts and then comparing the codes between participants (Rowley, 2012; Leedy and Ormrod, 2013). What emerged by the manual coding is the application of the key sustainability competencies that frame the discussions revealed by the participants. Each researcher cross reviewed the analysis to test the trustworthiness of the emergent themes and data was collected over several years to provide a varied perspective from different participants.

For anonymity, each participant was given a coded name, for example, P1=participant number 1. The cites chosen for our discussion in section 4 represent the emerging themes that the participants gave during the interviews and were verified by continuing dialogs with participants at different universities. The interview responses were also verified by participating teachers to assess our interpretation of the responses. The translation of the Swedish speaking interviews into English was conducted when both researchers had come to an agreement about the information and meaning behind the chosen response data quotes used in the paper.

4 Results: a dialog with teachers in higher education

After listening to many teachers in higher education during interviews, project presentations, workshops and other collaborations

¹ Art, history, literature and language, philosophy, law, religious studies, anthropology, economics, geography, political science, psychology, sociology, biology, chemistry, physics, earth science, computer science, mathematics, architecture, design, business, education, engineering and technology, environmental science, forestry, media, library, and medicine.

at universities, we have developed a thematic presentation of the narrative. The following results will provide perspectives about how SE has been experienced in the higher education systems at different universities across several countries. The analysis is organized to answer the three research questions: (1) what teachers experience across disciplines to teach sustainability, (2) how have teachers captured opportunities to build student capacity for sustainability, and (3) why teachers implement SE?

4.1 What teachers experience across disciplines to teach sustainability

When listening to teachers discuss their experience with teaching sustainability education, it became apparent that the participants were applying their systems and strategic thinking competence to sustainability education. While thinking about the education system that sustainability education is applied within, teachers provide insight into the different strategies that have been applied and the strategies that are preferred. Teachers that participated in this study have called for a renewal of guidance by sustainability education leaders and innovative methods to deal with time restraints.

4.1.1 Strategic thinking: renew guidance

There are several international groups that provide guidance toward transforming education to a sustainability perspective, for example the principles for responsible management education (PRME) and the UN's sustainable development solutions network (SDSN). There are also several national and local initiatives that can help guide teachers through their work to transform SE in their subjects. Despite the efforts made by many, teachers can struggle to find the guidance and leadership required for applying sustainability education. While reflecting on the sustainability education strategies, several participants pointed out a need for more guidance from outside their personal network, saying:

We personally know some people that are doing research on certain things in certain areas, and we can talk to them. But what if we make it a bit more formal by saying that, you know, for questions related to that, you may have these people that you can talk to or you need some guidance when it comes to teaching sustainability related issues. You may have a discussion with them that could be in a very nice way to also kind of have a better team when it comes to teaching certain phenomena (P3).

Guidance only being provided from personal networks is not sufficient and there is an outspoken need for direction. "From above, you can give more support and also directives that sustainability should become a natural part of our education" (P 21). [Evans \(2015\)](#) finds that when there are visionary leaders in position at the administration of universities transformations on a transdisciplinary level will be most successful. Support from sustainability education leaders is on demand and organising formal support to facilitate capacity building in sustainability teaching is recommended.

The system of sustainability education can differ tremendously between universities across countries, some have been able to create full learning labs dedicated to sustainability education, while others feel that they do not know how to integrate sustainability into their

education. Some participants point out that guidance about what to expect from the next class of students is lacking in the system of educational programs, saying,

To know what the knowledge of students is, the background knowledge of students who are coming to you, to your course... you do not know if they [the students] already have had some introduction... this fragmented nature of the way we teach sustainability that it's usually used just like a small thing here, a lecture here and you do not know how sort of the overall progression of learning looks like with students...there's a fragmentation of sustainability learning (P9).

Formative assessments ([Andrade, 2019](#)) can help teachers to plan and provide lessons adapted to the students' needs. Several of the participants also called for a whole school approach as a strategy, for example "I think if we had kind of a more common understanding as a school, how we want to teach about it and how to teach about it, and then any kind of guidelines that we could have, almost some kind of teachers' manual" (P18). Guidance from the whole school could provide a strategy to achieve a sustainability perspective integrated in a sustainability science curriculum for transdisciplinary learning ([Barth et al., 2023](#)). We have experienced that there is a clear voice from all countries that asks for more formal support to guide SE transformations, support which is considered vital in the abilities of teachers to create transformations in their teaching activities ([Henderson and Tilbury, 2006](#); [Copsey, 2018](#)).

