Sustainable Competences in Higher Education – Pre-pilot Study

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ABSTRACT

This paper presents results from a case study of a Pre-pilot educational activity in the Erasmus+ project on Sustainable Competences in Higher Education Institutions (2022-2024). Teacher students' acquisition of sustainable competences represents a major educational challenge at bachelor level and generally in education in Nordic countries and internationally. With reference to UNESCO guidelines, the overview of results indicated that in the cognitive domain learning outcomes in a medium to a high degree included acquisition of natural science knowledge about sand mining and sustainability. Furthermore, the interdisciplinary teaching methods seemed to a medium degree to facilitate teacher student motivation and learning outcomes in relation to socio-emotional dimensions and interculturality. In the behavioral domain, results indicated that student teachers to a high degree acquired competences to imagine realistic scenarios within an educational context. More research is needed in student-centered approaches, and we hope that the project has contributed to the current need for bridging the gap between traditional education and more student-centered learning in relation to 'Futures of Education'.

KEYWORDS: ESD; Socio-scientific issues; action competence; teacher students; UNESCO

Introduction

The aim of this paper is to present results from an Erasmus+ project on Sustainable Competences in Higher Education Institutions (2022-2024). Students' acquisition of sustainable competences represents a major educational challenge at bachelor level and generally in education in Nordic countries and internationally, as stated by scholars during the last decade (Læssøe et al, 2009; Læssøe & Mochizuki, 2015; Lysgaard & Jørgensen, 2020; Garsdal, 2020; Larsen et al., 2022). The Project Sustainable Competences in Higher Education is funded by

Erasmus+ and the European HEI partners: University of Agder, Norway, Masaryk University in the Czech Republic, University of Ljubljana in Slovenia and UCL University College in Denmark. With the duration of thirty months from February 2022 till November 2024 it was an intention to bridge the gap between traditional sector divided educations via the development of an interdisciplinary, future-oriented curriculum for teaching 'Education for Sustainable Development' at bachelor level in higher education. With reference to the UNESCO framework, it was an aim that HE students at bachelor level would develop sustainable competences such as cognitive competences in the form of 'knowledge about' sustainability and the related problems; socio-emotional competences in the form of intercultural understanding, interpersonal skills; behavioral competences such as digital readiness, real-time experiences with online collaboration (COIL) and transversal competences to work problem based, project-oriented and to initiate, develop and conduct the needed transformations and changes (Application, Sustainable Competences in Higher Education, 2021).

The SustainComp State of the Art Report (Ruge et al., 2022) was conducted with case study research methods (Yin, 2009) and focused on previous ESD activities in the partner HEIs. The results documented that a limited number of lecturers at each HEI were including and integrating sustainability issues in their lectures. Further, these lecturers missed more educational resources and wished to become members of an ESD community. The case study inquiry documented that the teaching of ESD as a separate course was uncommon and only conducted by a few lecturers at each partner HEIs. Followingly, it was more common for lecturers to teach sustainability 'as part of other topics such as Social Science, Pedagogy, Arts, Biology (Ruge et al., 2022). The results documented that the UNSDGs were included as an educational resource, both to focus on certain challenges regarding sustainability and as full concept of seventeen goals for the 2030 agenda for sustainable development and the major challenges associated with reaching the goals. With reference to the insights from the State-of-the-Art report, the development work was initiated and undertaken by lecturers and researchers from the SustainComp HEI partners in spring 2023. The basic question that guided the development process in the project was: How can the teaching of sustainable development be integrated into existing subjects in a way that is meaningful and motivating for the students and support the acquisition of sustainable competences?

The development process was conducted as a 'design-based-research' approach, which included teacher training and conduction of two Pre-pilots in April 2023:

Teacher-training: On-site course at Masaryk University in fall 2022

Pre-pilot 1: On-site, focused on integration of Natural Science and English topics from a project-oriented approach (UCL)

Pre-pilot 2: On-line, focused on sustainable food systems from a student 'Collaborative Online International Learning' (MUNI)

After evaluation, the Pre-pilots provided early insights that led to internal adjustments that were transferred to the full-scale pilot in fall semester 2023. Similarly, this activity was evaluated and adjusted in the form of the finalized curriculum in 2024. The SustainComp curriculum is available as an Open Access educational resource from an online, e-learning platform by November 2024.

Starting with the Pre-pilot.

