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Teachers' ESD self-efficacy and practices: a longitudinal study on the impact of teacher professional development

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ABSTRACT

This longitudinal quantitative study investigated teachers' development of self-efficacy and teaching practices relating to education for sustainable development (ESD) in four compulsory schools in a Swedish municipality. The teachers participated in a professional development program over three school years designed to support them in implementing ESD. The program was based on five seminars that supported teachers to discuss and experiment with the principles, complexities and challenges of ESD. Data was collected at five different time points strategically planned at key moments in the program, using a questionnaire including scales measuring teachers' self-efficacy for ESD and their self-reported ESD practices. Descriptive and inferential statistics were used to follow the teachers' evolution across a time span of about three years. Results show that the teachers' self-efficacy was boosted early in the program, but fell back to initial levels after confrontation with practice. Through further experimentation in practice, the teachers' self-efficacy increased back to the initial level toward the end of the program. Furthermore, teachers started self-reporting ESD practices as the program progressed, and the correlation between self-efficacy for ESD and ESD practices grew. These results highlight the importance of providing teachers with long-term opportunities for bringing ESD into their own educational practice. The results also caution against using self-efficacy as an outcome measure in short-term professionalization initiatives.

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KEYWORDS

Education for sustainable development; self-efficacy; longitudinal analyses; professional development; teaching practices

1. Introduction

Education for Sustainable Development (ESD) is considered to be one of the key pathways to achieving a sustainable future (Hopkins 2012). It is a dynamic concept that incorporates a novel vision of education that seeks to empower people, to make it possible for every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future (Agbedahin 2019). In formal education, ESD has been described as having the potential to serve as a breeding ground for promoting innovations which meet and cope with the salient social challenges we face in an active and constructive manner (Rauch 2002). However, it presents

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diverse challenges for teachers, and initiatives to support teachers to develop competence and build self-efficacy for ESD are on the rise (e.g. Murphy et al., 2020; Murphy et al. 2021; Redman et al. 2021).

In the current paper, we focus on the evolution in the learning outcomes of teachers from four schools in Sweden, as they participated in a long-term professional development program built specifically to support them to implement this complex concept into their own educational practice and into their own school. In the current study we explicitly adopted a longitudinal design, studying the outcomes of teachers' participation in a professional development program spanning more than two years. This longitudinal design includes investigations of teachers' self-efficacy in ESD as well as their self-reported implementation of ESD teaching practices. This methodological approach is a much-needed innovation and contributes new and valuable information about the effectiveness of teachers' professional development in the field of ESD.

1.1. ESD as a challenge for teachers

When we look at definitions of ESD, its complexity is a characteristic that stands out both in the research literature (e.g. Vare and Scott, 2007) and at policy level (UNESCO, 2018). According to UNESCO (2018), ESD aims to provide knowledge about ever-changing planetary conditions and environmental issues, and their risks and causes. It empowers learners to make informed decisions and take responsible actions for environmental integrity, economic viability, and a just society for present and future generations, while ensuring respect for cultural diversity. It prepares people to cope with and find solutions to problems that threaten the sustainability of the planet and social systems (UNESCO, 2018). Consequently, ESD is suggested to promote competences such as critical thinking, imagining better futures and participatory decision-making. It also requires far-reaching changes in the way education is organized and delivered (UNESCO, 2014). Within ESD, educational efforts are described that aim to empower students with the necessary competences to deal with and act upon the complexity of sustainability issues (Breiting and Mogensen 1999; Sass et al. 2020), requiring a complex educational approach. For teachers, ESD presents a major professional challenge, connected to (among others) the complex educational principles that have emerged in recent ESD-related literature, such as holism, pluralism and action-orientation (Sinakou, Boeve-de Pauw, and Van Petegem 2019a).

Holism refers to the complex interconnectedness within issues of sustainability, crossing boundaries of social, economic and environmental dimensions, and thus requiring interdisciplinary expertise. Pluralism emphasizes the importance of diverse viewpoints, opinions and stakes within these issues (Öhman 2008; Rudsberg and Öhman 2010). Action-orientation in education brings learners' meaningful contributions toward solutions of issues to the forefront (Sinakou, Boeve-de Pauw, and Van Petegem 2019a). This becomes even more difficult when we consider the wicked nature (Rittel and Webber 1973) of sustainable development (Tomkinson 2011): there are many conflicting interests and no simple solutions, since often what is seen as a solution for some increases problems for others. A core question therefore arises as to what the focus or learning goal(s) of ESD should be within formal education. Sass et al. (2020) bring a revisited interpretation of action competence for sustainable development to the table and define it as a major goal for ESD. They posit that an action competent person:

is someone who is committed and passionate about solving a societal issue, has the relevant knowledge about the issue at stake as well as about the democratic processes involved, takes a critical but positive stance toward different ways for solving it, and has confidence in their own skills and capacities for changing the conditions for the better (p.17).

It is, thus, fair to state that ESD is notoriously complex and presents a real challenge for teachers since it requires a non-traditional interpretation of the goal of education (action

competence; Sass et al. 2020). It also requires teachers to bring into practice teaching approaches that they are unfamiliar with (holism, pluralism, action; Sinakou et al. 2019a). Many researchers have found that the practical implications and relevance of ESD is often not clear for teachers who are expected to adopt this approach into their own practice (Redman, Wiek, and Redman 2018; Vare et al. 2019). Borg et al. (2012) identified that common barriers to implementing ESD as experienced by teachers in Sweden include unfamiliarity with the subject and a lack of necessary expertise. In a more recent survey by Kang (2019) among Korean teachers, some of the main barriers for implementation of ESD into educational practice are a (self-perceived) lack of pedagogical knowledge and competency. Given the high complexity of ESD, both in terms of educational principles and of educational goals, it is not surprising that teachers feel ill-prepared to apply it in their schools and in their teaching.