There is some variation in how the interviewees perceive the level of support that already exists in different countries. There are perceptions of countries that have better support by the laws and policy that have been set. Participants in countries that have installed policies and laws on SE perceive that support is not given to create space to practically apply teaching. Participants in countries that have little law or policy support for SE find they have the space to create practical teaching opportunities with support between teachers, and instead ask for guidance from above to bring these initiatives to scale. Thus, the systems and strategies applied to SE can vary across countries, but all teachers perceive a need for support and guidance from management and between teachers and universities. Sustainability education leadership that facilitates teaching practices has been lacking across all disciplines on an international scale.

4.1.2 Systems thinking: restore time as the actor (innovator)

Reflecting on the education system, most participants have discussed lack of time as a challenge. Many universities create a system where teacher training hours are rewarded, and the planning is created around a specific number of hours applied to different university duties. There is a difference between disciplines within universities about how the working hours are delegated to teaching hours, research hours and other activities such as community engagement and meetings. The lack of time to train, to reflect, to adapt and create is very present in higher education, where work overload and overtime is expected and considered a norm in the culture of academia. If a teacher teaches 100 percent of their work time or more (overtime/work in their free time), when do teachers get to train, learn, adapt create build or find the space to transform their education for sustainability. This concern indicates a perspective on time in

sustainability education that is probably one of the reasons why sustainability as an add-on lecture is still the norm found in education today.

While reflecting on the higher education system of time and expectations for development, a participant explained,

I do not always have the time to prepare as much as I would like to. But I mean, that's a resource issue as well. You have to prioritize. Do one course at a time. And I can feel that sometimes what I'm talking about feels a bit outdated because so much happens in the area, but I do not always have the time to keep up...when I tried to bring these issues up [integrating sustainability education], people do not have time and then the meeting is over and then we do not talk about it. So, I mean, that approach [bottom-up] has not really worked. So, I think we need firmer top-down approach as well (P12).

This evidence represents a system developed to cope with a lack of resources in higher education. Sustainability leadership is not just needed in the policies driven from above, but also sustainability leadership for SE is a common discussion across all disciplines. A lack of resources indicates that teachers need to develop an approach to SE through systems thinking, by reflecting on what universities do have and creating interdisciplinary support where students can benefit from knowledge from different perspectives (Scholz and Steiner, 2015; Baumber, 2022). In order to help teachers to feel comfortable to take the risk to try something that they are not an expert in, requires a transformative mindset and a willing to work with the co-created curriculum approach (Bovill, 2020). Support for the teachers can come from active listening that can generate ideas for the teachers to connect what they already do to the sustainability perspective. An efficient approach that may not seem like time taking could be required. Evident in a reflection, a participant acknowledged how a lack of time and knowledge can be intertwined, saying,

I think that, or I want to think that nobody's against sustainability in our [workplace], with our colleagues, because it's well-educated people that should know better. But I think that in a lot of cases, it's time and knowledge...It's not that people do not want to. It's time to rethink and integrate it in a good way. When people are already swamped with work, to be honest (P6).

Since lack of time has become such a problem for these teachers, there is sense that even if there is a will the teachers have not been able to find space in the system to analyze where and how they can implement SE. One answer to seeing time as a restraint on building capacity could be eased by interdisciplinary support and input by practitioners, since efficiency in time and knowledge could transfer between disciplines to provide space to apply transdisciplinary SE. Furthermore, some participants revealed the lack of importance emphasized on SE, since training for SE would take time away from other work.

I think it's always about the fact that we have limited time. We have limited resources. Then I think it boils down to it taking too much time from other things or taking too many resources from other things that you also have to do (P11).

Several participants resonated with the suggestion that the university system expects too much from teachers in terms of the activities demanded in order to keep their job or climb the professional academic ladder; “publish or perish” is a common reiterated phrase, but nothing about teaching SE or your out. Hence, SE leadership is needed to inform and engage, encourage and create action for a transdisciplinary approach to higher education. Although some sustainability learning labs have begun a more inclusive whole institution approach to education for sustainability (Hald, 2010; Holmén et al., 2022), many teachers still lack such support networks. All participants have mentioned to us that they feel there are not many teachers that share the passion for SE and therefore find it difficult to organize courses or programs, and holistic learning or living labs that can provide such learning spaces are considered an even bigger challenge within the current university system. Many participants do not find they are given the right resources to support the work necessary for transformation of their educational practices.