The results presented in this paper only concern the educational activities in Pre-pilot 1, conducted at UCL in April during the spring semester of 2023. While the scope of the SustainComp project is wider than the results to be presented in this paper - such as the development of interdisciplinary and intercultural curriculum for a variety of bachelor students and the development of HE teacher training and online support - valuable insights were gained from Pre-pilot work that we suggest are relevant, both to the continued development and in a general perspective on ESD.

During Pre-pilot 1, a group of six lecturers at the bachelor's degree Program in Education at UCL collaborated on innovative, participatory research- and development activities in a way that corresponded with the UNESCO framework for ESD and the Frascati Manual for 'Research-and-Development' at HE (Frascati Manual, OECD 2015, p. 42-42). The UCL teacher group collaborated as a community of practice (COP) (Lave & Wenger, 2001) on the development of experimental, cross curricular teaching activities in bachelor subjects of 'English as a Foreign Language' and 'Nature & Technology' in spring 2023. The activities focused on 'Sand mining and Sustainability' in a local, regional, and global perspective, with reference to the UNSDGs and the scientific work of Mette Bendixen at McGill University in Canada (Bendixen et al., 2021).
Furthermore, the COP collaborated on associated research activities based on two research questions:

1) Aim & content: What did the students learn in the cognitive, socio-cultural, and behavioral domains of the teaching activities?
2) Project-oriented methods: What did students learn directly and indirectly about working project-oriented and problem-oriented?

Methods and conceptual framework

Generally, the application of an integrated 'Research-and-Development' (R&D) approach is a core activity at University Colleges in Denmark with reference to the Frascati Manual[1]. Further, applied research in didactical and pedagogical practices is emblematic of the research that is

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[1] Bachelor of Education Students are Teachers, Social Educators, Nurses, Physiotherapists, and other occupation within public 'welfare state'.
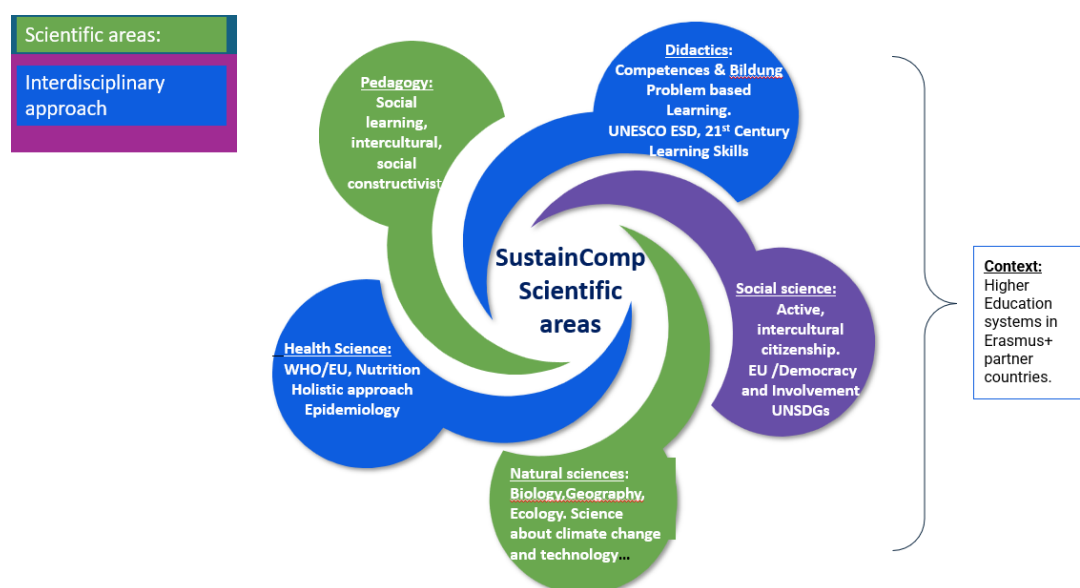
requested at University Colleges in Denmark[2]. In this perspective the research we have conducted in relation to the SustainComp project corresponds very well with the Frascati recommendations: "Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge" (Frascati Manual, OECD 2015, p. 42-42).