Recent work on the effectiveness of ESD has revealed that while ESD is difficult to bring into educational practice for teachers, when students report that they do experience ESD in the classroom, this has a positive effect on their competences for sustainability (Boeve-de Pauw et al. 2015; Olsson et al., 2022). Furthermore, ESD has not yet been widely anchored in pre- nor in-service teacher training (see e.g. Wilson 2012; Kang 2019). Across studies, teachers report overall low self-efficacy for implementing ESD and scholars highlight the need to provide engaging learning opportunities for (pre- and in-service) teachers to (continue to) build their confidence and experience in ESD (e.g. Evans, Tomas, and Woods 2016). Specifically, in Sweden, a review of the research shows that implementation efforts for ESD show limited impact on teaching practices (Gericke, Manni, and Stagell 2020), which has also been supported in nationwide evaluations at the practitioner level (Naturskyddsforeningen 2014; 2018). For these reasons, we joined forces with a local school district and designed a teacher professional development program aimed to support teachers' understanding of ESD and its implementation at their school and in their teaching. In this paper, we provide information on the design and implementation of the teacher professional development program and report the results of our monitoring and evaluation efforts with regard to the program's effectiveness in terms of its impact on the participants' self-efficacy for ESD and self-reported ESD practices.

1.2. Teachers' self-efficacy for ESD

Whether or not, and to what degree, someone is willing and able to engage in (professional) tasks has been studied extensively, and a major key concept in this field is that of self-efficacy (Bandura 1997). In his social learning theory, Bandura defines self-efficacy as the '*belief in one's capabilities to organize and execute the courses of action required to produce given attainments*' (p. 3). Generally, self-efficacy is considered to be one of the most powerful motives of behavior, as it has a strong relationship with the decision to perform a task, the amount of effort invested and the level of persistence (Gardner and Pierce 1998). In the context of education, this translates to teachers' self-efficacy as a self-judgment of their capabilities to bring about desired educational outcomes or a capacity to influence students' learning (Klassen et al. 2011). Teachers with high (general) teaching self-efficacy have been documented to explore more alternative methods of instruction and to experiment more with new and innovative instructional materials. In addition, they exhibit higher levels of professional commitment and produce higher students' achievement (Bray-Clark and Bates, 2003). Such findings on the impact of general self-efficacy are promising for the field of ESD. Recently, Malandrakis et al. (2019) developed a framework and measurement instrument that can be used to assess the current abilities of pre-service and in-service teachers to teach ESD: the Teachers' Self-Efficacy on Education for Sustainable Development (TSESESD). The validation process of the scale reports its strong psychometric properties, appropriateness for both pre-service and in-service primary school teachers and comprehensive nature, encompassing the current trends of ESD competences. Malandrakis et al. (2019) argue that:

[...] assessment and evaluation are essential components of any educational plan, so, such an instrument could be valuable in helping universities and teacher educators worldwide to assess teachers' self-efficacy in ESD, thus facilitating and improving the effectiveness of respective teachers' preparation and professional development programs (p. 24).

It is in this sense that we applied the scale in the current study to assess the impact of a professional development program for teachers, focusing on ESD. In its original form, the scale encompasses six subscales, each focusing on a specific aspect of ESD as identified by Sleurs (2008): 'Values and Ethics', 'Systems Thinking', 'Emotions and Feeling', 'Actions', '(perceived) content knowledge' and '(perceived) pedagogical content knowledge'. We only used the latter subscale in the current study, thereby focusing on the evolution of self-perceived pedagogical content knowledge of teachers participating in a long-term professional program on ESD.

Using a measure of self-efficacy beliefs as outcomes of professional development initiatives is relevant since these beliefs underlie and form a precondition for actual engagement in a task (Bandura 1997). We can, thus, argue that increased self-efficacy is a good basis for assuming that teachers could and will actually transition into a more frequent and more qualitative implementation of ESD in their educational practice. Nevertheless, we also include a measure for self-perceived implementation of ESD, in this study, to follow the evolution in both self-efficacy and self-reported teaching practices of the teachers participating in the professional development program. The reported ESD practices scale is based on an initial version that was used in Boeve-de Pauw et al. (2015). The inclusion of this scale is especially relevant given the results of research describing the 'dark side' of self-efficacy, whereby high self-efficacy can, in some instances and for some people, result in no or even a negative impact on performance. In several domains, such negative effects have been reported, for example, in education (Salanova, Lorente, and Martinez 2012; Mahmood 2016), marketing and sales (Childs et al. 2019) and hospitality (Koc 2021). Generally, it is understood that low performers can overestimate their own skills given their lack of competence to meaningfully assess their own skill level. This finding, which has been described as the Dunning-Kruger effect (Kruger and Dunning 1999), should be taken as a critical reflection on trusting too much in self-efficacy as the main or only measure that is used as an outcome of professional development. In a 2020 study by Hansen and Sillasen, a negative correlation was reported between self-efficacy for ESD of student science teachers and their actual knowledge of ESD. This indicates that the Dunning-Kruger effect might actually be in place among pre-service teachers, stressing the importance of including both a measure for self-efficacy and for teaching practices in the current study.

1.3. Teacher professional development for ESD

Results from a survey by Dahl (2019), among pre-service teachers from around Europe, show that ESD is mostly not integrated widely into their training. However, when present in their basic education, it is generally included only as an add-on or as a standalone course or topic. Furthermore, the pre-service teachers in Dahl's 2019 study indicated that while they generally felt well prepared for (or ready to develop) almost all of the tasks expected of them when they go into service as professional teachers, they felt ill prepared for enacting ESD. These findings are supported by a large nationwide Swedish study including more than 3,000 in-service teachers of different subjects identifying many barriers for implementing ESD. Among the barriers identified, the most common obstacles were that the teachers lacked inspiring examples of how to teach ESD, and that they lacked the necessary expertise (Borg et al. 2012).

These findings resonate with Tilbury's (1992) call in the early nineties to make environmental and sustainability education the 'priority of priorities' in pre-service teacher training programs. This call is presently met by an additional focus on the in-service professional development of teachers. Redman et al. (2021) argue that while programs focused on teacher education

for sustainability predominantly refer to the education of undergraduate university students (e.g. pre-service teachers, see Bürgener and Barth 2018; Nousheen et al. 2020), continuing professional development, which is offered to in-service teachers, presents a strong opportunity to build teachers' competence to support students in developing the capacity to address urgently needed sustainability solutions. Therefore, this may comprise a faster route to achieving a sustainable future than that through pre-service teacher training. In professional development on ESD for in-service teachers who are already working in schools, the teachers can capitalize on their expertise concerning the reality of their own school, their colleagues, their environment and their students (Redman et al. 2021). This is also identified by Biasutti, Concina, and Frate (2019) as a necessary pre-condition to implement new practices and motivate and convince others to engage.