However, some say “just do it!” (P25) and “Stop talking about time!” (P10) and indicate that sustainability education should be incorporated no matter the resources or time to work or resistance in the education system. An interdisciplinary approach to SE could help develop teachers' capacity to transform mindsets toward collaborative teaching programs that provide the needed knowledge environment for student sustainability learning. Therefore, there is some differentiation in how engaged and driven teachers are to develop their SE no matter what time they have for work or other activities.

It was apparent that strategic and systems thinking challenges for support and time were common across disciplines and universities in different countries. If time is the actor in this challenge, how do we transform teacher mindsets to consider time through an alternative lens (Facer, 2022). Innovations in how time is perceived and how time is used as well as how time drives transformations can be considered to adapt within the education systems or develop new educational systems. Future research can pursue these topics to find out more about what international transdisciplinary support networks can provide in terms of guidance, collaboration and resources that can implement SE transformation without needing more time. Also, how can time be used to benefit the needs of teachers and students in sustainability education. Moreover, future research could study why the actor of time is so urgent, uncertain and unsustainable across disciplines and nations.

4.2 How teachers practice sustainability education and imagine future teaching

When we discussed how teachers teach sustainability with the participants, there is great enthusiasm in engaging implementation thinking about how to inspire students into action to work with the sustainability challenges. There are many similarities practices across different countries that teachers wish to keep doing due to the success and engagement created with students. However, there is also a common understanding that some practices need to be renounced so that space is provided for a better learning environment for all students.

4.2.1 Implementation thinking: practices to keep and renounce

The participants have pointed out the availability of courses about SE provided for teachers at their university, but in most cases it is not mandatory for teachers to train in sustainability education. Courses on SE can help teachers to reflect on what they are doing and how they can develop their work as well as inspire new approaches. Several participants point out that they thought teacher education and training activities that can provide opportunities for reflection and innovation for implementing into lesson plans is needed.

To transform sustainability more effectively in higher education, researchers point out that there is a need to develop pedagogical approaches (Lozano et al., 2017; Backman et al., 2019) not just about sustainability but for sustainability (Persson et al., 2023). Several researchers (Wiek et al., 2011; Wals and Benavot, 2017; Brundiers et al., 2020) also recognize that we need to be able to teach for sustainability in a way that can enable students to act on the sustainability challenges we face; to work on creating solutions for a sustainable future (Browne et al., 2020). Holdsworth and Thomas (2015) have found that applying an interdisciplinary approach coupled with a holistic framework can help teachers develop their sustainability education. Some examples of pedagogical activities disclosed by participants of this study include experiential approaches that benefit from a practical understanding, for example:

The literature, cases and examples we give creates a ground for discussions that helps to influence the students. It is quite important to choose something that is interesting and guest lectures that come from the practical world gain more interest from students than researchers as teachers. It is important that the course works on follow-ups to the guest teachers' points to keep the knowledge flowing about current practical points. What are the negative consequences and what can we do better? (P13).

Experiential activities can create opportunities to learn and contribute to society's sustainability challenges through real-world learning practices. It is evident that academics across participating nations include out-reach activities in the activities planned for SE to build capacity in implementation competency. Some lectures informed us that they have designed capstone projects where students work with organizations that have proven to develop intrapersonal thinking competencies for sustainability, visible in the reflection work set for students that take part in these experiential activities.

A common discussion we had with participants is that there are different perspectives about whether the teacher teaches a course that includes sustainability, teach a course about sustainability, or whether sustainability is a pedagogical approach applied to teach. One participant explained:

It's the balance, because it's a lot of things in each course that we want to teach them, that I want them to have with them and to really let them dig into it, but still not take over the entire course because it's not a course in sustainability... it cannot be the only thing we need to think about when we are planning... and there are several other factors that are also important (P16).

While some teachers still struggle with how they can teach about sustainability, others build capacity for sustainability through

the pedagogical activities and resources they use to develop the students' competence in sustainability. Some participants pointed out that integrating SE into the education system will be a natural learning curve process that needs to solidify in real, tangible applications with each subject. A participant explains their experience, saying:

Teachers should not be left to include sustainability... gender was important 20 years ago... it was good that the department was focusing on, for example, female researchers and there should be similar tangible programs for sustainability. People who research on sustainability should be awarded and students... promoting, also financing research projects, and systematically including our own research in teaching, would be good. I mean, make it tangible. Not only promises and ideas (P7).

