# Discussion

## Overview

My analysis of 208 self-reported surveys demonstrates complex heterogeneity of the influence of an innovative ESD intervention on changes of sustainability competencies. On the one hand, contrary to my predictions, I revealed that one year after the end of the intervention, sustainability attitude and behaviour did not increase (Figure XX) for neither involved, nor control group suggesting a rejection of my alternative hypothesis of a positive relationship. On the other hand, in line with my predictions, I demonstrated that the involved group (n= 7) reported overall higher sustainability attitude and sustainability behaviour, than the control group, one year after the intervention (Figure XX), indicating positive effects of an innovative ESD interventions on changes of sustainability competencies. Yet, differences between the groups, were already present at the start of the intervention (Figure XX). This highlights the importance of long-term empirical data collection when analysing the effects of ESD interventions. Careful considerations in terms of the generality of the results should be made, due to the very low sample size (n=7) of the involved students at the third measurement point. I found a strong positive relationship between the scales of sustainability attitude and sustainability behaviour operationalised with the theory of planned behaviour and the scales operationalised with the construct of efficacy beliefs (Figure XX), pointing towards the reciprocal validation of both scales to capture the same latent constructs of sustainability competencies and an indication towards validation through prediction of an impact-relevant behaviour. I uncovered no differences between personal and collective efficacy beliefs within and between the involved and the control group (Figure XX), highlighting the need to incorporate collective efficacy as a goal dimension in ESD intervention designs. In line with my predictions, I found that the involved students reported higher aim focussed self-efficacy beliefs (Figure XX), indicating the stabilisation of the formation of sustainability intentions and at the same time, highlighting the importance of also considering outside barriers. The lack of sufficient data prevented me from conducting more statistically robust tests and leads to strong limitations on the generalisability of the results, which highlights the challenges of collecting comprehensive data in school contexts. Measuring the outcome of ESD interventions requires many considerations and trade-offs - by using a quantitative, longitudinal, treatment-control group, outcome-focussed approach, I uncovered heterogenous responses of sustainability competencies of high school students, aiming to contribute to ongoing improvements in the measurability of sustainability competencies and pointing towards the potential of innovative ESD interventions.

Sustainability competencies measurements have been criticised for various reasons with important implications for the interpretation of the results.A big discussion within the field of ESD measurement and research is the context sensitivity. Behavioural outcomes can vary significantly across different contexts and cultures. An intervention that promotes sustainable behaviour in one setting might not have the same effect in another due to varying social norms, economic conditions, and cultural values. This variability challenges the universality of behaviour-focused outcomes. When using indicators, there is an inherent trade-off between wanting to achieve a global scope, to allow for comparisons, contradicting the need for context-specificity. Thinking globally, I did not research beyond the western perspective, given the resource limitations and the scope of this study. All of the underlying theories stem from a western context and so does most of the empirical research of cited studies. Given western dominance in research, caution should be paid to global claim of the indicators and their relevance in different (also non-western contexts). A very first step I see to try and overcome western hegemony in research is to state the own positionality and set the research in the context, which I tried to do here. Besides the limited empirical and theoretical base of this study on western literature, this study is also only based on one school in Freiburg, questioning the generalisability of the findings heavily. To allow for long-term data collection, I used a scale developed for a master thesis by Pauli (2023) operationalised through the theory of planned behaviour to capture sustainability attitudes and sustainability behaviour. Although Pauli, tried to partly adjust the scales to students, I would argue that they have limited fit for young people and students, as many of the questions used are neither age-appropriate, not necessarily in the hands of the students, especially the behavioural intentions ones (e.g. I support an increase in fuel taxes to reduce fossil fuel consumption OR I mainly drive or am driven by a car or a motor-scooter). In terms of using indicators for young people and students, better alternatives exist, for example in the project ProBiKlima (REF). Furthermore, the context and thereby project-specific goals need to be stated as well. The goals of the KRS project were only partly aimed at enhancing students’ competencies toward sustainability attitudes and sustainability behaviours. Rather the focus was also on enhancing democracy education (KRS). As the scales I used did not capture these dimensions at all, the analysis is limited. While I consider my critical reflections on the usefulness of the indicators used in this study as contributing to SC measurement research, the empirical data gained from this study is very limited and not very generalisable.