Andic (2020) critically examined the relation between teacher competence in ESD and participation in professional development, and concluded that (in Croatia) there is an inadequate implementation of ESD in the teachers' professional development. Teacher professional development programs are still too often single shot, stand-alone, decontextualized and theoretical sessions for groups of individual teachers (e.g. Popova, Evans, and Arancibia 2016). In an effort to overcome the shortcomings of such initiatives, we have developed, implemented and evaluated a long-term, intensive, real-world, hands-on, team-oriented professional development program on ESD, specifically tailored to a small group of schools in a single municipality in Sweden (see section 2.2 for more information on the program). This is in line with Dessimone's (2009) call for longer duration, multi-session approaches to teacher professional development that integrate teachers' learning during sessions with their learning within their classroom and school. Relating to the impact measurement of the program, we can position this study within the framework of Dessimone (2009), who elaborates that the core features of a program (content, active learning, coherence, duration, collective participation) connect to an intended increase in teacher knowledge and skills and change in attitudes and beliefs, followed by a change in instruction and finally, improved student learning. Our current study focuses on the central part of this framework. We evaluate the impact of the program on the participating teachers' self-efficacy and self-reported teaching practices relating to ESD.

1.4. Research questions

As in many fields of educational science, for impact research, there is a clear need to go beyond cross-sectional research and install longitudinal designs (e.g. Boeve-de Pauw 2014). This is specifically true when studying the impact of long-term, scaffolded educational interventions, such as the professional development program we designed and implemented. Given all the above considerations, we put forward three interconnected research questions:

RQ1. How does teachers' self-efficacy in ESD evolve over time as they participate in the professional development program on ESD?

RQ2. How do teachers' (self-reported) ESD practices evolve over time as they participate in the professional development program on ESD?

RQ3. How does the relation between self-efficacy and teaching practices in ESD evolve over the same timeframe?

2. Background

2.1. The Swedish school system and ESD in formal education in Sweden

Education in Sweden is mandatory from the age of six (pre-school class) to the ages of 15 to 16 (grade 9). These grades constitute the compulsory schooling level. Most children in Sweden start their schooling at the pre-school level (ages 1 to 5) and continue after the compulsory

school level to a vocational or preparatory upper secondary school program of their interest (grades 10–12). The concept of sustainable development is included as an important concept in Swedish curricula for all levels of the school system, from the pre-school level to upper secondary level (Skolverket 2011, 2013, 2018). However, there is no national strategy or system for mandatory further training to support teachers to implement ESD into the teaching at their schools. Instead, it is each one of the 290 Swedish municipalities own responsibility to develop a strategy for implementing ESD in their schools. A report shows that only 30% of the Swedish municipalities have an ESD strategy for their schools (Spangenberg et al. 2017). In Sweden, this means that many schools lack support for ESD teaching and learning, unless they themselves seek such support from, for example, authorities and non-governmental organizations in Sweden. Collaboration between researchers and municipalities, to work together towards effective ESD implementation strategies, is therefore one important way forward.

2.2. The teacher professional development program on ESD

This study is part of a larger research project (financed by the Swedish Institute for Educational Research) investigating the development of ESD in schools in a Swedish municipality. In collaboration with us as researchers, the municipality designed a teacher professional development program based on the model for effective teacher professional development (Dessimone 2009) in which one of the main ideas was to develop action competence for sustainability among students. The municipal school authorities invited schools to partake in a three-year combined school improvement and professional development program using a whole school approach for ESD (Tilbury and Wortman 2006; Mogren, Gericke, and Scherp 2019). The underlying aim was to institutionalize ESD through a school improvement process by engaging all the stakeholders, that is, teachers, students, school leaders, school board and other staff. The professional development part of the project consisted of teachers' collaborative work. It also included seminars with external experts that should support the initiation of 'bottom-up' processes of ESD, and the installation of a facilitator in each of the schools (see also below). Two of the researchers were employed as project leaders by the municipality.

The teachers in the project have had the opportunity to develop their own ESD teaching competence and to implement ESD at their school, which in turn was hypothesized to result in a development of ESD learning outcomes and competences at the student level (Dessimone 2009). We designed and implemented a teacher development program in several pre-schools (see Borg and Gericke 2021), schools at the compulsory schooling level and one upper secondary school in a municipality of a medium-sized town in Sweden. In the current study, we report on the quantitative teacher results for the four schools at the compulsory schooling level that participated in the program. The four schools cover the range from grade 1 to grade 9 of the compulsory schooling level. The entire school team, in each school, was invited and participated in the five seminars that were organized across three school years. During these seminars, which lasted half or full days, we engaged teachers with scaffolded ESD learning experiences. There were lectures, workshops and discussions related to ESD. The first three seminars aimed to develop teachers' knowledge and self-efficacy toward ESD. The last two seminars were more directly focused on transforming the teaching at the teachers' own schools to be more cross-disciplinary and to adopt a more action-oriented, pluralistic approach to the teaching. In short, the seminar occasions can be summarized as follows:

- **Seminar 1 – October 2016.** A full-day seminar focusing on what education for sustainable development entails. It was introduced through collective viewing and discussion of the movie *Hope Builders* (Dansereau, 2010), which documents the process of the implementation of ESD in a school in Canada. Furthermore, experienced teachers

(unaffiliated to the participating schools) were invited to give testimonials on their lived experiences with, and understanding of, ESD at their own school.

