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Making sense of frustration and complexity when introducing sustainability in teacher education

Abstract

Teacher educators must question whether we are sufficiently preparing student teachers to educate children and young people who will have to cope with climate and environmental crises. This article reports on the introduction of environmental and sustainability education (ESE) in a large Norwegian teacher education institution and is framed by the institution's existing formal structures, practices, and local resources. We explore what opportunities, tensions, and obstacles emerged during a one-week intervention to reorient teacher education toward sustainability, drawing on several data sources, such as group interviews, surveys, and video recordings of student teacher group work. Our analyses emphasize the voices of student teachers in the analyses of this intervention. The participating student teachers had to recognize and negotiate complexity along both institutional and thematic dimensions. This complexity was related to both interdisciplinarity and sustainability. Authenticity also surfaced as an important concern because some of the student teachers questioned whether ESE in schools would contain similar interdisciplinary processes. The study indicates that structural transformations are needed in order for teacher education programs to accommodate both sustainability and interdisciplinarity as the student teachers are introduced to tools and resources that support their inquiries into complexity. If student teachers become familiar with interdisciplinary approaches, they will be better equipped to meet the complexity of sustainability, which involves ontological, normative and political concerns. Our attempt to introduce ESE to our institution's teacher education programs has not led to large-scale change, and ESE remains a limited perspective in these programs. However, given the challenges of global warming and the loss of biodiversity, we contend that more significant interventions are urgently needed.

Keywords: environmental and sustainability education, teacher education, complexity, interdisciplinarity, higher education

Bærekraft i lærerutdanningen – å gi mening til frustrasjon og kompleksitet

Sammendrag

Barn og unge vokser i dag opp til et liv med klimakrise og miljøkrise. Dette må skolen forholde seg til, og lærerutdannere må reflektere over hvorvidt vi forbereder våre studenter godt nok til denne oppgaven. Denne artikkelen er en studie av innføringen av bærekraftdidaktikk i en større lærerutdanningsinstitusjon i Norge. Intervensjonen varte én uke og ble gjennomført innenfor rammene av eksisterende strukturer, prosesser og lokale ressurser. Vi utforsker hvilke muligheter, spenninger og hindringer som viser seg i intervensjonen med henblikk på å videreutvikle lærerutdanningen i møte med bærekraftutfordringene. Analysene er særlig orientert mot å få fram studentstemmer, med et empirisk materiale som består av gruppeintervjuer, spørreundersøkelser og videoopptak av gruppearbeid. Lærerstudentene som deltok måtte forholde seg til kompleksitet med hensyn til både tverrfaglighet og bærekraft. Autentisitet var også et anliggende som trådte fram. Noen av studentene stilte spørsmål ved hvorvidt det tverrfaglige arbeidet i intervensjonen reflekterte bærekraftundervisningen i dagens skole. Studien indikerer at i lærerutdanningsprogrammer som vil romme både tverrfaglighet og bærekraft, er det nødvendig med strukturelle endringer. Hvis lærerstudentene er blitt fortrolige med tverrfaglige tilnærminger, vil de også bedre være i stand til å møte kompleksiteten forbundet med bærekraft som et ontologisk, normativt og politiske anliggende. Vårt forsøk på å innføre bærekraftdidaktikk i våre lærerutdanningsprogrammer har ikke ført til betydelige endringer, og bærekraftdidaktikk er fortsatt et begrenset perspektiv i disse programmene. Men gitt utfordringene som global oppvarming og tap av biologisk mangfold representerer, er det behov for raskt å få på plass større endringer.

Nøkkelord: bærekraftdidaktikk, miljø- og bærekraftundervisning, lærerutdanning, kompleksitet, tverrfaglighet, høyere utdanning

Introduction

Teacher education institutions have been identified as key agents in introducing and strengthening sustainability in education. Sustainability issues are complex, interrelated, and systemic (Jones et al., 2010). Consequently, this complexity requires "interdisciplinary coursework on sustainability for student teachers" (UNESCO, 2005, p. 43) based on interdisciplinary research. Teacher educators interact with future teachers at a formative time in their lives, designing situations that allow student teachers to experiment and reflect, both on and off campus, in order to prepare for their future work as teachers. Given this, we teacher educators must ask whether we are preparing student teachers sufficiently to educate children and young people who will have to cope with the climate and environmental crises.

In the Anthropocene, nature can no longer be regarded as a neutral stage or passive, static framework for human activity; instead, humans cause and experience changes in biosphere interactions on a planetary scale, within the timescale

of a human life, as nature interacts with our actions (Latour, 2017). Key reports from United Nations intergovernmental panels (IPCC, 2018, 2019, 2021; IPBES, 2019) call for a transformative change that the United Nations' report on bio-diversity defined as "a fundamental, system-wide reorganization across techno-logical, economic and social factors, including paradigms, goals and values" (IPBES, 2019). This necessary change implies that teachers and their students must challenge existing norms, practices, institutions, and policies (Leichenko & O'Brien, 2019); however, the means of enacting this opposition are not intuitive.