Regarding the pedagogical content in the R&D activities, Education for Sustainable Development' (ESD), was previously taught at UCL as a specialized course for bachelor students at UCL teacher education since 2018, in the format of a 1-semester (10 ECTS) course. Lectures have been conducted as co-teaching between Kristensen, Lecturer in Geography and Ruge, Lecturer, Environment and Planning. The conceptual framework for these courses has taken the point of departure in an interdisciplinary, UNESCO based approach, that also encompass PBL and a project-oriented approach. Action research on students' learning outcome from these courses has been conducted and disseminated (Ruge & Kristensen, 2023) in a 'teacher educator as researcher' approach (MacPhail, 2020). Results indicated that Bachelor of Education students acquired both new knowledge and skills (cognitive), increased engagement (socio-emotional) and action competence (behavioral) regarding ESD. Especially, the project-oriented part of the ESD course, which requested students to develop a didactical product for ESD in primary og secondary school, was appreciated by the students, because they expected that competences to collaborate on ESD in an inter-disciplinary context would be in demand by future employers – in schools and in municipalities. This teaching method meant that learning for sustainability - often referred to as 'ESD 1' - and 'Critical thinking about sustainable development - often referred to as 'ESD 2' (Vare & Scott, 2007) was integrated in a meaningful way. To those bachelor student teachers, the preparation of a lesson plan and the teaching activity represented a concrete action for the promotion of sustainable development.

During the development stages of the SustainComp project, experiences and results from UCL were included and combined with experiences from ESD I the partner HEIs and transformed into an interdisciplinary framework that also reflects to typical topic domains in Bachelor Teacher Education. This is illustrated in Figure 1.

Figure 1. Interdisciplinary framework that reflects to typical topic domains in bachelor teacher education. Development model for SustainComp curriculum (SustainComp Project, 2022)

[2] Public announcement about University Colleges in Denmark, Retsinformation, Bekendtgørelse LBK 779 om Professionshøjskoler (2019) https://www.retsinformation.dk/eli/lta/2019/779

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In March 2023, a new executive order for Teacher Education was introduced by the Danish government. Of high interest for SustainComp, the notion of education in a democratic and sustainable perspective was included in the new aim: Teacher training must prepare the students to work actively, independently and responsibly in the development of the primary school, in accordance with the purpose of the primary school and in a democratic and sustainable perspective'.

As the SustainComp project is interdisciplinary in nature and approach, models and theories from both respective fields of English (English as Second Language) and Natural Science are applied. The teaching activities included 'co-teaching' between the lecturers: Lauridsen (Natural Science) and Gaarsmand (English), who represented the integrated 'Pedagogical Content Knowledge' (PCK), the competences that lecturers applied to conduct the course (Shulman, 2015; Ellebæk & Nielsen, 2016). An example of this is how they collaborated on the joint lesson plan that was inquiry and project-based, and how they lectured and guided students together. For applying an interdisciplinary method that integrated natural science and English, students were introduced to the SSIBL model of 'Socio-Scientific-Inquiry-Based Learning' (Levinson et al., 2017; Amos & Levinson, 2019) that was developed in the PARRISE project. According to Amos & Levinson, this pedagogical model incorporates the European Commission's approach to 'Responsible Research and Innovation' to encourage students to ask real-world questions that interest them, collect evidence to answer the questions and as a result act. The model was developed with special attention to the UNSDGs as a framework for ESD. For Pre-pilot one, Gaarsmand and Lauridsen planned the pedagogical activities with inspiration from SSIBL to plan and conduct interdisciplinary, cross-curricular teaching. See figure 2. To focus on the context of Bachelor Teacher Education we added a stage called 'Extend', where students as part of their assignment developed a year-adjusted lesson plan for the chosen topic regarding sustainability.

Figure 2. Plan for lectures and activities (Lauridsen & Gaarsmand, 2023) inspired by the SSIBL model (Amos & Levinson, 2019)
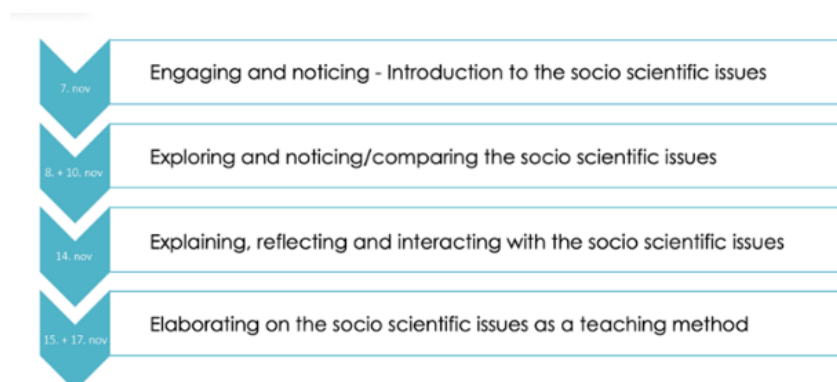
Additionally, from the English curriculum at Bachelor Teacher Education, theories and research about intercultural competences was applied (Byram, 2002). Regarding the special focus on sustainability, theories about the four Cs, also known as 21st Century learning skills and the UN Sustainable Development Goals (UNESCO, 2019) were introduced to the students as educational resources.