- **Seminar 2 – June 2017.** A full-day seminar that introduced the UN sustainable development goals (SDGs) as a broad framework to further expand the participating schools' understanding of sustainable development and create awareness that the program does not only focus on environmental issues, but explicitly seeks to introduce an interdisciplinary approach. The concepts of holism, pluralism and action-orientation were introduced by experts in the field of ESD, and teachers were supported to reflect on how the SDGs, holism, pluralism and action were presently included in their own school. Per school, teachers were invited and supported to formulate short-term and long-term goals that they wanted to achieve in their own educational practice.
- **Seminar 3 – November 2017.** This third, full-day seminar engaged the teachers with concrete sustainability issues. Two dilemmas were explored: local flooding problems, on the one hand, and cheap clothing, on the other. The teachers were first invited to explore the issues through a systems thinking approach focusing on environmental, social and economic perspectives, to then map the stakes of the different stakeholders involved. Finally, they explored how they themselves could contribute to adaptation or mitigation measures through meaningful action (both individually and collectively) in each of the dilemmas. In the next phase of this seminar, teachers were supported to explore how to address these issues in educational practice, while applying the holism, pluralism and action principles.
- **Seminar 4 – June 2018.** A half-day seminar on examples of how to arrange cross-curricular collaboration in education. The day included both a lecture by a scholar who was also a teacher at a large school in the capital of Sweden, and who had extensive experience with cross-disciplinary teaching at the upper secondary level. Different approaches to cross-curricular teaching were presented and discussed, and the participating teachers were invited to first reflect on how such collaboration was currently evident and whether it might be possible in their own school, and then to formulate goals to be achieved and steps to be taken to reach these goals. During their reflection and goal setting, the teachers were supported by education experts on how to achieve mandated curricular goals through such an approach.
- **Seminar 5 – November 2018.** A final full-day seminar focusing on hands-on activities for the work teams at the schools. During this, the teachers explored more deeply how the implementation of ESD in their school was evolving and which were the next meaningful steps for their own school. On this final seminar day, special attention was given to the role of the physical environment in which teaching and learning happen and how it can be designed and modified to optimize successful implementation of ESD.

In parallel with these workshops, the teachers worked locally to implement ESD in their work teams at the school in between the seminars. The teachers had regular meetings on a weekly basis, where teaching of the students and the development of action competences for sustainability among the students could be discussed along with other practical and urgent issues related to the ESD implementation efforts. To support the teacher work teams, one teacher at each school was appointed as a facilitator and 20% of their working hours were allocated for this purpose. Moreover, the facilitators met the two project leaders, and the facilitators from other schools in the municipality, to discuss and support each other in the local development of ESD at the schools. These meetings were held on a regular basis (two-hour meetings three to four times each semester). Also, to accommodate for organizational and leadership issues related to the project, once each semester the two project leaders met the school leaders at the schools to plan and discuss how to further enact the professional development program with the teachers.

3. Methodology

3.1. Study design and sample

In the current study, we report on the quantitative results of the teachers from the four participating compulsory schools in the professional development program. Between and after the seminars described above, we collected online survey data from the participating teachers. The timing for the seminars and of the surveys was made separately, based on the availability of the teachers, expert contributors and the academic planning of the school year, and after consultation with the participating schools' principals. We did not achieve a fixed timing of the period between the seminar and the surveys but did manage to plan a survey between each of the seminars, as well as a final survey a couple of months after the final seminar. [Figure 1](#) shows an overview of the timing for the five seminars as well as the five data collection moments. This arrangement allowed us to monitor changes that occurred across a timeframe of three school years.

All the teachers in the four schools were invited to respond to the survey at each data collection moment. Only teachers involved in teaching with the students were invited. Hence, other staff at the schools did not participate in the surveys. Invitations to complete the surveys were sent to all teachers through e-mails and the school facilitators supported the data collection by word-of-mouth and email reminders. A timeframe of two weeks was provided for the teachers to submit their answers. Since all teachers from the four schools participated in the program, they were all invited to complete each survey. The number of employed teachers varied during the three school years, mainly based on additional temporary employments due to teachers changing jobs, illness or parental leave. The number of respondents and some basic background information is provided in [Table 1](#) for all respondents collectively, as well as for each school separately. Across all time points, there are 414 data entries; the mean age of the survey respondents is 30.5 years and 75% of respondents are women.

3.2. Dependent variables

Two outcome variables are central in this study, namely, the teachers' self-efficacy for ESD (SEFF) and their self-reported ESD practices (PRAC). In late 2016, we used the early work of Malandrakis et al. (2019) as a starting point to operationalize teachers' self-efficacy for teaching education for sustainable development in a 12-item 5-point Likert scale (1 = disagree, 2 = rather disagree, 3 = agree nor disagree, 4 = rather agree, 5 = agree), specifically the subscale tapping into teachers' self-perceived pedagogical content knowledge. Sample SEFF items are '*I feel confident that I can work with sustainable development based on a multidisciplinary approach*' and '*I feel confident that I can evaluate an ESD project that I/we have implemented*'. An overview of all items can be seen in [Table 2](#), in the results section. We tested the SEFF scale for validity and reliability, respectively, through exploratory factor analysis (principal component analysis, PCA) and internal consistency analysis. Results of a PCA with varimax rotation indicate a factor solution with a single factor

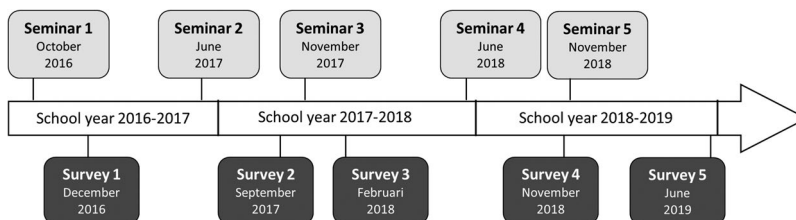


Figure 1. Timing of the seminars and surveys across the professional development program.

Table 1. Sample and basic demographics from respondents at each data collection moment.

		School 1	School 2	School 3	School 4	Full sample
All surveys	Sample size	116	73	121	104	414
	Response rate	55%	72%	74%	68%	66%
	Gender ratio (F:M)	0,76	0,65	0,91	0,67	0,75
	Mean age (in years)	30,15	30,5	30,25	29,3	30
Survey 1	Sample size	19	14	25	20	78
	Response rate	54%	70%	78%	61%	65%
	Gender ratio (F:M)	0,78	0,66	0,88	0,68	0,75
	Mean age (in years)	29,5	29	30	28,25	29,25
Survey 2	Sample size	14	13	22	12	61
	Response rate	30%	59%	71%	39%	47%
	Gender ratio (F:M)	0,74	0,69	0,91	0,71	0,76
	Mean age (in years)	30	30	29,5	28,75	29,5
Survey 3	Sample size	24	12	26	31	93
	Response rate	51%	55%	84%	97%	70%
	Gender ratio (F:M)	0,87	0,68	0,88	0,61	0,76
	Mean age (in years)	30,25	31,5	30,5	29,5	30,5
Survey 4	Sample size	39	18	30	22	109
	Response rate	95%	95%	86%	79%	89%
	Gender ratio (F:M)	0,79	0,65	0,9	0,68	0,76
	Mean age (in years)	30,5	31	30,5	29,75	30,5
Survey 5	Sample size	20	16	18	19	73
	Response rate	49%	84%	51%	68%	59%
	Gender ratio (F:M)	0,7	0,58	1	0,68	0,74
	Mean age (in years)	30,5	31	30,75	30,25	30,75

with an eigenvalue of 7.737 explaining 74% of all variance and including all 12 items with factor loadings between .730 and .865. With a Cronbach's alpha value of .919, the SEFF scale can be considered to have excellent reliability in this study.