Environmental and sustainability education (ESE) is clearly relevant across the entire curriculum in Norway, and different school subjects offer a range of perspectives and entry points via which to explore complex environmental and sustainability issues (Jones et al., 2010; Kvamme & Sæther, 2019). In the Nor-wegian context, ESE has rarely been practiced in this broad, inclusive way. For instance, school subjects such as mathematics, the language arts, and history have not traditionally engaged explicitly with ESE, and ESE has often been confined to science classes, offering only minor contributions to social studies and geo-graphy. Andresen et al. (2015) reported that few educational projects on sustain-ability have addressed issues such as inclusion, democracy, or social justice, indicating a predominantly natural science framing of ESE (see also Kvamme, 2018). For student teachers at discipline-oriented educational institutions, viewing ESE as interdisciplinary can be difficult, as UNESCO (2005) suggests. While disciplines are grounded in familiar categories, interdisciplinarity involves the mutual integration of different subject perspectives (Klein, 2017).

In the current article, we explore an ESE intervention in our own teacher education. The intervention was designed to bring student teachers from diverse backgrounds together through interdisciplinary cooperation. Student teachers were asked to work in interdisciplinary groups, combining their respective school subjects to design group work for their hypothetical school students. We describe this assignment in more detail in the Context and methodology section. This particular case enabled us to explore key aspects of ESE education, including interdisciplinarity, complexity, and ESE's integration into teacher education. Although ESE has been prioritized in both national and international strategy documents (e.g., Ministry of Education and Research, 2012; UNESCO, 2006), in 2015, ESE played a limited role at our teacher education institution.

Analyzing this kind of intervention highlights the challenges of reforming teacher education. New content and perspectives easily become controversial when they threaten to displace valued content and processes. This article does not address the collegial processes of introducing sustainability into teacher educa-tion; rather, it adopts a bottom-up perspective, focusing on student teachers' perspectives. Participating in the studied intervention as teacher educators, we analyzed student teachers' ESE practices and carefully considered their concerns. We aimed to elicit insights and critical reflections regarding an interdisciplinary approach to ESE in teacher education. We posed the following research question:

What opportunities, tensions, and obstacles emerge during an intervention to reorient teacher education toward sustainability?

Sustainability, complexity, and interdisciplinarity

As teacher educators seeking to strengthen ESE, we drew on research about integrating sustainability into teacher education programs (e.g., Buchanan, 2012; North & Jansen, 2013; Rasmussen, 2017; Sims & Falkenberg, 2013; Wright & Wright, 2010; Sjögren, 2016) and teacher education curricula (Dumitru, 2017). Some of these studies specifically addressed the challenges of reorienting teacher education toward sustainability (notably Buchanan, 2012; North & Jansen, 2013; Dyment & Hill, 2015), highlighting the obstacles noted in the *Guidelines and recommendations for reorienting teacher education to address sustainability* (UNESCO, 2005), which include shortfalls in institutional and policy support, funding, and time, as well as a lack of necessary curiosity to establish an inter-disciplinary perspective across established academic boundaries.

In general, educational institutions are the outcomes of political processes that reduce complexity (Biesta, 2010). School subjects are discipline-based, and this structure is reflected in teacher education programs. Therefore, the introduction of sustainability necessarily increases complexity for student teachers due to both the interdisciplinarity and complex problems of sustainability issues. Dale and Newman (2005, p. 352), summing up the educational challenges of ESE, state that "human societies and ecological systems are so interconnected that they are co-adaptive, reacting to each other and to previous interactions and reactions in a network of feedbacks," demanding a "complex, transdisciplinary, and broad" educational approach (see also Jones et al., 2010, p. 20).

In a qualitative study on sustainability and education, Sund (2015) interviewed five experienced teachers from certified sustainability schools in Sweden, exploring their understandings of their teaching's central purposes. Conspicuously, Sund's findings emphasize complexity as an important component across these teachers' understandings. As Sund concluded, "The findings from this study show that these experienced teachers approach the expectations and misgivings of ESE by tackling complexity, and do not aim to simplify or reduce it" (p. 31). The participating teachers highlighted purposes linked to student development, em-phasizing humility, awareness, personal connection, developing tools, and notions of negotiable truth. The realization of these purposes adds to the complexity already encountered in the sustainability theme and school organization. Also, Rieckmann's (2011) Delphi study on key ESE competencies revealed the ability to handle complexity as a core ESE competency for student teachers.

More generally, educational research has explored complexity as an inevitable aspect of open systems (Osberg & Biesta, 2010; Biesta, 2010), which interact with their environments in non-deterministic ways. According to Biesta (2010),

educators must reduce complexity for practical purposes. Because complexity reduction involves power and exclusion mechanisms, it also involves a political dimension and can never be neutrally didactic. As a consequence, the question of "who is reducing complexity for whom and in whose interest" becomes a vital concern (Biesta, 2010, p. 7). In Sund's study (2015), participating teachers associated the challenge of sustainability with complexity. Without adequate support, students often apply cognitive heuristics to make complex problems more manageable (Kahneman, 2011). For example, Byhring and Knain (2016) found that upper secondary school students who were expected to discuss conflicts of interest in a complex socio-scientific issue tended to rely on the descriptive, fact-reproducing genre of school science if the students were not sufficiently supported when inquiring into complexity. Simplifications of this kind are based on familiar interaction patterns that benefit the dominant culture's institutional practices (Biesta, 2010).

Our intervention is aligned with the concept of sustainability education design as an interdisciplinary endeavor, which has been acknowledged both in the research field (see Jones et al., 2010) and the UNESCO policy field (UNESCO, 2005, 2006, 2014). According to Klein (2017), the decisive mark of interdisciplinarity is *integration*, combining content or method elements from diverse disciplines. This approach involves bridge-building to uphold the integrity of the disciplines involved. Interdisciplinarity can also be regarded as a continuum between multidisciplinarity (working on the same problem without integration) and transdisciplinarity (dissolving the boundaries between disciplines) (see also Sæther & Kvamme, 2019). As this study's theoretical background, the notion of *complexity* informed our exploration of student teachers' engagement in interdisciplinary assignments, the products they develop, and their learning experiences regarding the challenges involved.

