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The Sustainable Backpack: Education for sustainable development through a nationwide professional development programme

Abstract

Education for sustainable development (ESD) provides crucial opportunities for young people to be involved authentically in addressing socio-ecological challenges in their local and global communities. While many studies on education for sustainable development have documented efforts within higher education, few examples exist of large-scale programmes that engage primary and secondary students. Norway's Sustainable Backpack programme is a notable exception. In this paper, we present insights from this nationwide professional development effort to support teachers to implement ESD. We describe design principles that guide the programme and present evidence of success through teacher interpretations of their experiences and those of their students. Data sources include teacher survey data and insights into the programme by the authors as participant observers. Our goal is to provide initial insights into important aspects of professional development at a large scale for ESD and recommendations for future work.

Keywords: professional development, education for sustainable development, interdisciplinarity

Den naturlige skolesekken: Utdanning for bærekraftig utvikling og profesjonell kompetanseutvikling i et nasjonalt nettverk

Sammendrag

Utdanning for bærekraftig utvikling (UBU) gir barn og unge muligheter til å få innsikt i, delta og påvirke komplekse bærekraftutfordringer lokalt, nasjonalt og globalt. Det er mange studier om utdanning for bærekraftig utvikling som doku-

menterer innsats innen høyere utdanning, men få eksempler på storskala programmer som involverer grunnskole og videregående skole. Den naturlige skolesekken i Norge er et unntak i så måte. I denne artikkelen deler vi innsikt fra det nasjonale, faglige utviklingsarbeidet som støtter skoler, lærere og elever i å nærme seg UBU på en tverrfaglig måte. Vi beskriver designprinsippene som ligger til grunn for programmet, presenterer forutsetningene lærerne mener er viktige for å lykkes, deres egne erfaringer og den utviklingen de ser hos elevene sine. Datakildene inkluderer spørreundersøkelse blant lærerne og innsikt i programmet fra forfatterne som deltakende observatører. Vårt mål er å gi en innsikt i viktige aspekter og erfaringer fra profesjonsutvikling på nasjonalt nivå for UBU, samt å komme med anbefalinger for fremtidig arbeid på feltet.

Nøkkelord: profesjonell kompetanseutvikling, utdanning for bærekraftig utvikling, tverrfaglighet

Introduction

This study's objective is to report initial insights from a professional development programme that has supported teachers and students in authentic, interdisciplinary, community-based *education for sustainable development* (ESD) on a national scale for approximately 10 years. To address some of ESD's challenges and provide insights into strategies that can be effective in a variety of contexts, we examine the Sustainable Backpack programme, a nationwide ESD programme for primary and secondary students in Norway. The Sustainable Backpack programme continues to support teacher teams in developing interdisciplinary projects focussed on wicked problems, action competencies, interdisciplinary practices, community-based partnerships and local contexts. Though existing studies of ESD have documented efforts within higher education institutions and primary and secondary programmes, as Olsson, Gerick, and Chang Rundgren (2016) note, there are few examples of *large-scale projects* that engage primary and secondary students in addressing socio-ecological challenges in their communities, making this work an important contribution to the ESD field.

ESD provides crucial opportunities for young people to be involved authentically in addressing socio-ecological challenges in their communities. ESD is recognised widely as “education which empowers learners to make informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while respecting cultural diversity” (UNESCO, 2014, p. 12). ESD's objective, according to UNESCO, is to develop competencies that empower individuals to reflect on their own actions, taking into account their current and future social, cultural, economic and environmental impacts, from a local and a global perspective (UNESCO, 2017, p. 7). Though ESD has been gaining momentum worldwide, ESD can be

challenging for teachers (Borg, Gericke, Höglund, & Bergman, 2014; Pharo et al., 2012). For example, schools' disciplinary nature and sustainability issues' interdisciplinary nature make it difficult to address real-world problems authentically. Though more schools are addressing this in part by adopting a whole-school approach (Breiting, Mayer, & Mogensen, 2005; Rickinson, Hall, & Reid, 2016), others argue that this level of reform is not practical for most schools (e.g., Pepper & Wildy, 2008, p. 627). Other issues, such as many countries' increased focus on high-stakes testing, have made it challenging for teachers and schools to implement ESD at a large scale (Sinnes & Eriksen, 2016). This study set out to document the Sustainable Backpack programme's components and investigate the following research question: How can a professional development program at a large scale support teachers in implementing education for sustainable development?

Existing studies have made recommendations for addressing these issues. Uitto and Saloranta (2017) argue that subject teachers would benefit from professional development on how to teach sustainability more holistically. The authors argue that it is likely that teachers are unaware of their competencies because they do not fully understand sustainable development. Teacher education courses could make the background and pedagogy of ESD explicit to help build their awareness. Borg, Gericke, Höglund, and Bergman (2014) recommend that teachers plan in cross-disciplinary teams to gain a common understanding of sustainable development and share knowledge and practices with each other, but recognise that this approach is uncommon in many places (Borg et al., 2012, 2014). We argue that teachers and teacher educators need a better understanding of cross-disciplinary practices that support ESD.