Self-reported ESD practices (PRAC) were measured with a 10-item 5-point scale that we based on the operationalization of Boeve-de Pauw et al. (2015) work on teachers' practices in line with the definition of ESD as a combination of holism and pluralism (Öhman 2008) and action-orientation (Sinakou, Boeve-de Pauw, and Van Petegem 2019a). Sample items are '*I let my students work with local and global issues and how they fit together*' and '*In my lessons, there are often conversations in which different views are presented and discussed*'. An overview of all items can be seen in Table 3, in the results section. The results of a PCA with varimax rotation indicate a factor solution with a single factor with an eigenvalue of 5.704 explaining 57.01% of all variance and including all 10 items with factor loadings between .626 and .806, indicating satisfactory scale validity. With a Cronbach's alpha value of .846, the PRAC scale can furthermore also be considered to have excellent reliability.

3.3. Analyses

The response ratio in the schools varied across time and, since we were not able to collect water-tight personal identifiers for the individual teachers, we were not able to connect respondents across the five time points. In the analyses, all data observations were therefore treated as independent and pooled together across the schools to reach a sufficient sample size for inferential analyses. Factor analytical techniques were used to establish validity and reliability (see 3.2). Descriptive analyses were used to calculate mean and standard deviations for both dependent variables for all teachers at the different time points, both at the level of individual items and on that of the scale (mean values across items). To study the differences in teachers' self-efficacy and self-reported ESD practices between those time points, we performed ANOVA tests, each time comparing the scores at the different time points (September 2017, February 2018, November 2018, June 2019) to that at the baseline assessment in December 2016. Effect

Table 2. Descriptive results ($M \pm SD$) for teachers' self-efficacy beliefs at the five time points.

Item	I feel confident that I can currently...	Dec '16	Sep '17	Feb '18	Nov '18	Jun '19
SEFF_01	... realize education for sustainable development (ESD) in my school	3.00 ± 1.07	3.80 ± 1.05	3.33 ± 1.01	3.37 ± 0.99	3.60 ± 0.89
SEFF_02	... evaluate an ESD project that I / we have implemented	2.91 ± 1.08	3.72 ± 1.14	3.33 ± 1.10	3.33 ± 1.17	3.45 ± 1.12
SEFF_03	... teach for sustainable development	3.53 ± 1.02	3.87 ± 0.90	3.70 ± 0.98	3.72 ± 1.05	3.93 ± 0.79
SEFF_04	... determine educational objectives in relation to sustainable development and the students I teach	3.54 ± 1.09	3.98 ± 0.96	3.62 ± 1.00	3.64 ± 1.00	3.85 ± 0.84
SEFF_05	... develop dynamic learning environments for teaching sustainability issues	3.05 ± 0.94	3.57 ± 0.97	3.20 ± 0.96	3.33 ± 0.97	3.44 ± 0.87
SEFF_06	... deal with environmental aspects of issues related to sustainable development	3.45 ± 0.98	3.72 ± 1.02	3.52 ± 1.04	3.63 ± 1.01	3.70 ± 0.84
SEFF_07	... deal with social aspects of issues related to sustainable development	3.31 ± 1.02	3.87 ± 0.96	3.58 ± 1.01	3.57 ± 0.93	3.68 ± 0.88
SEFF_08	... deal with economic aspects of issues related to sustainable development	2.91 ± 1.10	3.56 ± 0.94	3.15 ± 1.02	3.26 ± 0.94	3.41 ± 0.91
SEFF_09	... deal with the political aspects of issues related to sustainable development	2.69 ± 1.04	3.44 ± 0.98	2.83 ± 1.08	3.21 ± 0.93	3.26 ± 0.93
SEFF_10	... deal with the international aspects of issues related to sustainable development	2.85 ± 1.01	3.44 ± 0.90	3.00 ± 1.06	3.35 ± 0.86	3.41 ± 0.88
SEFF_11	... work with sustainable development in line with the objectives of the curriculum and guidelines	3.56 ± 1.08	3.93 ± 0.87	3.67 ± 0.98	3.75 ± 0.94	3.86 ± 0.92
SEFF_12	... work with sustainable development based on a multidisciplinary approach	3.54 ± 1.10	3.98 ± 1.01	3.63 ± 1.04	3.61 ± 0.97	3.88 ± 0.87
SEFF_ESD	Scale mean	3.19 ± 0.82	3.74 ± 0.78	3.39 ± 0.84	3.49 ± 0.79	3.63 ± 0.66

Reported on a five-point Likert scale.

sizes are reported using Cohen's d , regarding effects as small, moderate, medium, and large if $d > 0.2$, > 0.3 , > 0.5 and > 0.8 , respectively (Cohen 1988). The relations between self-efficacy and reported practices at the different measurement occasions were quantified through Pearson correlations. All analyses were performed in SPSS 26.

4. Results

Below we present the results of the analyses performed to answer our three research questions. We first describe the results of descriptive analyses on the ESD self-efficacy and self-reported ESD practices of the teachers, highlighting where high and low scores can be found for specific items at specific times throughout the professional development course. In a second step, we

report on the changes across time at scale level for both self-efficacy and self-reported practices, to finally show how these two concepts relate to each other at the different time points in our study.