Tangible application of the sustainability perspective requires a transformation of mindset in how sustainability science can be taught. It is no longer an additional application of material that teachers need to apply, but a perspective on science with a transdisciplinary approach (Salovaara et al., 2020). Sustainability competencies are something that enables the student to act for a sustainable future, to transform societies and take on their ethical responsibility (Sterling, 2010).

Some participants in the Netherlands, the United Kingdom, Sweden, and United States have shared with us about how they have implemented creative approaches to teaching, becoming facilitators (rather than the role of teacher) and providing students with the space to co-create learning activities. The activities include real-world experiential support but also traditional discussion and literature-based study. The systems are described as flexible that can also control for university norms, such as expected learning outcomes, program goals and set text literature.

Several participants across countries have discussed a reluctance to share ideas, resources, tools used in the classroom. Some have even discussed the intangible patent on their own ideas, material and classroom material, suggesting ownership over pedagogics. However, some have revealed more open approaches and believe in shared resources for all teachers. Thus, approaches to SE practices differ between nations due to national academic norms. The competence to implement SE is similar across disciplines, where most participants mentioned how there are only a few that really get involved and thus there is much room for improvement and a need to transform mindsets of teachers in each discipline to be able to implement SE on a transdisciplinary scale across universities. Future research could investigate what practices can facilitate the international application of sustainability education, how can transdisciplinary knowledge be best applied in teacher learning activities across nations, and why applying alternative creative and flexible transdisciplinary practices in SE can be met with resistance.

4.3 Why teachers implement sustainability education

As we discussed the teachers' own interest toward SE their intrapersonal and values thinking competencies showed diverse perspectives across countries and disciplines. It is widely regarded (Brundiers et al., 2020; Redman and Wiek, 2021) that attitudes and

interests influence self-awareness and the mindset that builds intrapersonal thinking competency. The teachers' intrapersonal thinking and implementation brings meaning to SE that can then build student capacity for sustainability competence. When we asked participants about what they would change in SE, the participants future thinking revealed that they would like opportunities to collaborate and use creative innovations in SE.

4.3.1 Intrapersonal and values thinking: reunite with diversity

The expectations from policies made at management in departments and at the main university governing body can be faced by a group of teachers that have diverse attitudes, interests and values toward the sustainability perspective. During interviews, we noticed that some feel that they should or must implement sustainability, while others feel it's not natural or it's not 'my' subject. Other teachers are completely comfortable with the demands of policy or law to integrate SE into the curriculum, for example one participant said, "we need to make teachers realize that it is important" (P2). However, it was revealed that many teachers feel alone in their work to teach SE. For example,

I take one course at a time and try to focus a bit more on developing that one, but we can do that in a more strategic way and a joint way, rather than just me doing it all by myself when I'm basing the choice of where to go and what to do on my own knowledge and values, rather than the strategy of the school overall (P26).

This is an example of how teachers question their own influence on the SE they can provide, showing that self-awareness and resilience is a fundamental capacity needed in higher education. This first stage approach to SE where the teacher experiments with what they know can have its positive effects, to start from somewhere there is a safe space (Holmén et al., 2021). However, to take the next step and transform SE the teacher needs support to feel comfortable to experiment with new interventions. "There is certainly support that I'm not aware of for this teaching sustainability, but it's very much up to the individual teacher" (P20). Support from collaborative groups to know how to teach for sustainability is lacking (Persson et al., 2023).

One obstacle to transforming SE is the different interests that teachers hold themselves. If a teacher holds an opposing position on what is taught and how it is taught, they may find it hard to see the benefits of why they teach sustainability. This was indicated by participants that said:

I think it might be the interest. People have different interests in sustainability ... I think the clarity from above can also become clearer. There is a trade-off here. The academic freedom that we should have and then the one that slips it into everything that we do at the university, regardless of whether it is research, teaching or going to meetings or whatever (P14).