Context and methodology

As a research team, we conducted this study's intervention at a large university during the fall of 2015 and the spring of 2016. The intervention involved two cohorts from two teacher education programs. The student teachers in the first cohort were in a one-year program for student teachers who already have a bachelor's or master's degree (Cohort 1, 180 student teachers). The student teachers in the second cohort attended an integrated master's program combining university disciplinary courses with teacher education courses (Cohort 2, 150 student teachers). The same intervention design was used for both cohorts in the form of a one-week ESE course. This ESE week built on a previous design to prepare student teachers for facilitating group talk involving both lectures and workshops. Our intervention added plenary lectures that addressed ESE theoretically and practically. These lectures also presented resources such as role-play, socio-

scientific issues (SSI) and conflict issues, socio-scientific reasoning, and examples of former ESE projects. In addition to the lectures, the student teachers had two 1.5 hour interdisciplinary workshops. The workshop assignment instructed participants to plan a group work session on sustainable development for secondary school students. Cohort 1 was instructed to design group work focusing on water, while Cohort 2 was instructed to design group work focusing on food. In designing the study's intervention, we chose water and food as topics because they are open and complex, involving cultural, social, and scientific dimensions of sustainability.

The student teachers worked in interdisciplinary groups of 3–4 individuals that, as nearly as possible, combined student teachers with backgrounds in the humanities, social studies, and natural sciences. As a consequence, every school subject within the teacher education programs was brought in: Norwegian Language Arts, English, Foreign Languages (including French, Spanish, German, and Russian), Social Studies, Science, Mathematics, Geography, History, and Religious and Moral Education. The student teachers used their first workshop to plan their group work and find ways to include and combine competence aims from their respective subject curricula in their planned ESE group work. During the second workshop, the student teachers established new groups, using the jigsaw-learning model (Aronson & Patnoe, 2011) to convey knowledge, ideas, and experiences from their previous group work. During this second workshop, the student teachers were instructed to play the role of teachers instructing school students about the proposed group work on water or food. Afterward, each interdisciplinary group of student teachers discussed and reflected on their group work together.

Data collection and analyses

This study's data comprise group interviews, evaluation form responses, and video observations of participants' group work. The empirical data sources are presented in Table 1 and further described in the following.

Table 1. An overview of the empirical data used to answer the overarching research question

Empirical data	Cohort 1 (N = 180)	Cohort 2 (N = 150)	Analysis
Group interviews (audio)	n = 6 (70 minutes)	n = 4 (54 minutes)	Thematic analysis
Evaluation form responses (paper)	n = 60	n = 31	Descriptive statistics
Video observations of group work		4 groups of student teachers (4 × 1.5 hours = 6 hours)	Interpretive content analysis

The student teachers in both cohorts received an invitation from the student administration at our department to participate in semi-structured group interviews at the end of the intervention week. Six student teachers from Cohort 1 participated in the group interview, which lasted 70 minutes. From Cohort 2, there were four student teachers who took part in the group interview, which lasted 54

minutes. The interview guide addressed student teachers' reflections on how the week had prepared them to work with ESE in a school setting, and the interview brought up experiences during the various types of group work the student teachers had participated in.

The evaluation forms were distributed among the student teachers at the end of the ESE week's final lecture. The lecture was not compulsory, and many students did not attend. Hence, the number of respondents is 60 in Cohort 1 and 31 in Cohort 2. The evaluation form questions were identical to the interview guide for the group interviews.

After the first round of our intervention, we wanted more detailed insights into the student teachers' group discussion in the interdisciplinary workshops, and we added video observation as a method. Four workshop groups in Cohort 2 consented to and were selected for video observation of the first interdisciplinary workshop, in which student teachers designed and planned their group work.

The group interviews were transcribed and analyzed using thematic analysis (Clarke & Braun, 2013). We began with exploratory open coding, which we performed independently before discussing emergent patterns as a project group. We used ATLAS.ti (Qualcomm) for a second round of coding across the entire data set before writing memos summarizing the emergent themes based on the code structure. In the memos, we interpreted the citations linked to each code to scrutinize whether they belonged to that code or should, rather, be connected to a different code or new code, as well as whether the code and, eventually, the theme required adjustment. The interview questions were also used in the evaluation forms, and these were analyzed using descriptive statistics, with the authors inspecting and discussing the distributions and then providing an interpretation.

The video observations were analyzed using qualitative interpretive content analysis (Drisko & Maschi, 2016). These analyses were performed by two of the authors and sought to capture the range of participants' interpretations of interdisciplinary sustainability education, as well as their negotiations and problem-solving during the intervention week.

Drawing on three data sources, our qualitative analysis foregrounds the student teachers' perspectives. Most studies on student teachers' ESE experiences have been quantitative (Kyridis et al., 2005; Wilson, 2012; O'Gorman & Davis, 2013; Dyment & Hill, 2015; Alkaher & Goldman, 2018). O'Gorman and Davis (2013) also included a qualitative study, but we are not aware of any research that has included interviews with student teachers about their experiences in study programs that addressed sustainability. The priority of the group interviews over the student evaluations in this study is also due to the low response rate of the student evaluations, confer Table 1. The written answers cannot be said to represent all the students, but still provide contextual information that enrich the data collected through the group interviews and video recorded group discussions.

