The Effectiveness of Education for Sustainable Development in Promoting Students' Action Competence for Sustainability.

1. Objectives

This study revisits the seminal question of the effectiveness of education for sustainable development (ESD). Scholarly attention in the past decade has been increasingly directed towards the concept of action competence for sustainability. However, little is still known about the effects of ESD as a teaching approach to help develop students' action competence for sustainability. This study therefore aims to investigate the effects of ESD on upper secondary science and technology students' action competence for sustainability by taking a longitudinal approach. Students' experience of ESD will be investigated in terms of holism and pluralism using the items presented in the study of Boeve-de Pauw et al. (2015). The outcomes of ESD at the student level will be investigated through the concept of action competence and the questionnaire instrument of self-perceived action competence for sustainability (Olsson et al., 2020), which is an instrument adapted to the re-conceptualization of the action competence concept (Sass et al., 2020). By adopting a longitudinal design in which we followed an upper secondary school development project with the intention of implementing ESD, we contribute a novel approach of investigating the effects of ESD at the student level.

The following research questions will guide the investigation:

(1) What is the development of the student's self-perceived action competence for sustainability and their experience of the ESD teaching?
(2) What is the effect of ESD on the students' self-perceived action competence for sustainability?

2. Theoretical framework

Through ESD research and policy development we know that teachers have an important task conducting the teaching in a way that students gain knowledge, skills and competences to cope with sustainability issues (e.g. Rieckmann, 2017). ESD is described as a teaching approach where action competence for sustainability is at the very core of education (Mogensen & Schnack, 2010; Sinakou et al., 2019). Such an approach is often referred to as a transformation of the current teaching and learning (Blythe & Harré, 2020), but what exactly does this mean for the teaching and learning practice? To accomplish this shift in education and promote action competence among students, Sinakou et al. (2019) argue for an action competence-oriented ESD including the teaching approaches of holism and pluralism.

Action-orientation involves taking action on real sustainability issues, student leadership and the interaction with peers and the surrounding community (Sinakou et al., 2019). The interdisciplinary nature of actions in sustainability supports the development of students' understanding of the contribution of different disciplines to the solutions (Sinakou et al., 2019). This leads us to the first component in the action competence-oriented ESD, referred to as

holism. This teaching component emphasizes multiple perspectives of the content and the importance of including the environmental, economic, and social perspectives of sustainable development, as well as their interactions in time and space (Boeve-de Pauw et al., 2015; Hopkins, 2012). The second component is referred to as *pluralism* and focuses on how to develop competencies among students so they can make informed decisions on sustainability issues (Mogensen & Schnack, 2010). Pluralism could be seen as a participatory approach where students are involved in discussions where different views and values are acknowledged in relation to the sustainability issue at hand. Because of the wicked nature of sustainability issues, the pluralistic teaching is not directed towards a predefined solution, which thus highlights the need for a critical discussion of different perspectives on sustainability solutions in ESD.

Several studies from the last decade have focused on gathering empirical evidence for the impact of ESD teaching and learning on action competence in terms of cognitive, affective, and/or behavioral outcomes among students (see Ardoin et al., 2018; Chen & Liu, 2020). However, we have identified three problems connected to previous research. 1) Most of these studies are problematic because they take school labels or policy documents as proxy for ESD schools, but there is usually no evidence for what has really occurred in the classroom (for more on this topic, see Boeve-de pauw et al., 2015). 2) The bulk of studies in ESD research include a cross-sectional design or a comparison between an experimental group and a control group with a narrow time frame between pre- and post-tests (Chen & Liu, 2020). 3) Researchers in environmental and sustainability education use very diverse interpretations of the action competence concept and its outcomes (Chen & Liu, 2020; Sass et al., 2020). To our knowledge, no studies have used a wider time frame, investigating the ESD development of students longitudinally over time and its effect on students' action competence. In this study, we therefore revisit the issue of the effectiveness of ESD through a novel longitudinal study design.

3. Methods and materials

This study is part of a larger research project investigating the development of ESD in schools in a Swedish municipality. The present longitudinal study took place between the spring of 2017 and the end of 2019 in one upper secondary school for science and technology students, where the teachers participated in an ESD municipality school development project. In this study, we specifically collected longitudinal questionnaire data to investigate the effects on students' experiences of the ESD teaching and on their ESD outcomes in terms of self-perceived action competence for sustainability.

Two scales were used to follow the students longitudinally. First, the self-perceived action competence for sustainability scale (SPACS-scale), developed by Olsson et al. (2020) to cover the construct of action competence. The scale consists of three sub-scales (four items each) covering the constructs *knowledge of action possibilities*, *confidence in one's own influence* and the *willingness to act* (see Olsson et al., 2020). Secondly, we used the ESD, holism, and pluralism scale (see Boeve-de Pauw et al., 2015). The scale consists of seven items, where three items cover the students' experience of holism and four cover the students experience of pluralism in the teaching.