If higher education teachers have a lack of incentive (Cho, 2017) and argue for academic freedom (Hugé et al., 2016), it can be difficult to persuade teachers to educate for sustainability when their attitude toward it is reluctance, negative or in disagreement. Teachers feel they

need to communicate these diverse values and capabilities for intrapersonal reflexivity and be heard. Transforming teachers' mindsets toward a transdisciplinary approach where diverse knowledge can emerge could help bridge this divide in SE values. Transformative learning encourages new ways of reflecting and understanding the complex challenges of sustainability and requires collaboration and support (Baumber, 2022). Another participant points out:

It would be interesting to hear other people's perspectives on how sustainability can be incorporated into it [a course], because I do not see that it's always a natural fit, although I have not thought that much about it, but you know. Perhaps we should. Perhaps we have to, but I do not see that it's always a natural bedfellow. In some areas, of course, it is perfect, you can talk about anything (P4).

It is apparent that the capacity for inner development differs between participants of different disciplines. Those in the humanities and especially art and music find self-awareness and reflecting on a sustainability mindset is a natural experience, while those in mathematics, chemistry and physics have shown less engagement with their own capacity to work with SE. Another participant explained their position through their understanding of sustainability as a political agenda, "The 24 goals. Is it 24 goals of the UN? Teaching sustainability seems very politicized to me" (P22), showing a disinterest in how many UN SDGs there are and showing a disliking in the politics of how Greta Thunberg has been used or how activists behave, the participant continues:

"What I want to say is I do not ever want to be doctrinal. This is why I do not like the whole Greta movement, because to me it's doctrinal. I mean, if I may elaborate on that, the way she's dealing with this current issue, she's a mouthpiece for whomever. She has influence over millions of young people. And I think she's the anti-Trump actually. I think they are both as dangerous as each other" (P22).

The nature of sustainable development as a political movement, derived from development diplomacy (Bolis et al., 2014; Moomaw et al., 2017) has created an overwhelming emphasis on the values of one type of sustainability. Several participants point out that they have experienced a resistance to the term transformation or students as change-agents, since it holds a political opinion that some believe academics should not hold (Shephard and Furnari, 2013; Hugé et al., 2016). However, the value of transformational learning has its background in understanding diverse cultural values and sustainability science has a value base where transdisciplinary knowledge exchange is emphasized (Sprain and Timpson, 2012). Although the scientific values of sustainability should be understood by teachers, through a scientific dialog, sustainability as a science has not been emphasized as much as the UNs SDGs (Bendell, 2022). A teacher set in the sustainability science approach explained their position,

If someone is trying to change a text description or a learning outcome related to sustainability, I'm not accepting it, really. It will not be accepted unless it's covered in some other way. Which is

then an improvement, probably, but taking something out related to sustainability will not fly (P5).

This complex environment of values conflicts can hinder the transformation of the education process. The values of sustainability may be misinterpreted when thinking only through the UN's SDGs. Teachers have their own values as well as work within a system of values and a community of different values, for example "some people might not want to, or they do not feel confident, so they need this kind of, you know, encouragement" (P1). Teachers also have their own personal attitudes and self-awareness. For example, one participant suggested "I think we need to make it interesting for people to work with" (P2), implying that SE is not interesting enough to put effort into transforming the existing education. Comparatively, a teacher in the arts states "I think it is art that will save us. It is art that connects us, helps us to understand, to feel, to connect, communicate and enjoy life" (P24). Teachers' attitudes and knowledge of sustainability can affect their ability to transform SE (Jones et al., 2010). The diversity of teachers' attitudes, interests and values across disciplines creates a complex environment where collaboration needs to be encouraged.

4.3.2 Futuring and interpersonal thinking: imagining creations

Transforming education so that students can act on what they know is of primary concern to the participants of this study. Teachers talked about how there is a need to develop a network of local, regional, national and international colleagues for SE to enable a learning space for students that can act on the transdisciplinary of sustainability challenges. When we discussed what the teachers thought would help them transform their education for sustainability, participants replied "Maybe just sit together and talk about it because it's kind of seems like one of those things you kind of talk about informally, but how you would actually do it creatively" (P8). Also,

I would like collegial discussions, or workshops or seminars or something for the teachers ...support of my colleagues. I mean, if we were to discuss and develop these things together, that would be a great leap forward. And then we can also have directed development issues that focus like I do now by myself (P15).

Although workshop and seminar series are often created and ongoing in most higher education institutions, the problem of having no time to attend comes up again. Several participants point out how there are low attendance rates for seminar series about SE already provided. Since many of these participants also noted that they do not know about such opportunities, it seems that information dissemination across campuses and between universities is lacking. Explained well in a participant's response,

If there was a possibility of creating and maintaining a sort of pedagogical community which is interested in this [sustainability education], and questions, deeply and wants to explore together how we can improve teaching...how could we develop our teaching in order to make things work? So, a sort of community of this kind would be interesting (P17).