One approach to these issues that warrants further examination, is the creation of a learning network, in which teachers are encouraged to come together regularly over time to learn from best practices in the field, collaborate with their colleagues in other subjects and share expertise (Grossman, Wineburg, & Woolworth, 2001). Previous work has shown that support from colleagues and school administrators is an important factor in teacher growth and successful uptake of new knowledge and practices (e.g., Ertsås & Irgens, 2012; Helstad, 2013). Specifically in ESD, Mogren, Gericke, and Scherp (2019) found that both professional knowledge creation and routine and structures in school organisation were especially important when comparing schools actively implementing ESD with other schools that are not. The Sustainable Backpack programme draws on these findings and recommendations, taking a *community of learners* approach to supporting teachers and schools to implement ESD at the primary and secondary levels (Grossman, Wineburg, & Woolworth, 2001).

The Sustainable Backpack Programme: Professional Development for Education for Sustainable Development

This study is a part of a larger research endeavour carried out by research and programme staff at the Norwegian Centre for Science Education about the Sustainable Backpack programme. The authors of this paper have been working to some extent as participant observers (Geertz, 1984). The lead author has been deeply involved in the planning, leading, and implementation of the Sustainable Backpack programme, and the second author has been involved for one year. We draw on the research base, empirical evidence, and our deep knowledge of and experience with the programme to provide insight into the design principles and findings presented here.

As programme staff with the Sustainable Backpack programme, we have become increasingly aware that today, the Norwegian education system is responsible, both nationally and internationally, for educating the public about ESD. The current curriculum for education in Norway contains several competency goals for sustainable development to ensure that Norwegian students have the awareness, understanding and competencies needed to act in ways that support sustainable development. As we describe below, this commitment to ESD has evolved substantially in the past two decades, in response to the International Decade of Education for Sustainable Development 2004–2014 (UNESCO, 2005).

The Sustainable Backpack programme, which was initiated in 2009 through the Ministry of Education and Research and Ministry of Climate and Environment (Scheie, 2014), serves primary, lower secondary and upper secondary schools and has evolved over time as the field learns more about how to address the challenges of ESD in Norway and internationally. Figure 1 shows the organisation of the Sustainable Backpack programme. Today, the programme aims to build a community of learners through professional development that leads to increased ESD awareness, understanding and competencies among teachers and students.

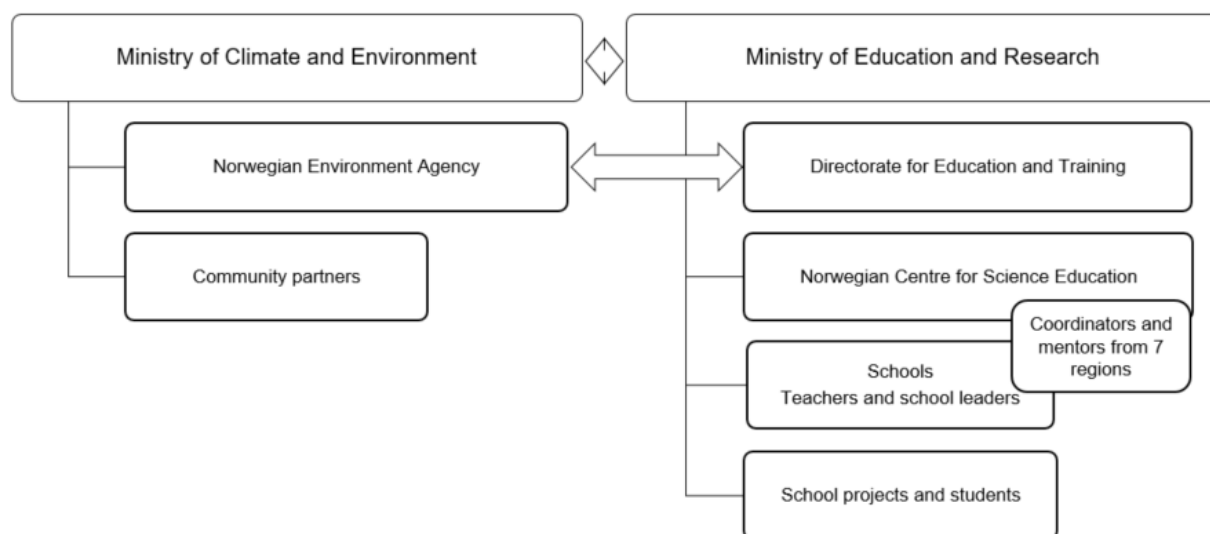


Figure 1. Organisation of the Sustainable Backpack programme.

In 2011, national survey results showed that only 9% of school leaders in Norway were inspired by the United Nations declaration of the International Decade on Education for Sustainable Development to change their teaching (Vibe, 2012). While 58% of school leaders responded that they were interested in issues related to sustainable development, only 27% reported that they had the competencies needed to teach ESD at their schools (Vibe, 2012).

In 2013, a committee was established to consider basic education subjects for competence needs in a future society, including working life. Sustainable development has been highlighted as one of three interdisciplinary topics that have been determined to be of national importance to schools of the future (Kunnskapsdepartementet, 2017). In 2018, a new core curriculum was being developed in Norway to challenge the educational system by calling for cross-curricular teaching to address interdisciplinary themes of: 1) sustainable development; 2) democracy and citizenship; and 3) public health and well-being (Kunnskapsdepartementet, 2017). Clearly, this new focus makes programmes like the Sustainable Backpack programme even more relevant for the future of teaching and learning.