Ethical considerations and researcher reflexivity

The requirements of research ethics encompass researchers' quality, integrity, and responsibilities to their research community and society at large. A particular interest in our study's context is the reference to sustainability concerns in the Norwegian National Committees for Research Ethics' general guidelines (2014): "Research should help counteract global injustice and preserve biological diversity." The current study was informed by this norm. All participants in the study's group interviews and observations signed written consent forms, and all participants were anonymized. The NSD Data Collection Services approved the study's procedures for anonymization and the storage of personal information.

Reflexive methodology (Alvesson & Sköldberg, 2009) has stressed the importance of acknowledging researchers' active role in constructing empirical data. The present study examined an intervention that we, as teacher educators, initiated and implemented in order to strengthen ESE's presence and quality in our teacher education. As an intervention study within ESE, our project involves a normative dimension, reflecting the assumption that education plays a key role in the transition to a sustainable society. However, we recognize that multiple perspectives were involved. Our analysis process used a characteristically abductive approach (Douven, 2017), with the aim of contributing to the theoretical reflections on ESE in teacher education institutions.

Results

As we noted in the previous section, this study was particularly oriented toward student teachers' experiences. In our analyses, we foregrounded the study's group interviews to emphasize student teachers' perspectives on the intervention. The other elements of our analysis complemented this focus, confirming, modifying, and refining the insights we gleaned from our study's group interviews. The relationships between the study's various elements are as follows: first, the questions on the student teacher evaluation form were identical to the interview guide for the semi-structured group interviews. While the group interviews invited participating student teachers to express their opinions, feelings, and experiences retrospectively, the video recordings showed how the intervention was enacted in educational practices involving group discussions.

Group interview discussions

From our analyses of the group interviews, three particularly prominent themes emerged:
1. relating workshop assignments to school-teaching practices
2. connecting tools and resources from plenaries to workshops
3. the quality of the group processes

These themes all related to interdisciplinarity.

Relating workshop assignments to school-teaching practices

The workshops conducted during the study's ESE week received major attention in the group interviews. In these workshops, student teachers cooperated with their peers to prepare for interdisciplinary student group work addressing sustainability. As described in detail above, each group could include student teachers in any of the school subjects addressed in the teacher education program, allowing for combinations that were perceived as unconventional by the student teachers. Participants in the group interviews contended that the workshops would be more authentic if the case determined which disciplines should cooperate. For instance, one student teacher stated the following:

> Yes, I do not know how much I can say that I have gained from this personally. I wish that I could say that I have made some experiences related to working with sustainability—more correctly, working with interdisciplinary questions in really unusual constellations—[but] that would not make sense in a school setting, as I see it.

This student teacher questioned the workshop assignment's authenticity due to its unusual combination of disciplines in the interdisciplinary assignment. Other student teachers expressed having benefited from the intervention's interdisciplinary focus in itself. One student teacher stated that the ESE week had helped her "see possibilities with interdisciplinary work". Another student teacher noted that the intervention had helped him see "why we should work interdisciplinary", and a third student teacher emphasized that the week had opened her eyes to the "potentials for interdisciplinary work". One student teacher explained, "If we had been given the opportunity to enter interdisciplinary practices at a previous stage, it would hardly have been as sensational to, so to say, be permitted access [to such practices] here." Consequently, our intervention introduced student teachers not just to ESE but also to the challenge of interdisciplinarity. The group interviews presented evidence that interdisciplinarity dominated participants' framing of the workshop challenges, while sustainability faded in importance.

Regarding authenticity, the relationship between group work and teaching practices could also be seen as a supportive and motivating factor, as one student teacher noted during one of the group interviews:

> I have previously worked with that theme in school, so I have designed interdisciplinary lessons before. I was very concerned to design a lesson that could be used for real, so we managed to get the others to come along. And, now, we are going to work to build up experience—even if the combination of school subjects seems a bit odd and would never be like that.

In this feedback, authenticity stood out as an aim within the participant's reach—although our intervention's unconventional combination of school subjects was also noted here as having breached the student teacher's notion of how interdisciplinarity is conducted at schools. The significance of experiences from interdisciplinary collaboration in teacher education is thus emphasized.

A lack of prior experience seems to have contributed to some participants' frustrations. One participant noted that their classroom practice had involved sequences of relatively short lessons, affording little opportunity to develop longer interdisciplinary lessons. However, as this subsection has noted, other participants reported that the workshops had generated specific examples of interdisciplinarity, which they regarded as an important learning experience. Among the student teachers who struggled with our invention, a range of problems became apparent during the group interviews. One significant problem was a perceived lack of strategies and supporting resources for interdisciplinary group work.

Connecting tools and resources from plenaries to workshops
While the group interviews revealed the relationship between student workshops and school-teaching practices to be significant, another theme that emerged was the connections between plenaries and workshops, particularly *vis-à-vis* which tools and resources had become available to students. This theme also related to interdisciplinarity.

During the intervention's plenary sessions, several lectures offered a practical approach, presenting examples and teaching tools to inspire student teachers in their interdisciplinary workshop assignment. Some student teachers were able to use these tools in the workshops, and one student teacher expressed feeling that they helped "narrow it down more, getting a little more specific about what it was about". This student teacher emphasized, "It helps to make a lesson plan when you are a student teacher [to accommodate] education for sustainable development." Also, other student teachers had experienced the plenaries as helpful and inspirational:

> In fact, the plenaries have been so good this week, and it seems to me that they have been connected with the central issue because, when I learn about the various pedagogical tools, I think, "Oops, this is super interesting to try out."