A core critique of sustainability competencies measurements is the challenge of appropriately operationalising ESD and its outcomes, including the associated goals. The method and instrument for operationalising sustainability competencies aim to equip students with core competencies for shaping a sustainable future. However, this raises questions about evaluation, definition, and the need for openness in the ESD concept to remain adaptable to future sustainability challenges. As Wals et al. conclude, “the main point is that there is no single model of education and learning for environmental sustainability, nor should there be” (Wals, 2017). Maintaining an adaptive and flexible concept of ESD should not hinder empirical research efforts to verify the effectiveness of ESD programs. Evaluating and improving ESD measures is necessary to ensure they enable learners to shape a sustainable future. This compatibility between ESD and empirical research is crucial, particularly when differentiating between ESD1 (instrumental) and ESD2 (emancipatory) approaches. While ESD1 focuses on specific behavioural outcomes, ESD2 emphasizes the process of learning and critical engagement, rather than predetermined results. Similarly, the discussion should continue, whether behavioural change should be the outcome of studies, given the complexity of behaviour, its multitude of influences, including factors outside the individual, especially for young people. To try and address these critiques, I applied the Triple-A framework of efficacy beliefs, which offers a promising approach to navigate the instrumental vs. emancipatory debate by concentrating on whether agents believe they can achieve their self-chosen goals, instead of mandating specific behaviours. This framework inherently incorporates external factors, with higher efficacy emerging when individuals believe they can effect change. Additionally, the framework does not necessarily prescribe specific behaviours, aligning well with the broader and more flexible aims of ESD2. Empowerment research further challenges scientists to consider shifts in actual power and agency, not just self-reported outcomes, emphasizing the importance of real-world impacts on collective social and ecological aims (Cattaneo & Chapman, 2010; Cattaneo et al., 2014; Drury et al., 2005; Zimmerman, 1995; Louis, La Macchia, et al., 2016). Incorporating self-efficacy beliefs and collective efficacy as outcome indicators can address some critiques of non-instrumental ESD by capturing the complexity of human motivations and broader educational goals. While behavioural change remains an important indicator, it should be complemented by measures that foster critical thinking, empowerment, and intrinsic motivation. This comprehensive approach ensures that interventions not only alter behaviour but also cultivate the underlying values and beliefs necessary for sustained and meaningful engagement with sustainability issues. Although my research on sustainability competencies is limited by data availability, it can contribute to the debate on suitable indicators for sustainability competencies by including efficacy beliefs of students. Assessing these efficacy beliefs over time and in relation to project development would offer valuable insights. Despite the cautious interpretation of my findings due to limited data, this research adds to the understanding of sustainability competencies, their continuous development, and the possibilities for their measurement, helping to identify effective strategies for ESD interventions.