Schools and the Sustainable Backpack programme

The Sustainable Backpack programme has the potential to be an important resource for meeting the new core curriculum's goals in Norway. Historically, when schools have applied to the programme, around 140 are accepted each year. Schools applied for support (financial and teacher training) to develop and implement sustainable development projects or programmes in their classrooms. Participating teachers became part of a professional ESD learning community that has met several times during the school year, both regionally and nationally. School teams have been required to include at least two subjects, an inquiry focus, the utilisation of learning settings outside classrooms and local relevance for students. Schools have included as many subjects as they like in their projects, but science or social science have been required. Additionally, schools were encouraged to collaborate with external partners or community organisations.

Schools also were encouraged to develop their teaching and projects over three years, with the goal of establishing sustainable, practical programmes in schools. Teachers committed themselves to participating in a national conference and two regional meetings each year. These meetings have been chaired by teacher education mentors and aim to improve teachers' competence levels in scientific and pedagogical content. Teachers deliver mid-term reflection reports, describing and justifying their project implementation plans while continuing to receive guidance from mentors. After one year, the teachers deliver their final reflection reports on their curriculum units.

Preliminary data collection has helped to show the importance of the Sustainable Backpack project, as well as determine how to focus on professional development. For example, an internal study at the Norwegian Centre for Science

Education on the 2012 and 2013 school projects showed that teachers in the Sustainable Backpack programme reported increased awareness of sustainable development and competencies to teach sustainable development (Scheie, 2014). Teachers reported the need for more support in this work (Scheie, 2014; Scheie & Korsager, 2014).

During 2012 and 2013, 70% of the teachers reported increases in their use of the local environment, and 40% used inquiry-based teaching because of the Sustainable Backpack initiative (Scheie, 2014). However, teachers remained challenged on how to assess sustainability projects. At that time, an external evaluation survey of the Sustainable Backpack programme showed that the students involved in the project had improved knowledge, attitudes and skills related to sustainable development (Sjaastad, Carlsten, Opheim, & Jensen, 2014).

Finally, a more recent study by Gabrielsen and Korsager (2018) of teachers in the Sustainable Backpack programme concluded that teachers recognised the benefits of the local environment as a learning setting in ESD in four categories: 1) exemplification of various perspectives of sustainable development; 2) authentic and concrete learning; 3) opportunity for action; and 4) affective influences (e.g., personal experiences and feelings). In line with the Sustainable Backpack programme's focus on implementing ESD within teachers' own practice, the authors argue that this could contribute to a shift in focus—from abstract education policy on what ESD should be, to an emphasis on contextualised practice.

Design Principles

The Sustainable Backpack programme continues to support interdisciplinarity in ESD by creating networks of teachers with a three-pronged approach: a) teacher-focussed support; b) teaching and learning processes; and c) a local environment that includes partnerships with community-based organisations. In this section, we describe the theoretical and practical bases for the design principles that provide a structure for this approach.

Teacher-focussed support

While evidence exists of success in whole-school initiatives, in which school structures are reorganised at the institutional or systemic level to support interdisciplinary teaching and learning focussed on ESD, many schools and school systems do not have the capacity for this kind of system-level change (Pepper & Wildy, 2008). Instead, the Sustainable Backpack programme focuses on supporting buy-in from school leaders, but primarily works within the daily constraints of class schedules, planning time and teacher responsibilities. In this way, the programme draws heavily on models of spread and sustainability of reform efforts that privilege Coburn's (2003) *teacher-focussed support* that can lead to deep

changes in teachers' beliefs and norms of social interaction, rather than the institutional-level change required for a whole-school approach.

Supporting involvement by teachers and school leaders. The Sustainable Backpack programme aimed to balance institutional support's importance and the strength of teachers' professional development. A written application from the school and a contract with the principals have been required, specifying a commitment to disciplinary integration and the project itself. School leaders were involved from the beginning, writing the application together with teachers, taking on certain tasks in the contract and being invited to a national conference during the school year.

The programme takes bottom-up and top-down approaches to schools' projects. Most projects were initiated by teachers or school leadership and were based on teacher collaborations across subject or discipline borders. While project initiatives often come from teachers, they have reported anecdotally that they have been more likely to gain the necessary support from school leaders because of their schools' involvement in a national programme, such as the Sustainable Backpack project.

Teacher professional development. The programme offered professional development that emphasised teacher learning through communities of practice (Grossman, Wineburg, & Woolworth, 2001). In line with professional learning communities' best practices (Vescio, Ross, & Adams, 2008), teacher meetings aimed to honour both the knowledge and experience of teachers and knowledge and theory generated by other researchers. Contributions from competent others (e.g., regional coordinators, content experts, and external partners) supplemented and strengthened the learning community as argued for by Helstad (2013). Teacher meetings provided opportunities for learning, collaboration and reflection with immediate colleagues and between school teams. Regional coordinators drew on the expertise of the ESD field and previous research, and that of teachers in the room by reviewing school applications and assessing what teachers would need to run their ESD projects successfully. Meetings included readings and presentations in which regional coordinators presented theoretical foundations and example ESD projects for teachers to discuss and consider in the context of their own work. In addition, teachers brought their own experiences to share and worked to plan collaboratively with colleagues. They were tasked with incorporating new ideas from the day and sharing their plans with other school teams.