Other student teachers had very different experiences, reporting that too few tools and resources had been provided to solve the intervention's task. This response indicated that the coherence between the intervention's plenaries and workshop assignment was not sufficiently clear to these participants. The lack of clarity and coherence can partly be ascribed to the intervention's overall aim and structure, rather than the introduction of sustainability as a central issue. Above all, as Vold, Eriksen, Kvamme, and Scheie (2015) suggested in a previous study on the structure of such course weeks prior to the introduction of ESE, our ambition to integrate theory and practical exercises seems to have presented an ongoing challenge in terms of the coherence between the intervention's lectures and workshops.

Nevertheless, the study's interviews showed that some participants might have profited from more explicit support in terms of bridging between the plenary

sessions and workshops. The wording of the task sheet that the student teachers received was quite specific, but some participants found this sheet to offer rather limited guidance. For these student teachers, interpreting the task sheet was overwhelming, and they struggled to link the instructions to a broader understanding of the intervention's purpose and direction. In other words, tools that had been intended to support the participants were experienced as obstacles. In short, tools and resources do not have fixed meanings, and student teachers may need more support to interpret and connect them.

The quality of group processes

A third theme that emerged during the study's group interviews was the quality of the interventions' group processes themselves. One of the student teachers commented on interdisciplinarity and her experience, as a student teacher of religion and ethics, collaborating with student teachers in science. In the interview, she addressed the fellow student teachers with whom she had cooperated, stating:

> I found it to be super-exciting to be able to cooperate with you in the first workshop, partly because it includes a completely different perspective on the matter and a very different way to deal with the issues.

This feedback expressed a positive experience with interdisciplinary work, but the student teacher added, "But sustainable development somehow retreated more into the background." In her experience, the intervention's complex process of integrating different school subjects seems to have afforded less space in which to discuss sustainability.

Other participants also reported that the intervention's interdisciplinary group work had been enjoyable and expansive:

> Yes, we had quite a lot of fun along the way…getting to know each other, identifying [the relevant] school subjects, and stitching the project together until it became excellent. All school subjects had their own competence goals, the assignment was feasible, all of us were eager to see it realized, and it became fun. I wish that everyone could have that experience.

However, other student teachers reported that their group had lacked motivation and interest, with their group simply being eager to complete the project's task. One student teacher reported that a peer had suggested migration as a social process that often involves crossing water. This idea had been picked up by the group, though without integrating the group's various school subjects. This example accentuates the intricate relationship between a process, a product, and diverse strategies to reduce complexity. The sense of frustration that some student teachers expressed in the group interviews was further demonstrated in the video recordings discussed in the Workshop discussions section below.

Student teachers' evaluation forms

The group interviews addressed how the intervention had been differently experienced by the student teachers, and this range of assessments and experiences was also reflected in the evaluation form data. In Figure 1, the results obtained from the evaluation forms are presented. As previously noted, the questions on the evaluation form reflect the interview questions and were analyzed via descriptive statistics.

Figure 1. Evaluation form results (both cohorts)
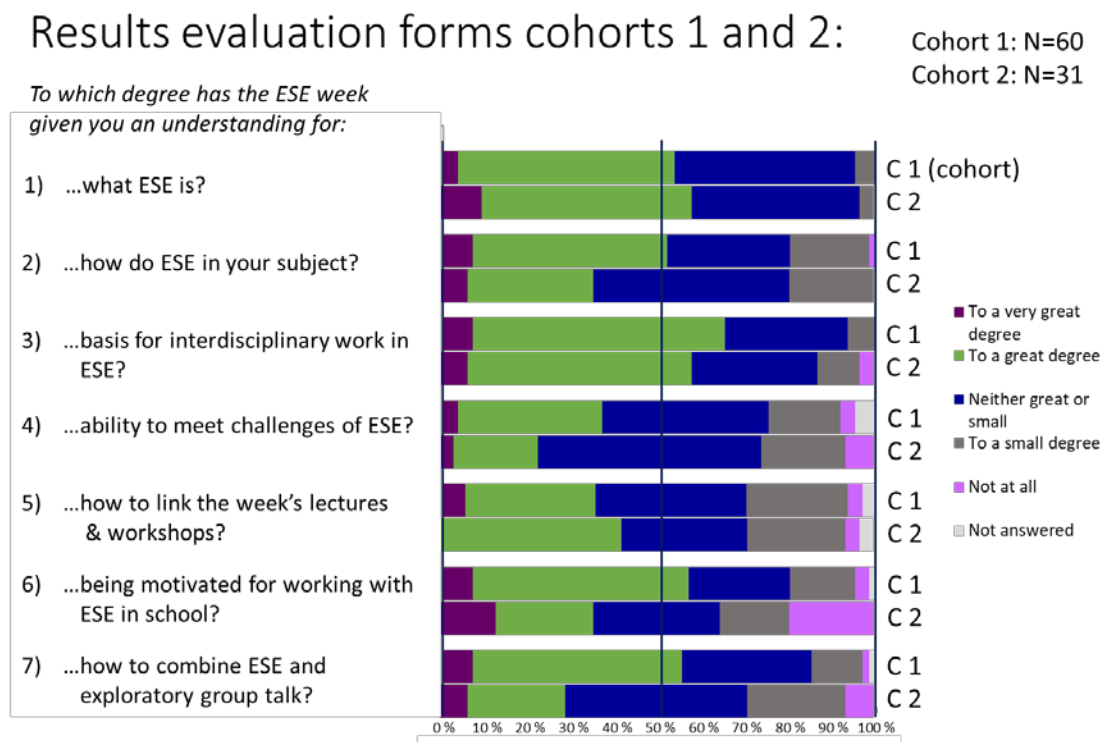
More than half of the respondents reported that the week had afforded them an understanding of environmental and sustainability education (ESE) to a great or very great degree, how it could be incorporated into their own school subjects, and how they could work with subject interdisciplinarity. There is, however, a minority who report that they obtained an ability to meet the challenges of ESE. This result should be seen in relation to findings in the interview data indicating that, for some students, interdisciplinarity eclipsed sustainability as a challenge. The question of how to link the week's lectures and workshops was also less positively perceived by the student teachers. However, our results also varied between the intervention's two cohorts. Cohort 1 was more positive about motivation and addressing ESE's challenges, as well as being more positive generally. Interestingly, the week's structure and content were almost identical for both cohorts. Few student teachers participated in this study (33 percent and 21 percent response rates, respectively), and no definitive conclusions about these motivations or challenges should be drawn. However, we note that the student teachers in Cohort 1 were distinguished by having completed an academic degree, and