And when asked about how to act on these ideas, participants revealed that creating a space for experimentation, where teachers can easily access information and collaborate on different scales, locally, nationally and internationally. A safe space to try ideas and experiment with new activities in the classroom (Holmén et al., 2021). For example,

There needs to be some kind of action and one action that has been done is like drawing it [sustainability education] into the different courses. But I think that a page on the Internet that provides tips and tricks and discussion, and that each section or someone responsible that is really good at different parts could come up with ideas on that subject. How to integrate sustainability into a subject... we create a hub of examples on how it can be done. Both integrating in different topics, but also sustainability in general... How do you do it in class? Depending on subject, because it's different, depending on subject (P8).

Practical and flexible resources in a coordinated open access environment requires collaboration, the will to share and support each other in a reciprocal relationship. This work to practically implement activities with students has also had a varied response. Some participants have talked about the difficulty of incorporating different practices when traditional practices need to also be taught, such as lab work and the use of different tools and materials. A space where ideas are shared could inspire different disciplines and how to adapt to include different activities. A participant disclosed,

Creating these pockets of experimentation and freedom. Because the thing is also when you do this, especially if you want to do something new, you want an environment where you can experiment and play and introduce things. And of course, within the existing structures that might be challenged. Could it mean like designing your courses? Could it mean, creating more space within existing courses? (P19).

There have been several examples of teachers who imagine a future where teaching has transformed. The futuring method (Sharpe et al., 2016; Liveley et al., 2021; Czerniewicz and Cronin, 2023) has proven to be a useful technique to help teachers imagine what is wanted and backcast to how teaching is experienced now, and then consider the changes in structure and behavior in order to achieve the imagined future. A technique and practical tool that can also be applied in many different student class contexts. There have been several successes in universities around the world (Hald, 2010), but many still call for guidance to sustainability education. Participants from all disciplines have discussed that they need support between universities on an international scale and believe that this could help to facilitate the imagined transformation in higher education.

5 Discussion and conclusion

In dialog with practicing university teachers on an international scale we listened to many experiences that call for reinforced support and collaboration to be able to create a space for the transformation

of sustainability in higher education. Add-on lectures are not sufficient, students need more (McCrory et al., 2020). Reflections on what we have been teaching, why we must continue this work and how we can achieve this have provided insights into the present state of SE and its imagined future.

We identified themes in the narrative about support and guidance, practical teaching inspiration and innovative time solutions, collaboration and facilitation of open resources, and most importantly action that can transform SE toward a student-centred approach. It is apparent that there is a relation (see Figure 1) between the support that can be provided by management and the support that can be shared between lectures across subjects, departments and universities on an international scale (strategy-interpersonal). Also, support to provide the imagined space to facilitate co-creation, student-centred learning and the transdisciplinary sustainability science approach (strategy-futures). In order to apply such transdisciplinary approaches (strategy-implementation), teachers discuss the inspiration of how some schools have abandoned the traditional approach to the higher education system and designed new schools (Ecoversties, 2018; LIS, 2024), while others have applied alternative approaches within the traditional education system (Hald, 2010).

Some teachers have brought up the complex connection that SE has with political agendas and suggest inspiration and shared resources between universities is needed to be able to apply sustainability didactics from a non-political perspective (values-implementation). In a call to open up a space for facilitation lectures ask to reconcile the diverse values and intrapersonal feelings toward sustainability education in order to better collaborate (values-interpersonal). Across these diverse teachers there is a common call for guidance from management in a whole school approach and

sustainability leaders across departments, disciplines and universities to share practices, knowledge and other resources with compassion (system-intrapersonal).

In order to implement transformations in SE teachers across countries have noticed some practices are not working and some practices that have been used for many decades have been well fitted to the SE approach (systems-implementation). Teachers are inspired by the learning experiences that have applied a transdisciplinary approach and many have discussed how sustainability didactics can help this process (futures-system) but recognize the complex nature of teaching across disciplines in current education systems.

To conclude, teachers reflected on the different types of guidance that direct sustainability in higher education. Some teachers disclosed how useful the policy and legal directives can be as a support since it can help with resistance from students or colleagues. Others commented on the dialog about sustainability science as an interdisciplinary knowledge approach to create dialog for SE support. Hence, the guidance and support from legal directives, institutional goals, visions and missions and departmental management policy can help drive the work of SE (Persson et al., 2023), but much more support from sustainability education leaders is needed from a sustainability science basis to create a transformation of the education system.