## Sustainability competencies as sustainability attitude and sustainability behaviour (TPB-based) (Research Question 1)

Contrary to my prediction, I found that one year after the ESD intervention, sustainability attitudes and behaviour did not increase for either the involved or the control group (Figure XX). On the other hand, in line with my predictions, I demonstrated that the involved group (n=7) reported statistically higher sustainability attitudes and behaviours (cumulated SA/SB and SB) than the control group one year after the intervention (Figure XX), possibly indicating positive effects of an innovative ESD intervention. For all scales, I observed a peak at the second measurement point (immediately after the ESD intervention) for the involved group, with scores significantly higher than those of the control group (Figure XX). At the same time, the cumulative SA/SB and SB were reported to be even significantly higher at the first measurement point (at the beginning of the ESD intervention), which raises the question of attributing sustainability competences to the ESD intervention (Figure XX). This doubt is reinforced by the fact that SA and SB peaked for the involved group, but then fell back to levels similar to those at the beginning of the intervention. The observed findings could be due to various reasons. Firstly, the path from an educational intervention to changes in SA and SB remain complex and hard to predict. Research suggests that sustainability attitude decreases as students become older (Krettenauer, 2017, BUGEN), potentially counterbalancing the impact of the intervention. When looking at the effectiveness of other ESD interventions, a meta study from 2021 has found that the ESD inventions led to greater environmental sensitivity [71], a reconsidering of preconceptions [78], an improved ability to solve complex problems related to the environment [75], a greater likelihood of naming environmental issues as personal concerns [73] and a relative maintenance of the new positive practices acquired [76] (SOSSE). Most of these studies focussed on small groups and used different operationalisations, making it difficult to compare. The literature agrees on the need for long-term longitudinal impact studies, considering other types of concrete ESD results that can be realized in a sometimes more distant horizon than what current studies can cover (activism in particular) (REF SOSSE?). No quantitative empirical research exists on the effectiveness of innovative ESD interventions, as the KRS project was (MONI). My findings highlight that conducting sustainability measurement based on long-term empirical and quasi-experimental design is essential when assessing effectiveness of (innovative) ESD interventions.

The observed findings could also be due to factors, that influenced SA and SB of the students more than the ESD intervention itself. A recent long-term study (BUGEN) based on the ESD goals in local education plans (and not based on a specific ESD intervention) found significant predictors of SA and SB to be the average school grade, sustainability-related attitudes at the beginning of the school year, participation in Fridays for Future, knowledge of the concept of sustainability (only SA predictive) and grade levels (only SA predictive), all of which I did not account for. Other factors that have been found to influence SA and SB were the social desirability (REF) of the answer possibilities and the influence of the media, potentially having a greater influence than ESD intervention especially in this age group (REF). Extracurricular learning environments (e.g. friends, family, social media) have a strong influence in adolescence, so the effectiveness of school-based ESD could be limited (REF). Furthermore, the role of the teacher or also in this case could be the role of the project conductor could influence sustainability competencies. Research has found that there seems to be negative relationship between the sustainability attitude and environmental consciousness of the teachers, leading to less SB of the students. It can also only be assumed that if the teacher makes overly pointed statements about their own environmental and sustainability awareness, this could possibly lead to reactance in the students' own attitudes (BUGEN). All these factors could explain, why over time there was no increase in SA and SB for neither involved, nor control group. To explain the decrease of the involved students from the peak at the second measurement point to the levels similar to the beginning at the third measurement point, this could also be due to frustration based on feedback from the environment. Research has shown that, if basic psychological needs for relatedness (belonging), competence (efficacy), and autonomy (self-determination) are not met, and need frustration arises, this could lead to a decrease of pro-environmental behaviour (WUllenkord). As my study did not investigate in how far the school implemented the roadmap, the lack thereof could have resulted in negative feelings of the involved students. My findings highlight the urgent need for whole-institution approaches (REF) of ESD and ESD intervention design.

## Relationship of sustainability attitude/ sustainability behaviour (TPB-based) and efficacy beliefs (Research Question 2)