Co-teaching as a didactical approach

During Pre-pilot 1 Gaarsmand and Lauridsen conducted 'co-teaching' which encompassed the joint planning of lectures and student exercises (Chang, 2018). In addition, teachers conducted lectures in each other's classes and observed each other during lectures. This approach is inspired by the work of Friend and Cook (Friend & Cook, 2010), who presented six strategies for co-teaching as a didactical approach: 1) One teach, one observes, in which one teacher leads large-group instruction while the other gathers academic, behavioral, or social data on specific students or the class group, 2) Station teaching, in which instruction is divided into three nonsequential parts and students, likewise divided into three groups, rotate from station to station, being taught by the teachers at two stations and working independently at the third, 3) Parallel teaching, in which the two teachers, each with half the class group, present the same material for the primary purpose of fostering instructional differentiation and increasing student participation, 4) Alternative teaching, in which one teacher works with most students while the other works with a small group for remediation, enrichment, assessment, pre-teaching, or another purpose, 5) Teaming, in which both teachers lead large-group instruction by both lecturing, representing opposing views in a debate, illustrating two ways to solve a problem, and so on, 6) One teach, one assist, in which one teacher leads instruction while the other circulates among the students offering individual assistance. (2010, 11-12). As a didactical approach, co-teaching has existed for many decades. While the work of Friend & Cook is widely known and respected amongst primary and secondary school teachers, as well as special education professionals, Jarvis & Kariuki (2017) report that from their review of co-teaching research, that research pertaining to the benefits and effectiveness of co-teaching in higher education seems to be lacking. As we surveyed the literature, we noted that while substantial

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formal and anecdotal research has been reported by teachers at the elementary and secondary school levels, far less material exists at the post-secondary and graduate study levels. (2017, 4). In the scope of the SustainComp project, co-teaching across educational methods and disciplines has enabled lecturers to collaborate and expand their 'Pedagogical Content Knowledge' in a way that encompasses both content, teaching methods, students' pre-understanding and their response to SSIBL approaches in teaching sustainability and UNSDGs. A deeper understanding of the co-teaching approach and the contribution to students' learning outcomes is beyond the scope of this paper but will be researched soon.

The co-teaching lecturers and their three co-researching colleagues constituted a Community of Practice (COP) (Lave & Wenger, 2001) while they collaborated on the development and action research of experimental, cross curricular teaching activities in English and Nature & Technology at bachelor level in spring 2023. The subject area for the teaching activities stemmed from the complex issues around sandmining and sustainability: Time is Running out for sand' (Bendixen et al., 2019). Overall, these issues were dealt with from the cognitive, socio-emotional, and behavioral domains with reference to UNESCO's guideline for ESD (UNESCO, 2019). The application of the UNSDGs as a semantic educational resource facilitated an integrated, local, regional, and global perspective during the lectures. As a socio-scientific issue this subject area touched on a high variety of domains and concepts, for instance the relation between nature and culture and how human activities are destroying the livelihoods of animals, plants, and other living organisms on the planet. As the lecturers did not have the 'solutions' students were involved in open-ended discussions and learning processes, which facilitated students' co-creation and critical thinking. (Garsdal et al., 2020). Students worked in groups and during their project work, they had the opportunity to choose to work on an associated or related Socio-Scientific Issue (SSI).

Activities and Data Collection

The display in Figure 3 Timeline illustrates how activities were organized and how data collection was conducted. Data was collected by researchers via qualitative methods in the form of observations of lectures, interviews with students, video, photo, recordings, and documents. Data was organized in TEAMS folder and analyzed by thematic analysis (Clarke and Braun, 2017)

Figure 3. Timeline. Participants, Educational Activities, and forms of Data Collection*

Time / week	Student Participants	Lecturer 1 & 2	Didactical & pedagogical approach	Activities	Data collection
April 10.-15. / Week 16 2023	StG1: N=22	Lauridsen (NS) &	Raising authentic questions	Student in groups raised questions regarding the sand mining and sustainability as an SSI	Observation. Focus-group interviews. Photo. Audio recording. Documents: co-teaching plan for lectures.
	StG2: N=28	Gaarsmand (ENG) Engaged in co-teaching	Enaction	Students in groups made inquiry about SSI, also other than sand mining. Critical reflections on solutions.	
April 17.-21. / Week 17 2023	StG1: N=22	Lauridsen (NS) & Gaarsmand (ENG) Engaged in co-teaching	Action	Students in groups initiated pedagogical activities and educational resources on selected SSI.	Observation. Focus-group interviews. Photo. Audio recording. Documents: Students' module assignment. (Make a 'lesson plan for school')
	StG2: N=28		Extend	Students in groups agreed on and made an age-adjusted lesson plan on the chosen topic as the 'Pre-pilot assignment'	