4.1. Descriptives

Tables 2 and 3 report the results of the descriptive analyses for, respectively, the teachers' self-efficacy for ESD and their self-reported ESD practices. While for both constructs the scale mean and standard deviations give a first impression of the changes in the teachers' self reports over time, these tables also provide information on the degree to which the teachers felt competent to handle each statement in the individual items (Table 2) as well as the experiences that they implemented in their teaching (Table 3). Among the self efficacy statements, several

Table 3. Descriptive results (M±SD) for teachers' self-reported ESD practices at the five time points.

Item		Dec '16	Sep '17	Feb '18	Nov '18	Jun '19
PRAC_01	When my students read texts at school, usually we critically examine the content	3.68±0.99	3.69±0.92	3.70±0.94	3.68±1.02	3.86±0.77
PRAC_02	In school, I encourage my students to take a stand and have their own opinion on the issues we work with	4.51±0.66	4.34±0.79	4.34±0.90	4.36±0.81	4.42±0.71
PRAC_03	I use many teaching approaches, depending on the character of knowledge	4.15±0.76	4.08±0.92	4.24±0.83	4.19±0.87	4.33±0.71
PRAC_04	In my lessons, there are often conversations in which different views are presented and discussed	3.96±0.95	3.97±0.89	3.65±1.06	3.81±1.11	4.22±0.71
PRAC_05	Societal actors from e.g. municipality, business or SMEs* are included in the learning environment in my teaching	2.81±1.08	2.82±1.12	2.80±1.08	2.95±1.19	3.14±1.17
PRAC_06	In school, I let my students work with how the past, present and future are linked in various matters	3.79±0.94	3.70±1.01	3.82±1.07	3.86±1.01	4.14±0.90
PRAC_07	In my teaching, nature or other outdoor environments are used	3.26±1.40	3.41±1.41	3.34±1.41	3.52±1.40	3.33±1.34
PRAC_08	In school, I let my students work with local and global issues and how they fit together	3.42±1.17	3.39±0.95	3.46±1.13	3.50±1.10	3.73±0.93
PRAC_09	In teaching, I tie an event to the current operating environment	3.78±0.99	3.82±0.97	3.68±1.06	3.94±0.88	3.88±1.00
PRAC_10	In school, I let my students work with the economic, social and environmental problems linked	3.12±1.29	3.16±1.29	3.12±1.20	3.18±1.20	3.42±1.00
PRAC_ ESD	Scale mean	3.64±0.64	3.63±0.67	3.61±0.77	3.70±0.67	3.85±0.57

Reported on a five-point Likert scale.

Note: * SMEs=small and medium enterprises.

items stand out as being perceived as difficult or experienced at a low or only moderate level of competency. As can be seen in [Table 2](#), dealing with the economic, political and international aspects (respectively, items SEFF_08, SEFF_09 and SEFF_10) appear to present the greatest challenge to the teachers that participated in this program and evaluation study. While we do see increased mean values for all these items as the teachers progress through the professional development program, they remain the main challenges for the teachers (i.e. the lowest mean scores are reported for these items). Similarly, the item tapping into the teachers' self-efficacy relating to evaluating student learning within ESD stand out as difficult for teachers. Items that consistently stand out in terms of high self-efficacy among the teachers are SEFF_04, SEFF_11, and SEFF_12, which relate to defining educational objectives and connecting ESD to the curriculum, on the one hand, and to applying a multidisciplinary approach in ESD, on the other.

The descriptive results in [Table 3](#) can be used to identify similar challenges in the self-reported ESD practices of the teachers. Items for which teachers consequently report low mean values relating to their teaching practices are PRAC_05, PRAC_07, and PRAC_10. These items relate, respectively, to incorporating collaboration with diverse societal actors, using the outdoor natural environment, and connecting economic, social and environmental aspects within the context of ESD. Items in the self-reported ESD practices scale that stand out in terms of a high mean value are PRAC_02 and PRAC_04, which relate to including diverse viewpoints in the classroom as well as encouraging students to identify their own opinions. Also, PRAC_03 consequently receives high scores, indicating that the teachers reported that they use a diversity of teaching approaches (working methods) depending on the topic they teach.

4.2. Changes over time

For each time point we estimated differences from the baseline (December 2016) for the teachers' self-efficacy and practices; [Table 4](#) summarizes the main results. As can be seen in the table, the teachers' self-efficacy started at a neutral $3,19 \pm 0,82$ in December 2016 and peaked after the first seminar to $3,74 \pm 0,78$ ($p > 0,001$; $d = 0,68$) in September 2017, but then dropped to $3,39 \pm 0,84$ (*ns*) in February 2018 and again climbed as the seminars continued and time progressed: $3,49 \pm 0,79$ ($p = 0,048$; $d = 0,37$) in November 2018 and $3,68 \pm 0,66$ ($p > 0,001$; $d = 0,66$) at the final data collection moment in June 2019. [Figure 2](#) gives a visual representation of these changes over time.

As shown in [Table 4](#), differences between the time points relating to the teachers' self-reported ESD practices were only reported toward the end of the program, with the baseline $3,64 \pm 0,66$ in December 2016. Comparable results in September 2017 and February 2018 drop slightly (though not significantly), but higher self-reports are shown in November 2018 ($3,71 \pm 0,67$). Finally, significantly higher self-reports are shown in June 2019 after the entire professional development program had been completed: $3,86 \pm 0,57$ ($p = 0,041$; $d = 0,36$). Again, [Figure 2](#) shows the different values the teachers reported relating to their ESD practices. A visual

Table 4. Mean values, standard deviations, effect size and correlations between SEFF and PRAC at the five time points.

Estimate	Dec '16	Sep '17	Feb '18	Nov '18	Jun '19
SEFF $M \pm SD$	3.19 ± 0.82	$3.74 \pm 0.78^*$	3.39 ± 0.84	$3.49 \pm 0.79^*$	$3.63 \pm 0.66^*$
Effect size (d)	/	0.68	/	0.37	0.66
PRAC $M \pm SD$	3.64 ± 0.64	3.63 ± 0.67	3.61 ± 0.77	3.70 ± 0.67	$3.85 \pm 0.57^*$
Effect size (d)	/	/	/	/	0.36
r (SEFF-PRAC)	0.436*	0.508*	0.572*	0.690*	0.791*

*Marks significant estimates. For SEFF and PRAC these are t-test comparisons to the baseline value in December 2016. For non-significant differences, no effect sizes were estimated.