many had limited or extensive work experience as well. The student teachers in Cohort 2 were younger and, though involved in a study program, had more years of academic study ahead and, likely, less teaching experience from school. Therefore, the older, more experienced student teachers in Cohort 1 may have been more prepared to adapt to the challenges of the study's ESE week than the younger student teachers in Cohort 2. This possibility encourages a consideration of how to adapt the intervention week to the specific needs of student teachers in various educational programs.

Workshop discussions: Frustrations and tensions in the inquiry process
Thus far, our analyses have focused on central themes in participants' discussions and assessments of the study's ESE week. Although these data constitute the foreground of this study, among our empirical material, we also included video recordings of the educational practices that occurred during the intervention's workshops.

Four of the Cohort 2 workshop discussions were videotaped, and these recordings were transcribed and analyzed to identify the issues that arose during the group interviews. Table 2 provides an overview of these educational practices, including which school subjects were addressed, and the content and organization of the planned school student assignments. Table 2 also provides an overview of the categories that emerged in the analysis, including tensions, handling complexity, and the issue of authenticity. These concerns were touched on in the group interviews as well, but they were even more explicitly expressed in the group interactions. We also observed a tendency to allow the challenge of interdisciplinarity to overshadow discussions of sustainability.

The observed tensions primarily related to integrating all school subjects into planned student assignments, specifically grappling with the status of school subjects such as third language and mathematics. These challenges also involved a lack of relevant background and competencies for the theme selected by a given group as a focus for their group work. Indeed, one of the groups even found including science to be challenging because the student teacher who represented science in the group had a background in physics and he did not feel that he had the necessary science competence to address topics such as sustainability and food. However, this case was an exception; generally, the student teachers with a background in the natural science and social studies seemed to have the strongest competence in ESE.

A more detailed view of one of the groups' works (Table 2, group 3) illustrates the role of discussion. The group's four participants (respectively representing the subjects of English, Spanish, Science and KRLE (Knowledge of Christianity, Religion, Philosophies of life, and Ethics)) engaged well in dialogues. However, they rarely addressed questions or meanings of sustainability from their school subjects' perspectives. This group focused on practical engagement with the task of creating a common interdisciplinary school project, and their workshop

discussion related mainly to completing the assignment. As we have seen, this tendency also emerged during the group interviews, during which ESE tended to fade into the background.

Table 2. Video recording analysis of four student teacher group discussions from Cohort 2

Group	1	2	3	4
School subjects	Mathematics Spanish English Social studies	Mathematics Norwegian Social studies	Spanish English Science KRLE*	Social studies Science English Norwegian
Theme decided by the student teacher group	Tracking of fruit and vegetables	Diet, food waste, meat production, genetically modified plants	Food in a global, cultural, sustainable perspective (or food waste)	Comparing food waste in particular countries and the world
Anticipated school student product	PowerPoint presentation	Movie	Movie	Wall newspaper
Organizing school students	Small school student groups (using jigsaw groups: shuffled to form new groups consisting of members from each previous group)	Small school student groups, movie presentation in plenary	Small school student groups	7 or 8 school student groups of 3
Tensions	How to include a foreign language in which school students have limited oral skills. Will the foreign language fade out if school students talk Norwegian?	Mathematics' role in the movie. Management of learning recourses in mathematics	Including foreign language, school students' language skills and the organizing of language teaching. Degree of openness in school student task	Physics student teacher does not feel competent in sustainability. Lack of energy and drive at the start of the discussion
Handling complexity	Discussion of the number of questions school students can handle. Simplification: Each school student group tracks one fruit or vegetable	Managing the role of mathematics. Simplification: Making a sub-task for mathematics. Let the teacher find learning resources	A movie as a school student product gave space for a foreign language. The degree of openness is unresolved	Cumulative discussion (avoiding conflict) Simplification: Let teachers decide which countries to include and provide links to appropriate online resources
Authenticity for school	Including cultural knowledge of Spanish-speaking countries	Solved by giving mathematics a specific task. Discussion of suitable school student tasks	Experience of one's own school practice confirmed the outsider status of the foreign language	Expectation of science taking responsibility for sustainability knowledge. Hence, physics student teacher withdraws.
Sustainability versus interdisciplinarity	Both in focus	Interdisciplinary approach, dominated by social science	Dominated by interdisciplinarity	Both, but with an emphasis on content (food waste)

* KRLE is a subject comprising Christianity, Religion, Philosophies of life, and Ethics

The participants expressed significant frustration regarding the interpretation of interdisciplinarity, especially *vis-à-vis* including language arts in the project. Additionally, tensions arose regarding how open-ended the designed task should be. These tensions were illustrated in some responses, such as "We have to give

them more instructions. They are only students." and "But we cannot just deliver instructions. The students are supposed to find out." The uncertainties echo the group interviews' calls for more tools and resources.