*Week 16: April 10-15, 2023, Week 17: April 17-21 ,2023.
Student Participants: Student Group 1 (StG1) N=22, Student Group 2 (StG2) N=28.
Lecturer Participants: Lecturer 1 (Lauridsen) Natural Science (NS), Lecturer 2 (Gaarsmand) English (ENG); SSI = Socio-Scientific Issue.

This group of lecturers and researchers also constituted a team of 'teacher educators as re-searchers' (MacPhail, 2020), where the members engaged in participatory action research and critical inquiry about own pedagogical and didactical practices and the associated critical re-flections (Creswell & Poth, 2016). The aim of the research was to obtain 'practical knowledge' (Flyvbjerg, 2016) about the results of the Pre-pilot, which could be transferred and applied to the subsequent stage of the project: The Full-Scale-Pilot in fall 2023. The interest of the action research group was directed to students' acquisition of 'sustainable competences' in corre-spondence with the overall aim and objectives of the SustainComp project as described in the introduction.

Analysis and Results in Display

In the following section there will be examples in the form of quotes from collected data that illustrate the results of thematic analysis. The research question was:
1) Aim & content: What did the students learn in the cognitive, socio-cultural, and behavioral domains of the teaching activities?
2) Project-oriented methods: What did students learn directly and indirectly about working project-oriented and problem-oriented?

1) Aim & content: What did students learn in the cognitive, socio-cultural and behavioral domains of the teaching activities?

Stage I Raising Questions:

Students' own work on their assignments indicated that they acquired competences to raise questions as an initial step in the PBL approach. Further, that these questions could be charaterized as 'authentic' questions about real-world problems, such as sandmining. Rasing questions in English contributed to students' acquisition of linguistic competences to notice. Examples in the following quote from qualitative data:

> **How was it to work inquiry- and project based?**
> It has been exciting. It has provided insight into how you can work in this way. Also, to make an outline for a lesson plan – that I found very rewarding.
>
> (Student, K)

> It was exciting to work with a current and global problem. Because it is large and broad subject, you work very openly, which means that you can dive right into exactly what you. Conversely, it can also be difficult to work
> with such a large problem and with such free rein. You got a lot of superficial knowledge and didn't really get in depth. At the same time, no concrete solution could be found. It felt a bit like no matter what you came up with you ran into a wall. Could be a little demotivating, but at the same time also force one to think in new ways.   (Student, N)

> **What is your opinion on working with socio scientific issues?**
> That's good. Often something becomes more exciting when you can see a problem, or there is something that becomes more real, and you can see that You can use it for something.   (Student, K

Stage II Enaction:

> We realized how present it is in so many different projects and work areas, and how wide-ranging the sustainability goals reach.   (Student A)

In general, I would say that the project was okay, and I can see that I can use it for other contexts. (Student Y)

Stage III Action

It is very important to create teaching that addresses problems that not only can the students be affected by, but also other societies and cultures. The subjects are countless and there will always be something for every single student's interests. Scaffolding and differentiation are important to consider when planning your teaching according to socio-scientific issues. (Student F)

We all enjoyed getting more in depth with a specific topic.

(Student B)

What have you learned about sustainability?

Solutions for sand shortage:

A thing you could do, is to reduce new construction, and when making new construction you could use sand substitutes. Concrete reuse from old abandoned buildings. We think that the government holds a responsibility to stop the overuse of sand in construction and other professions. Another possible solution to the problem is to invest more in the research of a sustainable alternative to sand - or if we can make "fake sand"?

Increase public awareness - Raise public awareness about the importance of sand ecosystems and the need to protect them. It can help to reduce negative human impact on the environment. Spread the message. A solution for the use of sand. When buying clothes, computers etc. look into buying sustainable products.

(Students O & M)

Strawcture Eco: Use straws from farms instead of the farmers burning them, which increases air pollution. Creating panels that consist of 90% straw.
The material can be used for 80% of the interior of a building. That includes walls, floor, ceiling, furniture, and doors. Rice, wheat and sugar cane crops alone produce 500 million tons of straw per year.