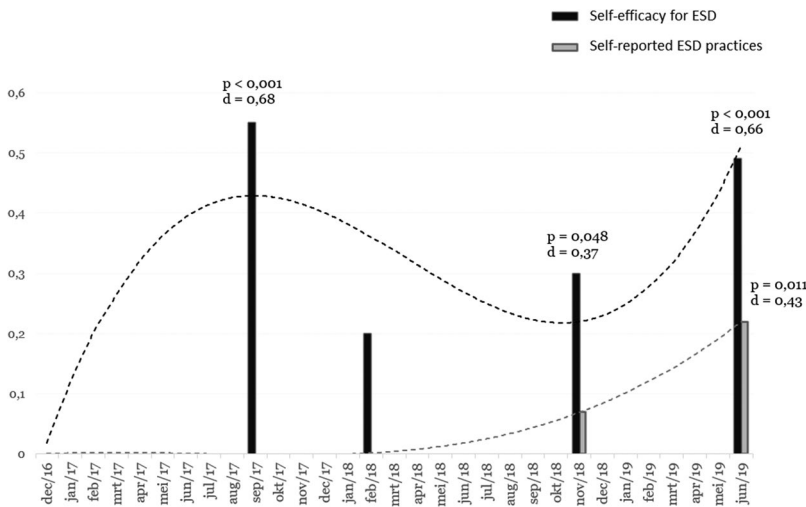


Figure 2. Changes in teachers' self-efficacy for ESD and self-reported ESD practices across the five time points in the professional development program.

representation of the mean differences from the baseline values in December 2016 is provided in [Figure 2](#), both for the teachers' self-efficacy for ESD and for the self-reported ESD practices. Polynomial regression lines have been added to aid visual interpretation of the figure.

Across the measurement occasions the correlation between self-efficacy for ESD and self-reported ESD practices gradually increased from a moderate $r = 0,436$ to a large $r = 0,791$. [Table 4](#) reports the correlation between the two constructs at the five different time points. All correlations were significant ($p < 0.001$).

5. Discussion

The main goal of our study was to evaluate the impact of a professional development program on ESD for teachers in compulsory schooling in a municipality in Sweden. Given the challenges that implementing ESD into educational practice presents to teachers, continued professional development is necessary, and evaluation of such initiatives is crucial (Redman, Wiek, and Redman 2018). Evaluation can be understood in many different ways. For teacher professional development, Dessimone (2009) articulates that it can focus on the characteristics and pedagogy applied, on the changes in beliefs or attitudes of the participants, or changes in their instructional practices and/or changes at the student level. Our study focused on the self-efficacy beliefs regarding ESD and self-reported ESD practices of teachers who participated in the professional development program.

Two main qualities of our current approach deserve to be highlighted. First, the immersive, long term, collaborative nature of the program, connecting ESD to the teachers' own educational reality in their school, supporting them to make meaning of ESD for their own students and to translate the principles of ESD into educational practices that fit their needs. Second, the long-term perspective of the research. We have collected data on the teacher outcomes on five different occasions, over a timeframe of 2.5 years, as they became acquainted with ESD, started experimenting and sharing experiences, and finally implemented it into their educational practice. The long-term perspective, both of the program and its evaluation, allows us to understand the teachers' professional development more deeply. The same surveys were used at each time point and, as such, respective comparisons with the baseline data allow us to study and understand the progression of the teachers in terms of their self-efficacy for ESD and the extent to which they themselves report that they implement ESD into their educational practices.

5.1. What is challenging for teachers?

The baseline survey provided insight on which aspects of ESD the teachers experienced as difficult (reported low self-efficacy) at the onset of the program. This allowed us to attune – in collaboration with the municipality that offered the program to the schools – the content and approach of the seminars. As can be seen in the results of our analyses in [table 2](#), at the first data collection moment the participants reported low self-efficacy for dealing with economic, political and international aspects of issues related to sustainable development in their teaching. Environmental aspects, on the other hand, presented less of a challenge according to our participants. This aligns with results that have been reported on teachers' personal understanding of sustainable development (Summers, Corney, and Childs 2003; Borg et al. 2014) as dealing mainly with environmental issues, and also with interpretations of sustainable development as representing an integrated versus a separated perspective (Berglund and Gericke 2016), or a harmony- versus conflict-based perspective (Öhman and Öhman 2012).

Our current results do not provide more insight into the participants' understanding of (education for) sustainable development, but they do highlight that between the different perspectives of ESD, the economic, political and international are especially challenging for the participating teachers to deal with in their educational practice (as can be seen in the results of our analyses presented in [table 3](#)). This resonates with results obtained from students in Sweden by Berglund and Gericke (2018), who highlighted that it is exactly the economic perspective within ESD that can explain important differences between students' appreciation of and engagement with sustainable development. Teachers should, therefore, have the tools and competence to address not just the ecological and social, but also the economic perspective within ESD. Herein lies a call for targeted professional development of teachers.

Our results also indicate that the teachers have low self-efficacy concerning evaluating student learning in ESD. Given the complex nature of the learning goals of ESD, this is not a surprising result. Educational evaluation of sustainability competences is not a sinecure, and it requires non-traditional evaluation methods and a well-corroborated combination of summative and formative assessment methods (e.g. Granit-Dgani, Kaplan, and Flum 2017). While a great deal of scholarly attention has been paid to defining sustainability competences and operationalizing them into quantitative and/or qualitative instruments for evaluation in the context of research, how to evaluate them in educational practice is less well developed. Here lies an important task for collaborative work between researchers, practitioners and curriculum developers.

If we look at the elements that teachers report as present in their current ESD practices, then several items stand out. At the baseline, the aspect with the lowest reports by teachers is collaboration with societal actors (such as local governments and business) and using the natural outdoor environment within ESD. These two aspects deserve attention, as they are highlighted as important in different frameworks on the quality of ESD, such as the 'whole school approach' to ESD (Mogren, Gericke, and Scherp 2019; Tilbury and Wortman 2006) that this project is aligned with, and the 'holism-pluralism-action' framework (Sinakou et al. 2019b), or the recent 'open schooling approach' to sustainability (e.g. Van Poeck and Östman 2019). Each of these frameworks articulates that a major quality of ESD is the meaningful collaboration with local stakeholders such as municipalities, small and medium enterprises, citizens etc. in exploring and tackling sustainability issues. Toward the end of the professional development program, we see a moderate increase in the teachers' reports of this kind of collaboration in an educational context. In the larger project of which this study is one part, we also focused a qualitative investigation to understand what changes have occurred, why and in which schools. Based on the current results of the present study, we can only identify the collaboration with societal stakeholders as challenging for teachers to bring into practice.