The student questionnaire data were collected in three waves in accordance with a longitudinal design. In total, 760 students (experimental group) participated in one, two, or all three waves.

The first wave included the students in grade 10 and 11 (17-18 years old). These students were then followed through grades 11 and 12 (18-19 years old) in the second and the final wave. Furthermore, data from a control group of students were collected from 11th and 12th graders in the same upper secondary school nine months before the first wave for the experimental group. The control group of students thus did not participate in the longitudinal data collection. This was done to investigate if development among students were related to what they have experienced in their teaching or was a result of a natural age development.

Our data were analyzed through structural equation modeling (SEM) and latent growth modeling (LGM) using the statistical software Mplus (Muthén & Muthén, 2017). In a multiple indicator longitudinal approach, there is a need to establish measurement invariance between the waves. This process and the subsequent LGM can be seen as a five-step process where the first three steps are related to the confirmatory factor analysis (CFA) and the establishment of measurement invariance between the three waves and the two last steps to the LGM (see Kelloway, 2014). Multiple fit indices were used to evaluate the CFA measurement invariance and the LGM models. All values were better than the recommended values of ~.95 for the comparative fit index (CFI) and Tucker-Lewis index (TLI), and values ≤.06 were used for the root mean square error of approximation (RMSEA) (Tabachnick & Fidell 2007). The default estimator for this type of analysis is a robust weighted least squares estimator (Muthén & Muthén, 2017).

4. Results

The main result as trajectories for the two ESD subconstructs of holism and pluralism is presented in Figure 1. Similarly, a representation of the trajectories for the three constructs of self-perceived action competence for sustainability can be seen in Figure 2. The result shows a significant increase over time for holism, but not for pluralism (Figure 1). This indicates that the students have experienced a development of the sustainability content in the teaching, but not of the pluralistic approach to the sustainability content in the teaching. The results in Figure 2 show a significant increase over time in terms of students' knowledge of action possibilities and willingness to act, but not for their confidence in their own influence.

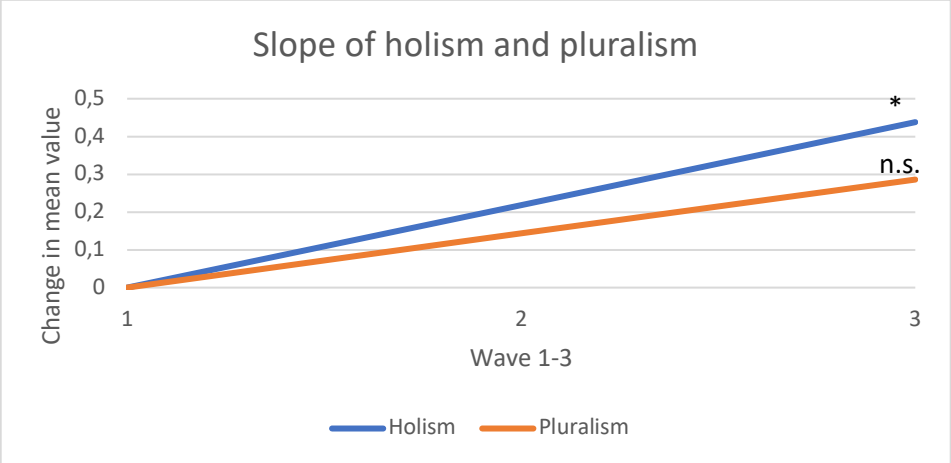

Figure 1. Slopes of the two ESD components holism and pluralism. *indicates p<0.05 and n.s. is not significant.