Eventually, the group of participants referred to above decided that they would instruct their students to make a short film about food from a global and cultural perspective on sustainability. Some interdisciplinary frustrations were resolved by agreeing to include ethical considerations and some spoken Spanish in the movie. However, the group remained focused on how to design the student task; the responsibility to address difficult sustainability issues was assigned either to the science teacher ("You can go through it in science first. Isn't sustainable development part of the science curriculum?") or the hypothetical students ("The students should decide themselves what to do. That's the fun part!"). This group of student teachers did not challenge the group assignment's authenticity. As some student teachers reported in the group interviews, prior experiences from their own practice were acknowledged as a valuable resource in this context, and group members had referred to relevant situations from their own schooling and practices as teachers.

The observed workshop discussions provided insight into the tensions and frustrations that arose from the complexity of interdisciplinary ESE topics. Unsurprisingly, participants' creative collaborations were often chaotic; however, we also observed creative solutions and ideas for exciting school projects. An inspection of the student teachers' workshop products shows that the task encouraged creativity among the student teachers. While all of the project synopses reflected the participant groups' interdisciplinary nature, they varied in their degrees of interaction between school subjects, ranging from multidisciplinary to trans-disciplinary, and many of the project synopses involved a global dimension. Also reflected in the group discussions, this global dimension was provided by the inclusion of English and third language in the student teacher groups (see Table 2, groups 1, 3, and 4), disrupting a national framing of the assignments.

Discussion

This paper explored the opportunities and challenges that student teachers encountered during a week-long ESE intervention involving an interdisciplinary ESE-related assignment. The studied intervention addressed the incorporation of sustainability and interdisciplinarity issues into teacher-education institutions' existing structures, processes, and local resources. Our findings based on the group discussions and supported by the evaluation forms suggest that many of the participating student teachers found the intervention to have improved their understandings of ESE, how it might be incorporated into their own subjects (although fewer of those who participated in the written evaluation, felt this way in Cohort 2), and how they could engage in interdisciplinary ESE practices. This

generally positive impression is interesting, given the intervention's limited scale of one week within participants' broader study programs—a week that also served other functions (such as student group talk) than strengthening student teachers' ESE abilities.

Despite this positive impression, some participants also expressed frustrations and concerns, demonstrating the challenges involved in such initiatives. These challenges may relate to complexity, which generally characterizes educational structures that are regarded as open systems (Biesta, 2010). In the current study, *complexity* also included how to approach sustainability and interdisciplinarity. The participating student teachers had to recognize and negotiate complexity along both institutional and thematic dimensions.

On the one hand, the ESE intervention's organization and structure were complex. Some student teachers called for strengthening the cohesion between the intervention's plenary lectures and interdisciplinary workshops, incorporating more specific tools and resources for interdisciplinary group work. These suggestions can be seen as means of reducing complexity. Some student teachers found the combination of school subjects in their interdisciplinary workshop groups to be inauthentic in that this combination failed to reflect current school practices and expanded the project's structural complexity. This problem seems to have been partly framed in terms of how to include school subjects that have not typically been associated with sustainability in ESE. These frustrations can also be regarded as expressions of student teachers' expectations that teacher education will prepare them for school as they already know it—not changing educational practices' structural framing. In the analyses of the group interviews and discussions, this concern was linked to the concept of authenticity. However, aligned with the call to transform prevailing structures and practices (United Nations, 2015), authenticity may be reconsidered in reflections on how school systems accommodate the sustainability challenges that the world is currently facing. Such an ambition should preferably be communicated to the students, calibrating their expectations.

Alongside interdisciplinarity, complexity also stems from challenges in sustainability—a perspective that, in itself, presupposes a systemic outlook requiring an interdisciplinary approach (Jones et al., 2010). The participating student teachers struggled to integrate various concerns and knowledge fields in the study's workshops.

These two perspectives on complexity—interdisciplinarity and sustainability—obviously connect in some ways. For instance, the intervention's plenary lectures offered student teachers practical, heuristic resources with which to address ESE's various dimensions and make connections with curricula. However, some student teachers still reported that they did not experience sufficient cohesion. More fundamentally, interdisciplinary education on sustainability calls for organizational changes. A sufficient understanding of sustainability requires structures that accommodate the subject's complexity.