Several constraints were revealed including the lack of resources in terms of time to develop courses, competencies in sustainability and being left alone to do the work. Many teachers talked about the feeling of being left alone leads to risks in the workplace due to diverse values and management approaches. Participants call for time to create space for a dialog supported in sustainability science to overcome the challenges faced in transformations of teaching sustainability education.

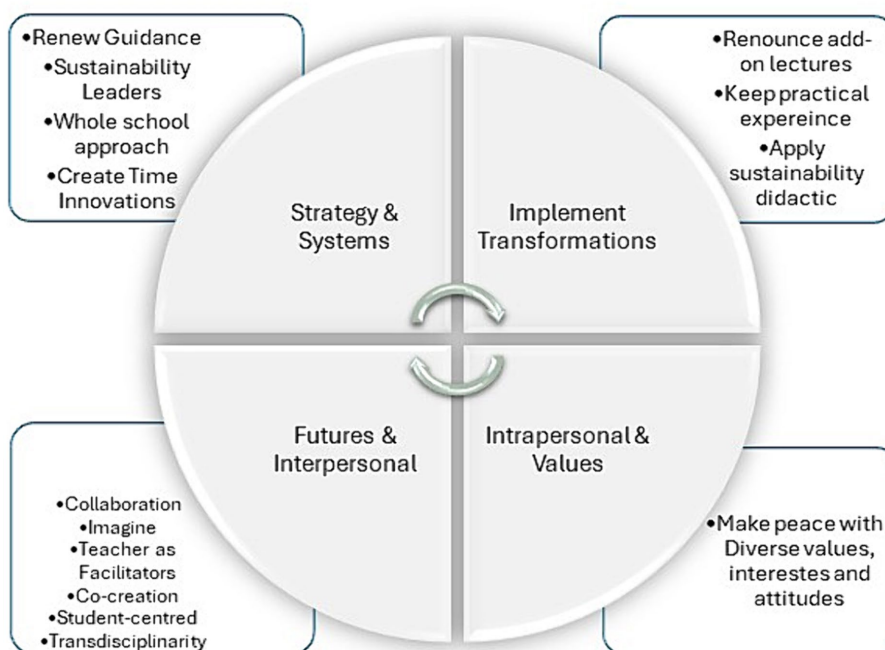


FIGURE 1 Space to facilitate transformations in sustainability education.

Across disciplines teachers shared common capacity to apply systems, strategic, interpersonal and futures thinking. However, they also signaled that their approach to provide SE through these competencies have different approaches and apply different theories. This indicates that there is room for an interdisciplinary approach where collaboration could provide knowledge from these different perspectives across disciplines and combine to create new knowledge as teachers and students learn from each other in sustainability science inquiry.

The discussion also revealed that teachers differ in their values, intrapersonal and implementation thinking competencies across disciplines. For example, engineering and business teachers are well experienced in implementation competency building and include practice in their SE, and teachers in the arts, literature and sociology find it is common to apply intrapersonal competencies since self-reflection activities are the norm. There is evidence to suggest that different disciplines work with values, intrapersonal and implementation competencies to different extents, some not at all touching on these competencies. Hence, there is a great possibility to learn from each other through interdisciplinary collaborations in SE. Teachers in higher education commonly train in pedagogics to improve their teaching. It would benefit SE if teachers could also train in different disciplines to improve their knowledge across disciplines.

Sustainability values are widely described as political and are regularly considered controversial in higher education. There is a need to move away from the idea that sustainability values are only a political notion, and instead move toward sustainability as a transdisciplinary science. Teachers who collaborate on an interdisciplinary scale to teach and to learn across disciplines, and of course, from practice, can provide a transformed sustainability education.

Data availability statement

The datasets presented in this article are not readily available because the interviews are anonymous. Requests to access the datasets should be directed to alice.annelin@umu.se.

Ethics statement

Ethical approval was not required for the studies involving humans because no sensitive information is obtained and therefore does not need to have an ethical review board approval according to Swedish law under the Act (2003: 460). The studies were conducted in

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accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. G-OB: Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. We were awarded funds during the research process by an internal to Umeå University fund for teaching, called PUNKTUM.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsus.2024.1416498/full#supplementary-material>

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