(Students L, K, M & M)

What have you learned about sustainability?
Student Group presentation (extract) Pre-pilot SustainComp April 2023.
(Students L, K, M & M)

Stage IV Extend

What have you learned about intercultural competences, Bildung and 21st century skills?

We liked working with socio scientific issues, as it gave us a better view of how it can help make cross-curricular lessons. We also got a lot of new knowledge.

(Student V)

The solutions / *to prevent sand shortage*/ are not bulletproof, and there is no perfect solution. All of the possible solutions have consequences and raise different and new questions that are to be answered. The UN goals are difficult to fulfill. E.g. if you were to remove child labor, you would increase poverty, because the children contribute to providing for their families. A lot of the materials that may propose an alternative are not usable on a larger scale, and it is difficult to make larger high rise of massive complexes with the more sustainable or local resources

(Students L, K, M &M)

All results have been condensed and displayed in Figure 4 in accordance with qualitative methods criteria (Yin, 2012) to provide insight into the degree of acquisition of learning outcomes and sustainable competences. The results were analyzed via thematic analysis by the UCL COP in an action research format. In the following section, the research questions are used to provide an overview of the results, especially about students learning outcomes and experiences with the project-oriented approach.

Figure 4. Display of results for how students in groups acquired 'sustainable competences' in the cognitive, socio-emotional, and behavioral domain (cf. UNESCO, 2019). The four stages in SSIBL teaching plan are combined with the following categories for acquisition of competences: Low Degree (LoD), Medium Degree (MeD), High Degree (HiD).

Nr.	Stage in SSIBL	PBL work		Cognitive: 'Natural Science'		Cognitive: 'English'		Socio-Emotional		Behavioral	
I	Raising questions	Competences to formulate a problem statement	MeD	Competence to raise authentic questions about 'sand-mining'	HiD	Linguistic skills. competences to notice.	HiD	Intercultural understanding. competences to ask relevant questions about SSI	MeD	Skills to make an SSI inquiry with relevant questions	MeD

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II	Enaction	Competence to plan an investigation in stages	MeD	Competence to suggest solutions to SSI based on interdisciplinary learning - and to extend into similar SSI.	MeD	Linguistic skills. competences to talk and write about SSI in English	MeD	Competence to be empathic and constructive while collaborating on the inquiry.	MeD	Skills to collaborate; critical thinking; transversal skills	MeD
III	Action	Competence to act from an educational perspective.	MeD	Competences to suggest educational activities based on interdisciplinary learning.	HiD	Linguistic skills. competences to talk, write collaboration about pedagogical aspects of ESD.	HiD	Competence on innovative edu-resources; to imagine school children's worries, pre-understanding, and motivation for ESD.	MeD	Skills to imagine realistic actions for an educational context.	HiD
IV	Extend	Competence to conduct an educational material	MeD	Competence to make a lesson plan for age-adjusted children in school.	HiD	Linguistic skills. Competences to make educational resources for ESD in English	MeD	Competences to extend actions into lesson plan with relevant activities. Listening to peer group presentations; giving and receiving response.	HiD	Skills to collaborate on ESD resources; to rehearse and present for peers.	HiD

The overview of results in Figure 4. indicates that the student learning outcomes about sustainable competences in a medium to high degree (MeD/HiD) included acquisition of Natural science knowledge in relation to the theme: Sand mining and sustainability.

Further, the interdisciplinary, problem- and project-based teaching methods in the Pre-pilot, seemed to a medium degree (MeD) to facilitate student motivation and learning outcomes in relation to socio-emotional dimensions such as intercultural understanding of poverty, illness, emigration, and associated socio-scientific issues (SSI) to find solutions or improvements for the common good.

In the behavioral domain, results indicate that students to a high degree (HiD) acquired competences to imagine realistic scenarios within an educational context. Also, students acquired linguistic competences making them able to present their own ideas and products for peers; to give and receive response and feedback.

Generally, students complained that they had too little time to make the inquiry, to get ideas for the educational resource and to make the actual lesson plan.

Discussions of results

The findings and results indicate that students developed 'sustainable competences' as defined in the planning of the activities, within the cognitive, socio-emotional, and behavioral domains. However, there is reason to make a critical reflection on the limitations of the study and the implications for practice and research.