Another issue that the teachers report, at the baseline, is that they only seldom bring cross-curricular teaching into practice, which has been argued to be a central aspect of

successful ESD (Sund and Gericke 2020). This is also in line with the abovementioned results relating to holism. In order to link the research with the professional development, we used the results of the baseline and consecutive surveys as input for designing the seminars as well as the on-site support offered to schools. The issue of cross-curricular working is a nice example of this approach in the project. Based on the results of the surveys we decided to focus specifically on this issue in two of the seminars, from a conceptual and a practical viewpoint, zooming in on the what, why and how of interdisciplinarity in ESD. Consequently, the results indicated that the teachers started implementing interdisciplinarity more often after these seminars. While we do see changes occurring in the teachers' reports of self-efficacy and ESD practices, the items highlighted here in this section do consistently remain the ones closest to the lower end of the scales: these are the main challenges for the teachers in our sample.

5.2. The impact of the professional development program

We also observed meaningful changes at the scale level, both for self-efficacy and for ESD practices. These changes (shown in Figure 2) can be summarized as follows: as the participants progress through the professional development program, they start with neutral self-efficacy and experience a peak after the first seminar, followed by drop back to the baseline and a steady climb back to peak level toward the end of the program. Self-reported ESD practices only increase toward the end of the program, 2.5 years after it has started. Figure 2 shows this pattern based on data from all four schools. We pooled data to reach sufficient statistical power, but a similar pattern was present in all four compulsory schools separately (though then with no significant effects due to small sample sizes). These results indicate that early in the professional development program, after participating in the seminar on the 'what' of ESD, teachers felt empowered to implement ESD at their school. This feeling dropped, possibly due to the return to day-to-day reality at school and confrontation with the complexities of ESD in real practice. The following seminars focused on the 'how' of ESD, first in general, and then specifically tailored to the individual schools. This is reflected in a resurgence of self-efficacy and, ultimately, in a significant increase in reported ESD practices. In summary, we see a fluctuation in the changes in self-efficacy and a slow and late increase in self-reported practices.

The disconnect in the pattern between the changes in self-efficacy and those in self-reported ESD practices merits more exploration. Hansen and Sillasen (2020) argue that self-efficacy for ESD for (student science) teachers can be negatively correlated with actual knowledge of ESD. This points toward a Dunning–Kruger effect, a cognitive decision-making bias, whereby unskilled individuals disproportionately overestimate their ability to effectively complete tasks (Kruger and Dunning 1999). Brief training to provide awareness of incompetence has been shown to help the insensitive both improve their skills and more accurately assess their competence at a task (Kruger and Dunning 1999). Our results do not fully align with these findings as they indicate a positive but moderate correlation between the participating teachers' self-efficacy for ESD and their (self-reported) actual teaching practices at the beginning of the professional development program. That correlation did increase to a higher level at the end of the program, suggesting that the high levels of reported self-efficacy at the beginning of the teacher professional development program might indeed be due to the Dunning–Kruger effect (Dunning 2011).

Our results point toward several important findings. The teachers who participated in our professional development program felt more confident in putting ESD into practice. We, furthermore, observed an increase in the (self-reported) ESD practices among the participating teachers. Finally, the measurement for self-efficacy becomes more meaningful as the results suggest that the Dunning–Kruger effect fades away throughout the program. This, in turn, highlights the importance of taking a long-term approach to professional development on ESD

and to studying the impact of such initiatives. These results empirically support that educational change takes a long time, often many years, as suggested in the literature (Fullan 2001). We did, indeed, early in the evaluation, observe a large increase in self-efficacy but no impact on self-reported ESD practices. Building claims about the impact of the program at that stage would have been premature and overly positive. Our results also highlight the importance of complementing the use of self-efficacy as a learning outcome measure of professional development with a measure focusing on actual implementation.

5.3. Limitations and future directions

While there are clear strengths to our study, in particular its longitudinal nature and the interwoven design with the seminars and surveys, we also need to acknowledge several limitations. First, in this study, we only have quantitative data of the participants reflecting on their own competence and practice. As with all data collected through surveys, there might be cognitive bias at play; for example, some teachers may understand some items incorrectly. We have tried to tackle this by connecting the concepts and language of the survey to that used in the seminars but cannot exclude cognitive bias. Second, in our longitudinal design we were unable to use personal identifiers. As a result, we treated the data as independent, while knowing that many teachers completed the survey on multiple occasions. In future work, more effort could be invested to overcome this, in line with relevant local ethical regulations. Personal identifiers would allow more sophisticated analyses of the evolution of the dependent variables across time (latent growth analyses, clustered analyses). Follow-up and parallel studies that we have planned focus on the students' perspectives and learning as their teachers participate in the program (Olsson et al. 2022), as well as a more in-depth understanding of the changes the teachers implemented in their educational practices (using interviews and log-book entries).

5.4. Conclusions

Our results indicate that we have designed a valuable and effective intervention that capitalizes on those learning experiences that can help teachers develop self-efficacy and actually bring ESD into their educational practice. Our results highlight the importance of a scaffolded long-term approach to teacher professional development on ESD, considering the local reality of schools and the need of school teams. They also warn against oversimplification of professional development in ESD by offering short-term or single-shot interventions. Finally, our results also highlight the importance of complementing the use of a self-efficacy measure with additional measures, preferably tapping into aspects of actual implementation in practice, to gain a nuanced view of the effects of professional development. The main challenges for teachers include cross-curricular approaches, student evaluation and collaboration with local stakeholders. These elements appear to be priorities for teacher professional development as well as topics for evaluation research of such initiatives.

Conflicts of interest

The authors declare no conflict of interest.

Ethics statement

Blinded.

Informed consent statement

The participants were informed about the purpose of the project and they all provided active informed consent for participating.

Data availability statement

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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The study follows the ethical guidelines provided by Karlstad University.

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