Teaching and learning processes

Issues of sustainability are complex, interdisciplinary and require a deep understanding of the current and future economic, environmental and social dimensions. Solutions require multiple perspectives, disciplines and approaches, and one right answer rarely exists. According to Pryshlakivsky and Searcy (2013), students must be engaged in determining a pluralistic strategy in which they critically approach different perspectives, rather than reflect on predefined

solutions to problems. To help teachers in the Sustainable Backpack programme engage deeply with this kind of interdisciplinary instruction, professional development meetings focussed on ‘wicked problems’ (Rittel & Webber, 1973), action competencies (e.g., Berglund & Gericke, 2016) and the 5E Instructional Model of inquiry as described by Wilson, Taylor, Kowalski, and Carlson (2010).

Wicked problems. Teachers were introduced to real-world challenges in sustainable development as ‘wicked problems’. Rittel and Webber (1973) describe the nature of wicked problems and the challenges that they present for solution-finding. Because wicked problems are so complex, no criteria exist for determining when a wicked problem has been solved. Instead, as people address wicked problems, we can only say ‘This is good enough’ (p. 162). Schools often proposed projects that focussed on sustainability with a ‘tame’ problem, like “How can we protect the newts in the local pound?” in which students engaged in more than one subject concurrently. Through the programme, schools began to develop their projects into ‘wicked’ problems that required students to take a more critical approach, drawing on specific practices from different subjects and considering the needs of a variety of stakeholders. The programme helped teachers take an interdisciplinary, holistic approach by including perspectives, practices and content from a variety of school subjects.

Action competencies. To address wicked problems, recent work in ESD has shifted from models that linked increased knowledge to environmental behaviour change, to focus on ‘action competencies’ (e.g., Berglund & Gericke, 2016; Hofman, 2015; Mogensen & Schnack, 2010). These models recognise that sustainable development requires students’ engagement, not compliance, in active, ongoing, democratic citizenship (Mogensen & Schnack, 2010, p. 69). In one example of the application of action competencies, the Quality Criteria for ESD Schools (Breiting, Mayer, & Mogensen, 2005) describes criteria for teaching/learning approaches, including listening to students’ concerns and encouraging cooperative learning and other student-centred strategies (p. 15).

Wicked problems entail high social, cognitive and knowledge/insight/recognition (epistemic) levels, as well as moral framing and interdisciplinary development of students’ skills (Palmer, Smith, Willets, & Mitchell, 2009). In the Sustainable Backpack programme, teachers were supported to plan for both depth and progression in student learning activities (Scheie & Korsager, 2016). Action competencies have been emphasised by centring on real-world issues of sustainability relevant to students’ everyday lives. This includes empowering students to speak and act in their own communities through activities such as writing arguments and articles that draw on school projects and democratic citizenship. An important goal for such projects is to help students develop as independent, critical thinkers equipped with the knowledge, attitudes and skills necessary for long-term, democratic and responsible conduct. For students to learn to take different perspectives into consideration, teachers in the Sustainable Backpack programme have been encouraged to support students in exploring, reflecting and

critically evaluating statements, arguments and actions (Scheie & Halvorsen, 2018).

5E instructional model. Along with the 2030 Agenda for Sustainable Development (UN DESA DSD, 2015), UNESCO published a guide to ESD in learning through the 17 Sustainable Development goals (2017). As with earlier guidelines, the guide suggested that in addition to the content, ESD should support: 1) learner participation; 2) collaborative problem-solving; 3) inter- and transdisciplinarity; and 4) linking of formal and informal learning (p. 7). The Sustainable Backpack programme has addressed these goals using the Biological Sciences Curriculum Study's (BSCS) 5E Instructional Model enactment of inquiry-based curriculum (Wilson, Taylor, Kowalski, & Carlson, 2010). The 5E model's *engage, explore, explain, elaborate, and evaluate* stages support student learning through 'classroom experiences and teaching strategies that provide students with opportunities to construct content understanding within the context of experiences consistent with science as inquiry' (p. 280).

Local environment and partnerships with community-based organisations

Finally, recent educational research across disciplines documents the importance of learning in authentic places and across settings, particularly for students to engage in action competencies as described above. Although it is difficult to measure students' motivation and actual contribution to a sustainable future, some studies show that teaching outside the classroom can contribute to achieving learning goals for ESD, better connections with the local environment, increased interest in nature and more environmentally conscious behaviour (e.g., Manni, Ottander, & Sporre, 2017). For example, Gabrielsen and Korsager (2018) concluded that learning in the local environment provided opportunities for meaningful learning in complex topics, such as sustainable development.

In the Environment and School Initiative's (ENSI) Quality Criteria for ESD (Breiting, Mayer, & Mogensen, 2005), the authors argue that partnerships with community organisations provide local relevance and opportunities for the school to act as 'an important voice for the planning of local sustainable development', taking on a central role in the community and allowing for students to practise citizenship (p. 42). Partnerships also have the potential to facilitate networking among schools, teachers and students, allowing for the exchange of ideas. Mogensen and Schnack (2010) argue that sustainability indicators should reflect the ESD's democratic values and be co-constructed by practitioners, learners and other stakeholders in their local learning communities. Hofman (2015) suggests that education for sustainable development should be place-based to deal with the local context's specific issues.