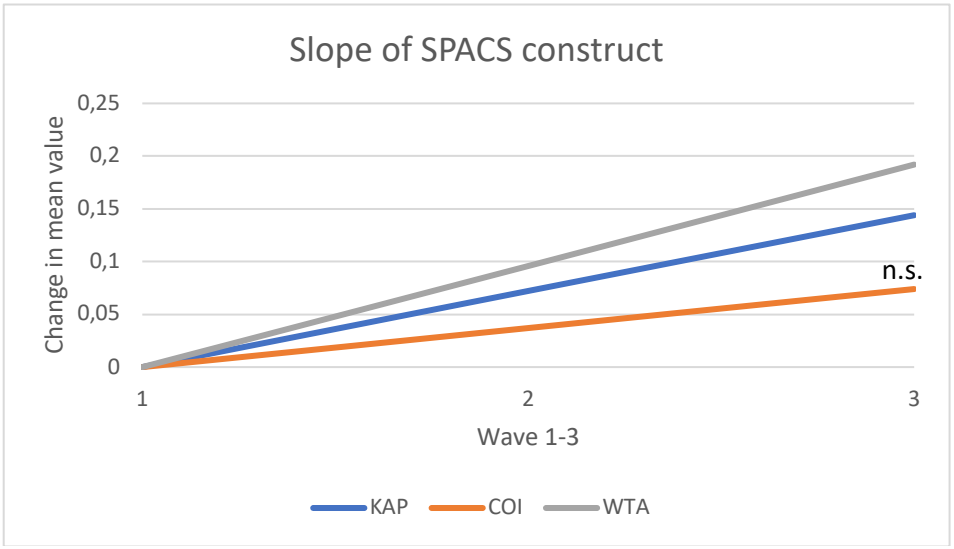

Figure 2. Slopes of the constructs of self-perceived action competence: knowledge of action possibilities (KAP), confidence in one´s own influence (COI) and willingness to act (WTA). ** indicates $p<0.01$, * $p<0.05$ and n.s. is not significant.

The comparison between the students in the final wave and the control group reveals that the findings for all constructs in Figure 1 and 2 are likely the result of something the students have experienced in the teaching, and not only because of a natural age-related development. The effects (Cohen's *d*) are small to medium for all constructs except pluralism, where no significant difference was found between the two groups.

Finally, the results of the SEM analyses used to test the effect of holism and pluralism on the three outcomes of action competence for sustainability at student level are reported in Figure 3. This result is related to our second research question. The standardized regression coefficients shown in this figure illustrate that the ESD dimensions of holism and pluralism have a positive effect on the action competence constructs at the student level, where students' experience of pluralism (if they experience it in the teaching) has the biggest effect on the action competence constructs.

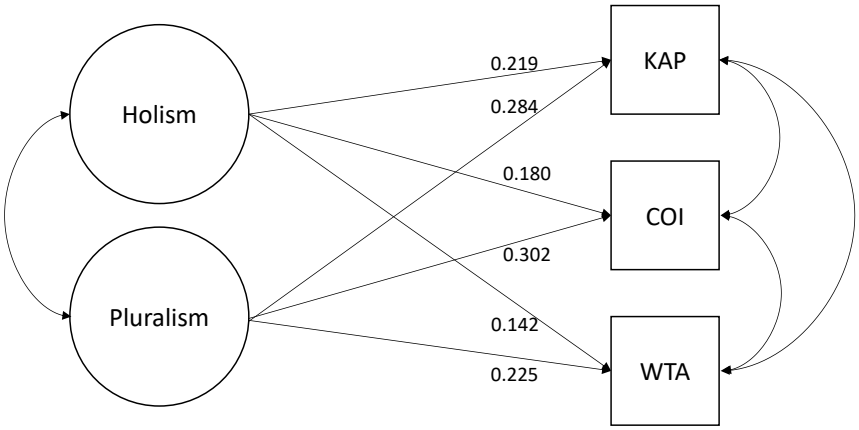

Figure 3. Effects of ESD (holism and pluralism) on the three constructs of action competence, knowledge of action possibilities (KAP), confidence in one's own influence (COI) and willingness to act (WTA).

5. Conclusions and relevance

A main conclusion of the result from our structural equation model is that ESD works (see Figure 3), which confirms and strengthens the result of Boeve-de Pauw et al. (2015). This study shows that ESD as a teaching approach is effective for the development of action competence for sustainability among upper secondary science and technology students. Moreover, this study also shows that teacher professional development initiatives can develop ESD teaching over time, at least the holistic dimension, and thereby promote student development of action competence for sustainability. The fact that the students did not significantly develop their confidence in their own influence in this study may reflect their experience of and level of participation in decisions and actions at their school. According to our results, the students' experience of pluralism in the teaching did not increase significantly during the time of the study, which therefore could have effected their confidence in their own influence. According to ESD research literature, it is not enough for the students to be exposed to sustainability content in teaching (Boeve-de Pauw et al. 2015). At the very core of the pluralistic approach in teaching lies the participation of students (Sinakou et al., 2019).

Given the sample of participants for this study, the results are not directly transferable to schools in general, but show that the efforts of teachers at a regular upper secondary science and technology school participating in a long-term ESD TPD program will have an impact at the student level. However, developing teaching where students experience pluralism still seems hard for teachers (compare with Boeve-de Pauw et al., 2015). We can therefore conclude that change in students' action competence for sustainability takes time and contributing longitudinal research to the field of ESD research is valuable. This study therefore responds to the call by Ardoin et al. (2018) and by Chen and Liu (2020) that studies need to look beyond the immediate impact of an intervention and consider the long-term effect of instruction to meet the goal of ESD.

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