Limitations of the study

The case study research method that we have applied has been conducted in accordance with Robert Yin's guidelines for a qualitative study. Thus, it has been an objective for us to be transparent about the activities or the interventions that led to the results. As this is a single-case study we cannot generalize or claim that other lecturers would find identical results if they followed the SustainComp Pre-pilot one curriculum plan. Rather, we would suggest that some of the results would be similar, but still different, because lecturers and students have different personalities, experiences, emotions, and pre-understandings. Even if we regard the learning environment as a kind of 'laboratory' it would only make sense with reference to the experimental nature - with reference to John Dewey's experimental schools - not to the application of an RCT study method. The limitations of the single-case study method can to some extent be reduced by the in-depth knowledge that we have gained. Especially about how teacher students respond to an interdisciplinary course that took the point of departure in a socio-scientific issue in a way that integrated natural science with English and intercultural competences. The limited time for Pre-pilot one was a precondition that we were unable to change, and we can understand that students had the experience of having too little time. We expect that there will be enhanced flexibility regarding these preconditions during the full-scale-pilot and when all sub-modules are transferred to the online e-learning platform in August 2024.

In a wider European perspective, it would have been an advantage if the Pre-pilot was also conducted at the partner HEIs in the SustainComp project in Norway, Czech Republic, and Slovenia. Further, we would also have approved of students having the opportunity to apply their ideas and lesson plans for children in schools.

Taking these limitations into consideration, we have reason to conclude that the application of the SSIBL method, combined with project-oriented approach, conducted via co-teaching is a manageable way to conduct interdisciplinary ESD in accordance with the UNESCO guidelines. This is important, as the options for conducting interdisciplinary and project-oriented teaching activities for 'whole weeks' time seems to be almost non-existent in regular lesson plans at most HEIs in these years.

Implications for practice and research

One example of 'practical wisdom' (Flyvbjerg, 2016) or implications for practice from Pre-pilot one was that the format of SSIBL in relation to ESD can be integrated in existing topics at European HEIs. Furthermore, this approach might be applied by other teachers internationally, providing a flexible room for eventual cultural differences in student pre-understanding and

the actions that students will suggest. The Pre-pilot has provided new insight in ESD that was later applied in the SustainComp design-based research process via full-scale-pilot and final implementation on Open Access platform I 2024.

In a broader research perspective, we will conclude, that more research in SSIBL, cross-curricular, project-oriented, and student-centered approaches is needed to disseminate, share, and implement the SustainComp curriculum. There is also reason to suggest that our coming research focuses on the lecturer's practices during the 'full-scale pilot's' will also provide new insights of general interest in the field. Despite the limitations, the results have contributed to the aim of developing a new curriculum for Bachelor Teacher Education students' development of sustainable competences as part of their Higher Education, including intercultural competences and democratic citizenship. In this sense, the project has contributed to the current need for bridging the gap between traditional education and more innovative, interdisciplinary, and student-centered learning approaches within ESD and – we hope – also to the UNESCO initiative 'Futures of Education'.

Acknowledgements

Literature

Amos, R., & Levinson, R. (2019). Socio-scientific inquiry-based learning: An approach for engaging with the 2030 Sustainable Development Goals through school science. International Journal of Development Education and Global Learning, 11(1), 29-49. http://dx.doi.org/10.18546/IJDEGL.11.1.03

Application Erasmus (2021) Sustainable Competences in Higher Education (not published).

Bendixen, M., Best, J., Hackney, C., & Iversen, L. L. (2019). Time is running out for sand. Nature, 571(7763), 29-31. http://dx.doi.org/10.1038/d41586-019-02042-4

Bendixen, M., Iversen, L. L., Best, J., Franks, D. M., Hackney, C. R., Latrubesse, E. M., & Tusting, L. S. (2021). Sand, gravel, and UN Sustainable Development Goals: Conflicts, synergies, and pathways forward. OneEarth,4(8),1095-1111. http://dx.doi.org/10.1016/j.oneear.2021.07.008

Byram, M, Gribkova, B. & Starkey, H. (2002) Developing the Intercultural Dimension in Language Teaching. A Practical Introduction for Teachers. Council of Europe, Strasbourg https://rm.coe.int/16802fc1c3

Chang, S. H. (2018). Co-Teaching in Student Teaching of an Elementary Education Program. Teacher Educators' Journal, 11, 105-113.

Clarke, V., & Braun, V. (2017). Thematic analysis. Journal of positive psychology, 12(3), 297-298.

Creswell, J. W., & Poth, C. N. (2016). Qualitative inquiry and research design: Choosing among five approaches. Sage publications.

Ellebæk, J. J., & Nielsen, B. L. (2016). Pedagogical Content Knowledge (PCK)–et tiltrængt naturfagsdidaktisk forskningsfelt i Danmark? MONA-Matematik-og Naturfagsdidaktik, (4).