Wals and Benavot (2017) argue that this kind of learning across boundaries is integral to education for sustainability. Learners must be involved in 'multi-stakeholder platforms and multi-level coalitions involving diverse partners, values and

interests and strategic alliances' that address local challenges through collaboration, diverse public leadership and opportunities to learn in varied settings in and out of school (p. 408). A central focus for schools in the Sustainable Backpack programme has been both to use authentic and concrete issues in students' local environment, as well as to collaborate with external partners or community organisations.

Methodology

This study's data analysis focussed on survey results from teachers in the Sustainable Backpack programme between 2014 and 2017. In total, 336 teachers participated in the survey, a response rate of 41%. 79 teachers participated for three years or more, 84 for two years and 173 for one year. The teachers were from primary, lower secondary and upper secondary schools (representing Norwegian grade levels 1–11, ages 6–16). The survey comprised Likert-scale and open-ended questions in several categories, including: 1) teacher agency and school support; 2) classroom implementation; 3) outcomes for teachers; 4) student engagement and outcomes; and 5) general ESD outcomes. Each quantitative item used a Likert-scale format, with responses coded on a scale from Strongly Disagree (1) to Strongly Agree (4).

In the analysis of quantitative survey data, we looked for patterns in teacher responses and feedback, as well as differences in teachers with more experience participating in the programme over time. We investigated the practical significance of several aspects of professional development by using descriptive statistics, including percentage of positive responses from teachers within several constructs. To examine effect size for each item, we report the mean (*M*) and standard deviation (*SD*), as well as Cohen's *d*, with the aim of describing the practical differences between teachers with more or less experience in the programme. By 'practical' we mean that these differences are interesting to the programme team in that they have the potential to inform directions for further examination, as well as inform our practice and implementation in working directly with teachers in the future even if the differences are not statistically significant. This focus is important for the Sustainable Backpack programme in that it examines the potential impacts of the commitment of teachers and schools to doing this work over time. These effect sizes provide some insight into the potential benefits of multi-year participation in a community of learners. To interpret the data, $d = 0.2$ is considered a 'small' effect size, 0.5 is considered a 'medium' effect size and 0.8 is a 'large' effect size. For example, a difference of 0.2 standard deviations or less describes only a trivial difference between two groups.

As authors and participant observers (Geertz, 1984), our experience informs our interpretation of the survey data. Our extensive knowledge of implementation

and experience supporting teachers and schools in the Sustainable Backpack programme and the statistical analyses yielded initial insights into teacher perspectives on their experiences within professional development and point to future areas of analyses that will help refine our design principles for professional development for ESD. Though the survey data do not allow us to make claims about the programme's direct impacts on implementation and learning, we can draw initial conclusions about which aspects of the programme teachers found the most useful and on where further, future iterations of professional development and examination of the outcomes should focus.

Findings

Teacher-focussed support

Overall, teachers were very positive about their involvement in the Sustainable Backpack programme regardless of the number of years of their participation. However, there are some important differences in how teachers in their first year and teachers in their third year rate specific aspects of the programme supports and the impacts on their teaching practice and outcomes for students. Here we highlight the findings that were most practically useful for understanding the outcomes of the programme overall and the potential importance of long-term involvement for teachers. There are a number of survey items which are not discussed in detail here due to space constraints, but which reflect small effect sizes that may warrant further examination in our future work.

Teachers' sense of support from school leaders is an indicator of long-term sustainability of educational improvements (Table 1). In the Sustainable Backpack programme, 94% of the teachers, regardless of their length of participation, reported that school leaders within their schools were supportive ($M = 3.86$), well-informed ($M = 3.72$), and believed that the project was beneficial ($M = 3.64$). Additionally, most teachers reported that their school leaders believed that the project was important enough to be funded independently ($M = 3.20$).

In terms of institutional support, more than two-thirds of the teachers reported that school leaders viewed the project as part of the overall school plan ($M = 3.12$). Teachers reported that leaders gave them time to work on their projects collaboratively ($M = 3.07$). Although the differences were not statistically significant, teachers in their third year (or later) of the project were more likely than year-one teachers to report that the entire school was familiar with the project. This insight warrants further examination into the mechanisms for how and why teachers and schools share their work with the entire school, an important aspect of the sustainability of their projects and of the Sustainable Backpack programme.

Table 1. Sustainable Backpack Teacher Survey Results: School Supports

Survey Questions	All responding teachers (n = 336)		Teachers with one year (1Y) in the programme (n = 173)		Teachers with three or more years (3Y+) in the programme (n = 79)		Differences between 1Y and 3Y+ teachers
	M	SD	M	SD	M	SD	Cohen's <i>d</i>
How well are you supported at your school to teach ESD through the Sustainable Backpack project?							
The school's leadership allows two teachers to attend regional meetings	3.86	0.47	3.79	0.59	3.88	0.37	0.09
The school's leadership is well informed about the project	3.72	0.56	3.71	0.57	3.77	0.50	0.04
The school's leadership believes that teachers benefit from participation	3.64	0.64	3.59	0.69	3.68	0.56	0.12
The school's leadership prioritises continuing the project regardless of external funds	3.20	0.90	3.13	0.90	3.33	0.88	0.10
The school's leadership has made the project part of the school's annual plans	3.12	1.08	3.06	1.16	3.30	0.93	0.08
The school's leadership provides time for collaboration among colleagues	3.07	0.99	3.59	1.00	3.01	0.96	0.04
The school's leadership wishes both younger and older students to participate	3.05	1.06	3.05	1.08	3.16	1.06	0.01
The school's leadership informs the entire school about the project	2.86	1.12	2.81	1.15	3.03	1.11	0.06