A major limitation of this study's intervention was that, while introducing sustainability and interdisciplinarity, we maintained the existing structures of our institution's study week and overall study program. These existing teacher education structures already involved limited scope and multiple competing aims. This background may illustrate how a perceived need to manage complexity at an institutional level may actually increase ESE's perceived complexity. One crucial point seems to be that the student teachers had not been acquainted with challenges of interdisciplinarity prior to the ESE week. As some student teachers reported during the study's group interviews, as quoted in the results section, the issue of interdisciplinarity would obviously have been less pressing during the week if they had already been introduced to interdisciplinary approaches. However, the ESE week intervention was the only occasion on which these student teachers were exposed to the challenges of both interdisciplinarity and sustainability during the study program. From a wider perspective, this structural limitation also applies to the national school curriculum of Norway. Our institution's teacher education program had prepared student teachers for educational practices at schools where interdisciplinarity had not been prioritized for a substantial period (2006–2020) and sustainability had largely been regarded as a discipline-specific topic in science.

In turn, the participating student teachers regarded the intervention's assigned task largely as a challenge of interdisciplinarity, devoting less attention to sustainability. The interviews and video recordings of the group processes confirmed that interdisciplinarity was participants' main concern. This focus posed a problem that may be demonstrated by distinguishing interdisciplinarity from sustainability. Paula Jones, David Selby, and Stephen Sterling (Jones et al., 2010, p. 19) point to interdisciplinarity as an approach to knowledge and inquiry with epistemological and methodological qualities, conceiving of sustainability as a state of mutual well-being, security, and survival distinguished by ontological and normative dimensions. A political dimension should be added to this perspective.

In this study's particular ESE intervention, plenary lectures addressed sustainability's normative dimension, and this dimension was also positively touched upon by student teachers during the group interviews. However, this dimension seems to have played a minor role in the study's workshops. In other words, the student teachers may have been less concerned with sustainability's meaning-making (i.e., ontologically and normatively elucidating its stakes) than with interdisciplinarity's meaning-making (i.e., how to deal with particular epistemological challenges). Still, as mentioned in connection with the analysis of the group discussions, this impression does not necessarily reflect the student teachers' products. Here, English and third language represent interesting cases. On the one hand, the group discussions demonstrated tensions and concerns with regard to the inclusion of these school subjects in the interdisciplinary endeavor, playing a dominating role in the group discussions at the expense of issues of sustainability. On the other hand, as suggested in the results section, the groups' inclusion of

English and third language actually accommodates a global dimension—in itself a vital aspect of sustainability's normativity and politics (Kvamme, 2020).

As we have seen, managing complexity was a central challenge for the student teachers during the study's week-long ESE intervention, as was particularly reflected in the video recordings from the workshops. Group dynamics were important because the student teachers needed to develop a shared understanding of their task and foresee teaching opportunities for their proposed assignments. They needed to achieve these goals by designing structured group tasks for their hypothetical students that would include creativity, inquiry, and student discussions. Bjønness and Kolstø (2015) investigated this challenge through an inquiry-based teaching approach, suggesting that the kind of open, complex inquiry we also investigated must be supported by tools, allowing both open inquiry and more structured phases. Our intervention design could likely be improved by being guided by the principles of open inquiry. Clearly, the intervention week would have been perceived as more targeted to and coherent with the sustainability challenge if this had been planned from the outset. However, the intervention made it necessary to negotiate with established structures, as accounted for above.

Concluding remarks

This article has reported on an intervention to introduce ESE at a large teacher education institution. As teacher educators, we initiated and implemented an ESE course week and analyzed student teachers' experiences through group interviews, evaluation forms and video-recorded group work. Our findings suggest that many participating student teachers found the intervention to have improved their understanding of ESE, how to incorporate ESE into their own teaching subjects, and how to conduct interdisciplinary ESE practices. In these respects, our intervention has demonstrated opportunities for ESE interventions in teacher education programs, emphasizing interdisciplinary workshops as a key element of such interventions. Nevertheless, our findings also revealed obstacles and tensions that emerge while introducing ESE into existing programs in that limited scopes and multiple, competing aims may make any such initiative a contested choice among teacher educators.

Like Sund (2015), our study confirmed that *complexity* is a key term in ESE. It was central to our discussion and analyses of this study's intervention week. Previously, we referred to Rieckmann's (2011) study on key ESE competencies to be developed in higher education, accentuating the ability to handle complexity as a vital competency alongside a tolerance for ambiguity and frustration. On the one hand, the perceived complexity of ESE's interdisciplinary dimension means that student teachers require appropriate scaffolding to productively engage with ESE issues. On the other hand, frustration does not conclusively indicate that teacher education should aim for complexity-free design in ESE teaching. Teacher

educators should, rather, prepare student teachers to recognize frustration and complexity and tolerate them as part of open inquiry processes. While learning processes involve reducing complexity, they may also—as we have seen in this study—involve increasing complexity. Complexity in institutional practices presents an opportunity to invite student teachers to recognize, question, and challenge existing norms, practices, institutions, and policies (Leichenko & O'Brien, 2019).

This study has also supported structural transformations of teacher education programs in order to accommodate both sustainability and interdisciplinarity. If student teachers have already worked with interdisciplinary approaches when they are exposed to the challenges of sustainability, they can more easily align sustainability's ontological and normative dimensions in their own teaching.

The final lesson to be learned from this study resulted from our exposition of student teachers' dynamic experiences and perspectives. For teacher educators, this multiplicity may serve as a reminder that diversity is always present in a cohort, calling for continuous reconsiderations of educational practices' situated-ness. Our attempt to introduce ESE to our institution's teacher education programs has not led to large-scale change, and ESE remains a limited perspective in these programs. However, given the challenges of global warming, the loss of bio-diversity, and global injustices, teacher educators across institutional and national boundaries must engage with one another and student teachers to create new, comprehensive approaches to ESE in teacher education.

Acknowledgements

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