Flyvbjerg, B. (2012). Making social science matter. Social Science and Policy Challenges: Democracy, Values, and Capacities, Paris: UNESCOPublishing,25-56. http://dx.doi.org/10.1017/CBO9780511810503

Friend, M., Reising, M., & Cook, L. (1993). Co-teaching: An overview of the past, a glimpse at the present, and considerations for the future. Preventing School Failure: Alternative Education for Children and Youth, 37(4), 6-10. http://dx.doi.org/10.1080/1045988X.1993.9944611

Garsdal, J. (2020). Bæredygtighed og bæredygtig udvikling: uddannelse, dannelse og fagdidaktik i skole, erhvervs-og professionsuddannelser. VIA University College. https://www.ucviden.dk/ws/portalfiles/portal/107138967/PEAS_udgivelse1_BU_Dannelse_Uddannelse_ONLINE_final.pdf

Jarvis, D., & Kariuki, M. (Eds.). (2017). Co-teaching in higher education: from theory to co-practice. University of Toronto Press.

Larsen, N. (Ed.). (2023). Bæredygtig udvikling og professionsdidaktiske nedslag. VIA University College. https://www.ucviden.dk/ws/portalfiles/portal/183744260/bredygtig-udvikling-bog-a5-02-23-online.pdf

Lave, J., & Wenger, E. (2001). Legitimate peripheral participation in communities of practice. Supporting lifelong learning, 1, 111-127. http://dx.doi.org/10.1016/B978-0-7506-7223-8.50010-1

Levinson, R., Knippels, M.C., van Dam, F., Kyza, E., Christodoulou, A., Chang-Rundgren, S.N., Grace, M., Yarden, A., Abril, A., Amos, R., Ariza, M.R., Bächtold, M., van Baren-Nawrocka, J., Cohen, R., Dekker, S., Dias, C., Egyed, L., Fonseca, M., Georgiou, Y., Hadjichambis, A., van Harskamp, M., Hasslöf, H., Heidinger, C. Hervé, N., Karpati, A., Keedus, K., Kiraly, A., Lundström, M., Molinatti, G., Nédélec, L., Ottander, C., Ottander, K., Quesada, A., Radits, F., Radmann, D., Rauch, F., Rundgren, C., Simonneaux, L., Simonneaux, J., Sjöström, J., Verhoeff, R., Veugelers,

Dorte Ruge, Heather D, Johannsen, Thujetha T Piratheepan, Anja Rousing Lauridsen,
Stinus Mikkelsen, Solveig Gaarsmand

W., Zafrani, E (2017) Scientific Inquiry-Based Learning: connecting formal and informal science education with society, Parrise. http://dx.doi.org/10.3390/su132011509

Lysgaard, J. A., & Jørgensen, N. J. (2020). Bæredygtighedens pædagogik: forskningsperspektiver og eksempler fra praksis. Frydenlund Academic.

Læssøe, J., Schnack, K., Breiting, S., Rolls, S., Feinstein, N., & Goh, K. C. (2009). Climate change and sustainable development: The response from education. A cross-national report from international alliance of leading education institutes. The Danish School of Education, Aarhus University.

Læssøe, J., & Mochizuki, Y. (2015). Recent trends in national policy on education for sustainable development and climate change education. Journal of Education for Sustainable Development, 9(1), 27-43. http://dx.doi.org/10.1177/0973408215569112

MacPhail, A. (2020). Teacher educator as researcher: Striving towards a greater visibility for teacher education. In Being a Teacher Educator (pp. 142-154). Routledge.

OECD (2015) Frascati Manual https://www.oecd.org/innovation/frascati-manual-2015-9789264239012-en.htm

Ruge, D., Johannsen, H. D., Graf, S. T., Kostanjevec, S., Kozina, F. L., Reissmannová, J. S., ... & Vik, F. N. (2022). Project SustainComp, State of the art Report.: A Case Study of Four Higher Education Institutions. Norway, Czech Republic, Slovenia and Denmark. .https://www.ucviden.dk/ws/files/168754777/SustainComp_State_of_the_Art_Report.pdf

Shulman, L. S. (2015). PCK: Its genesis and exodus. In Re-examining pedagogical content knowledge in science education (pp. 3-13). Routledge.

UNESCO (2017) Rieckmann, M. Education for sustainable development goals: Learning objectives. UNESCO publishing. https://doi.org/10.54675/CGBA9153

Yin, R. K. (2009). Case study research: Design and methods (Vol. 5). sage. http://dx.doi.org/10.3138/cjpe.30.1.108