The Sustainable Backpack programme offered many kinds of support for teachers in their work, which most teachers felt were beneficial to their ESD teaching (Table 2). Teachers particularly found opportunities to collaborate with colleagues ($M = 3.58$) on their projects and had the time to plan and try out their projects ($M = 3.50$). Opportunities to come together with their colleagues at regional meetings ($M = 3.22$) and at the national conference ($M = 3.20$) also were highly regarded among teachers. Additionally, these teachers were more likely to see the benefits to their teaching practice from the resources that the programme provided. Specifically, there were small effect sizes in differences in how year-three and year-one teachers recognised the usefulness of the national conference (Y1 $M = 3.17$, Y3 $M = 3.49$, $d = 0.26$) and support from regional coordinators (Y1 $M = 2.55$, Y3 $M = 3.03$, $d = 0.30$). Other resources such as the annual report, application process, guidance from regional coordinators and posters at the conference were helpful to teachers, but less so than other resources.

Table 2. Sustainable Backpack Teacher Survey Results: Project Resources

Survey Questions	All responding teachers (n = 336)		Teachers with one year (1Y) in the programme (n = 173)		Teachers with three or more years (3Y+) in the programme (n = 79)		Differences between 1Y and 3Y+ teachers
	M	SD	M	SD	M	SD	Cohen's <i>d</i>
Which of these aspects of the Sustainable Backpack programme benefitted your ESD teaching?							
Collaboration with colleagues in the project	3.58	0.62	3.61	0.60	3.50	0.61	0.06
Planning and implementation of the project	3.50	0.65	3.47	0.68	3.60	0.54	0.13
Regional meetings	3.22	0.92	3.17	0.96	3.42	0.84	0.14
Collaboration with external partners in the project	3.21	0.87	3.23	0.89	3.26	0.74	0.10
National conference attendance	3.20	0.95	3.17	0.98	3.49	0.83	0.26
Use of the school's local environment as the learning arena	3.20	0.83	3.13	0.86	3.37	0.69	0.12
Use of the community as a learning area	3.15	0.81	3.07	0.82	3.24	0.76	0.09
The Sustainable Backpack project's website	3.10	0.83	3.11	0.85	3.19	0.78	0.09
5E Model (Exploring)	3.05	0.83	2.96	0.88	3.15	0.77	0.17
Conducting cross-disciplinary/multi-disciplinary teaching programmes	3.03	0.82	2.92	0.87	3.13	0.71	0.12
Sustainable Backpack Planning Poster (Knowledge, Skills and Attitudes)	2.92	0.85	2.84	0.88	3.01	0.70	0.22
Annual Report	2.82	0.87	2.83	0.91	2.89	0.79	0.12
Application Writing	2.75	0.91	2.71	0.92	2.87	0.91	0.17
Guidance from mentors / regional coordinators / Norwegian Centre for Science Education	2.68	0.98	2.55	0.97	3.03	0.94	0.30
Posters at the Sustainable Backpack Conference	2.68	0.92	2.65	0.96	2.81	0.82	0.14

Teaching and learning processes

The Sustainable Backpack programme exerted a significant influence on teaching and learning, especially in terms of how it impacted teachers' attitudes about teaching and how they engaged students in ESD. First, teachers generally were positive about using the 5E Instructional Model in their teaching to engage

students in ESD (Table 3). Many teachers, regardless of experience, reported that the programme helped them understand the essence of inquiry-based teaching for ESD ($M = 3.17$). Around half the teachers felt it helped them communicate about ESD to their colleagues ($M = 2.85$). Teachers in their third year or later with the programme were more likely to recognise how 5E helped them plan (Y1 $M = 3.06$, Y3 $M = 3.27$, $d = 0.22$) and evaluate their ESD teaching (Y1 $M = 2.98$, Y3 $M = 3.17$, $d = 0.25$), pointing to the possibility that centring the 5E Instructional Model helped teachers organise their ESD projects over time.

Table 3. Sustainable Backpack Teacher Survey Results: 5E Model

Survey Questions	All responding teachers (n = 336)		Teachers with one year (1Y) in the programme (n = 173)		Teachers with three or more years (3Y+) in the programme (n = 79)		Differences between 1Y and 3Y+ teachers
	M	SD	M	SD	M	SD	Cohen's <i>d</i>
How did the focus on the 5E model in this project influence your teaching?							
Understand inquiry-based teaching for sustainable development	3.17	0.77	3.10	0.79	3.31	0.74	0.17
Plan my teaching for sustainable development	3.14	0.74	3.06	0.77	3.27	0.67	0.22
Ensure that my education for sustainable development is explorative	3.06	0.76	3.01	0.77	3.14	0.74	0.18
Evaluate teaching for sustainable development	3.02	0.76	2.98	0.79	3.17	0.67	0.25
Communicate about ESD to colleagues	2.85	0.83	2.79	0.82	2.91	0.86	0.12

Teachers reported on the project's influence on their practice beyond the project, an important aspect of the school projects' continued sustainability (Table 4). While not all teachers reported these outcomes, most reported amassing greater knowledge on sustainable development ($M = 3.41$), with many feeling that their teaching had become more varied, relevant and linked to other subjects. Cohen's *d* scores suggested a small practical significance in the differences between teachers in their third year or later and first-year teachers in how they found that the project helped them become more inquiry-based in their teaching ($d = 0.27$), more motivated ($d = 0.23$) and more varied ($d = 0.27$), with teaching becoming more relevant to students' everyday lives ($d = 0.31$), as they were more likely to use different settings ($d = 0.28$).

Table 4. Sustainable Backpack Teacher Survey Results: Changes in Teaching

Survey Questions	All responding teachers (n = 336)		Teachers with one year (1Y) in the programme (n = 173)		Teachers with three or more years (3Y+) in the programme (n = 79)		Differences between 1Y and 3Y+ teachers
	M	SD	M	SD	M	SD	Cohen's <i>d</i>
As a result of your participation in this project, how has your ESD teaching changed?							
I understand the concept of sustainable development	3.41	0.79	3.32	0.86	3.60	0.64	0.12
I'm more motivated to teach	3.08	0.85	2.78	0.85	3.30	0.68	0.23
My teaching has become more varied	2.97	0.86	2.82	0.83	3.25	0.76	0.27
I often add inquiry-based working methods	2.95	0.82	2.77	0.83	3.15	0.67	0.27
I shift more often between different learning arenas	2.93	0.84	2.87	0.86	3.14	0.7	0.28
My teaching has become more relevant to the students' everyday lives	2.90	0.85	2.52	0.89	3.10	0.68	0.31
My teaching has been linked to several subjects	2.99	0.89	3.17	0.94	3.11	0.75	0.15
I work more often with external partners in my teaching	2.60	0.95	3.17	0.98	2.67	0.82	0.07

The foci on inquiry-based and interdisciplinary teaching exerted a particularly positive impact on teaching (Table 5).

Table 5. Sustainable Backpack Teacher Survey Results: Teacher Attitudes

Survey Questions	All responding teachers (n = 336)		Teachers with one year (1Y) in the programme (n = 173)		Teachers with three or more years (3Y+) in the programme (n = 79)		Differences between 1Y and 3Y+ teachers
	M	SD	M	SD	M	SD	Cohen's <i>d</i>
How did the focus on inquiry-based teaching in this project influence your teaching?							
Increased the variation in my teaching	3.50	0.64	3.47	0.63	3.58	0.61	0.08
Increased my motivation to teach	3.41	0.69	3.35	0.72	3.52	0.65	0.15
Improved my teaching skills	3.34	0.72	3.30	0.72	3.37	0.64	0.13
How did this project's interdisciplinary focus influence your teaching?							
Increased the variation in my teaching	3.41	0.65	3.34	0.66	3.52	0.59	0.12
Increased my motivation to teach	3.29	0.72	3.22	0.77	3.35	0.63	0.12
Increased my teaching skills	3.25	0.72	3.19	0.74	3.31	0.66	0.15

Teachers also reported several outcomes for students who participated in the Sustainable Backpack programme (Table 6). More than three quarters of the teachers across the project reported that students participated in all the inquiry

practices, particularly in presenting their results to others ($M = 3.35$) and using different methods to find answers ($M = 3.34$), both core practices for engagement in interdisciplinary, authentic ESD. Students engaged in formulating their own questions less frequently than other practices ($M = 2.79$). In terms of teachers' perceptions of changes in students' attitudes, they gave the lowest ratings for students' *commitment to participate in democratic processes* ($M = 2.69$) and *interest in social rights* ($M = 2.46$), implying that the social aspect of ESD is missing to some extent.

Table 6. Sustainable Backpack Teacher Survey Results: Student Outcomes

Survey Questions	All responding teachers (n = 336)		Teachers with one year (1Y) in the programme (n = 173)		Teachers with three or more years (3Y+) in the programme (n = 79)		Differences between 1Y and 3Y+ teachers
	M	SD	M	SD	M	SD	Cohen's <i>d</i>
What kinds of outcomes did you see for students?							
Students conveyed their results to others	3.35	0.75	3.38	0.77	3.22	0.72	0.00
Students used different methods to find answers	3.34	0.69	3.34	0.71	3.33	0.70	0.04
Students collected data through field work to answer questions	3.30	0.83	3.28	0.85	3.28	0.81	0.05
Students discussed and interpreted the collected data	3.22	0.76	3.20	0.79	3.20	0.71	0.10
Students collected information using texts or other material to answer questions	3.20	0.78	3.19	0.81	3.18	0.74	0.01
Students formulated their own questions that were to be explored	2.79	0.88	2.72	0.89	2.78	0.89	0.02
Students developed a commitment to participate in democratic processes	2.69	0.84	2.59	0.84	2.70	0.75	0.04
Students developed an interest in social rights	2.46	0.85	2.37	0.85	2.59	0.85	0.09

One teacher described the outcomes in a way that represents a common refrain throughout the project:

Students know how to promote their views in the local community, and they are well aware of what is needed to justify their arguments. They know how to utilise their skills to work out a good argument. The students have been given the opportunity to learn to respect different views in one case and how to take this into account in a presentation. The students have become aware of the impact an intervention in a natural area can cause to the local community.

No practical differences were found in effect size for teachers with varying experiences in the programme regarding student outcomes (Table 6). This could be for two reasons: Either teachers do not see many differences in student outcomes as they relate to the duration of teachers' involvement, or else teachers start out optimistic about the outcomes for students, then their interpretations change over time. The results reported here warrant further research to better understand what is happening for students at a large scale.

Discussion and Conclusions

The present study provides evidence for the potential of professional development that supports teachers to implement education for sustainable development. Overall, teachers in the Sustainable Backpack programme reported positive outcomes for themselves, their students and their schools. Because only a very small effect size exists in the differences between reports from teachers in their third year of the programme and later vs. teachers in their first year, further examination might be warranted to investigate whether teachers see benefits of staying over time in relation to their teaching competence overall.

ESD studies are useful in that they provide the opportunity to describe and understand educational contexts deeply to yield lessons or theoretical models that can be applied elsewhere. The Norwegian context, like many contexts, has very specific affordances and constraints that allow for specific kinds of successes and challenges. To make the lessons learned in this study useful to other contexts, we have focussed on broader design principles and evidence of success. Design principles can be implemented in various contexts without concern for detailed fidelity. By examining the context and design principles that drove the development of the Sustainable Backpack professional development programme in Norway, as well as reflections from teachers, several broader implications can be drawn.

First, ESD benefits from support from both school leaders and teachers, i.e., a top-down and bottom-up model that draws on institutional support from school systems and teachers' expertise and capacity, in line with other researchers (Breiting, Mayer, & Mogensen, 2005; Mogren & Gericke, 2016). A practical focus on teaching and learning through wicked problems, action competencies and the 5E instructional model shows promise in shifting classroom practices and student activities toward inquiry-based participation in scientific practices. Work on the Sustainable Backpack programme has reinforced the idea that partnerships with community stakeholders and learning across settings (Breiting, Mayer, & Mogensen, 2005) have the potential to engage students in authentic, local problems—leading to increased student motivation and interest in ESD, as reported by teachers. The design principles described here may be transferable and useful to other schools, school districts and nations. However, further research

is needed to support the theoretical framework underlying these principles, built on an evidence base in this and other contexts.

In this study, we set out to demonstrate one approach in which teachers and schools can focus on ESD work, even when whole-school endeavours that require a reorganisation of school-level systems (e.g., length of class periods, time for teacher collaboration across disciplines) are not institutionally possible. However, it is important to highlight that teachers frequently reflected on the importance of collaboration with their colleagues, both in and out of their schools. In the Sustainable Backpack programme, this was made possible through a regional and national network model. As also argued for by other researchers (Grossman, Wineburg, & Woolworth, 2001), these meetings facilitate extended collaboration between teachers about ESD and teachers learn from best practice in the field. This is of special importance because teachers in other studies have reported on lack of collaboration with colleges and other teachers about ESD (Borg et al., 2012; Pharo et al., 2012). Additionally, teachers in other studies report that they are unsure on how to facilitate and teach about ESD (Blum, Nazir, Breiting, Goh, & Pedretti, 2013; Borg et al., 2012, 2014; Breiting & Wickenberg, 2010) and ask for more professional knowledge development, as they receive in the Sustainable Backpack programme. Though the effect sizes were small, the findings here show that potential exists for increased learning for teachers and students when teachers have extended experiences as part of a learning community. Overall, teachers who had been in the programme for three years or more reported experiencing a greater influence from the project on their teaching in some ways than teachers in their first year of the programme. While this finding may seem obvious, and the effect sizes were small to moderate, teachers who participate over a longer time frame experience broader outcomes. It is important to highlight that teachers saw the benefit of participating for multiple years and that growth can happen, albeit slowly. This is in line with the research of Mogren and Gericke (2016) who have looked at schools implementing ESD and argued for “long term plans” for the implementation. Further research and insight into what is important in “long-term plans” implementing ESD might illuminate details that exert an important influence on how teachers make use of professional learning communities’ best practices and what alternative models might be available in lieu of a regional or national network.

Finally, though teachers alluded to shifts toward interdisciplinarity in their teaching through the Sustainable Backpack project, we found that throughout the data and our experiences with teachers, it is difficult for teachers to articulate and implement thoroughly. In fact, it was even difficult for the Sustainable Backpack team of researchers and professional development providers to articulate what we wanted to see in teachers’ reflections that would indicate deepening levels of interdisciplinary teaching. While many studies of interdisciplinary teaching exist, theoretical frameworks are needed that articulate the specifics of interdisciplinary

teaching that can be used to examine everyday logistics, classroom practices and teacher attitudes.

Existing studies on ESD at a large scale in primary and secondary schools are crucial in determining promising approaches to providing young people with opportunities to be involved authentically in addressing the socio-ecological challenges in their local and global communities. This exploration of Norway's Sustainable Backpack programme presents some preliminary findings on a nationwide professional development effort to help teachers and students take an interdisciplinary approach to ESD. By describing the design principles that have resulted in shifts in teacher practice and have provided structure for successful engagement in ESD, this work can provide some initial insights into the potential for student and teacher learning through teachers' professional development at a large scale for ESD.

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