I found a strong positive relationship between the scales of sustainability attitude and sustainability behaviour operationalised with the theory of planned behaviour and the scales operationalised with the construct of efficacy beliefs (Figure XX). This indicates that they are capturing the same latent construct of sustainability competencies and can be used as a first step in a mutual validation of the scales. In a potential second step of validation, the (voluntary and self-determined) expert group participation (resulting in them being the involved group in this study) of the surveyed students could potentially be used to draw conclusions about environmental activism resulting from a high level of environmental attitudes. The participation in this group can be interpreted as a behavioural manifestation aimed at promoting a more sustainable school, which consequently serves to achieve the ESD goals. The participation in the involved group was recorded at the first measurement point of the project with a simple question regarding this activity. In this case, the self-reported behaviour was regarded as a valid proxy for actual behaviour. The data showed that the students of the involved group showed higher SA/SB than students who were not involved (FIGURE RQ1). Normally, the validation through prediction of an impact-relevant behaviour is conducted by checking SA and then at a second measurement point, seeing whether the higher SA translated into actual behaviour. Given the fact, that at the first measurement point in this study, the group has formed, but not started their work yet, it could be argued that their high SA resulted in actual behaviour by then joining the group. The question remains in how far socially desirable answers played a role, as being part of the involved group and perceiving themselves as such, even if the work had not started yet, could have influenced their results. With caution, the participation in the expert group could be considered as a validation through prediction of impact-relevant behaviour. Nevertheless, by validating the scales, as a consequence, the competency differences which were assessed with this measurement instrument could point toward meaningful differences between the students which may have an actual impact on their future behaviour. To my knowledge in the literature, I found no validation processes for either of these two scales. My findings highlight the importance of continuous and critical validation of indicators and scales used, as to whether the measurement meet their goals and be able to predict actual behaviour.

## Sustainability competencies as efficacy beliefs (Research Question 3)

Change order, first aim and then collective?

### Collective efficacy beliefs as outcomes

Contrary to my predictions, I uncovered no differences between personal and collective efficacy beliefs within and between the involved and the control group (Figure XX). Although all the mean scores, including the ones of the control group, were very similar, interestingly, I found that for the involved group, the individual self-efficacy beliefs were higher than the collective self-efficacy beliefs (despite no statistically significant differences). The observed findings could be due to various reasons. On the one hand, both personal and collective efficacy beliefs could have reinforced each other mutually, leading to no detectable difference between them. Studies have found that individuals can derive personal benefits (e.g., self-efficacy beliefs) from social groups because groups can make them feel personally capable and in control [[**31**](https://www.mdpi.com/2071-1050/9/2/200#B31-sustainability-09-00200),[**32**](https://www.mdpi.com/2071-1050/9/2/200#B32-sustainability-09-00200)]). In fact, Jugert et al. [[**12**](https://www.mdpi.com/2071-1050/9/2/200#B12-sustainability-09-00200)] could show that through collective efficacy, individuals came to feel in control of their outcomes: People’s intention to act was enhanced through providing a sense of efficacy transferred from the group to the self. Similarly, using a qualitative research approach, Cocking and Drury [[**11**](https://www.mdpi.com/2071-1050/9/2/200#B11-sustainability-09-00200)] found that collective efficacy led to a feeling of personal empowerment. Thus, with collective and self-efficacy being strong and closely intertwined predictors of pro-environmental action and reinforcing each other. On the other hand from a theoretical perspective, the participative and innovative design of the ESD intervention could have led to an increase in collective efficacy beliefs of the involved group. Bandura (1997) suggests that efficacy is enhanced when individuals acquire the specific skills necessary for pro-environmental behaviour and are verbally encouraged about their capability to perform such actions. These self-efficacy sources are effective when individuals evaluate the pro-environmental effectiveness of their own groups. Consequently, if a group successfully completes a task and receives positive reinforcement for its pro-environmental efforts, its members are likely to have a stronger belief in their ability to achieve the desired outcomes. To foster the belief that their actions can impact their environment, a commitment to collective efforts is essential. This increased belief in turn, can then again lead to a greater willingness to engage in pro-environmental behaviour (Chen). Given the findings that the involved group did not express more collective efficacy beliefs than the control group, the question comes up about the relevance of the chosen group, the desirability of the aims asked in the survey, but also about the success of their efforts and the extent of positive reinforcement from the outside. The advantage of differentiation, being the option to self-categorise the agent, is undermined by the fact, that in a quantitative survey without a pilot study, the relevant self-categorisations could not be found out. Empirically, very little research exists, that differentiates between personal and collective efficacy. Furthermore, the very few existent studies that applied this differentiation between personal and collective efficacy beliefs found that collective efficacy was significantly stronger, when the task difficulty was intermediate – rather than easy or difficult. Behaviours that are simple to perform typically have a lower environmental impact. People may perceive that actions which are too easy (e.g., avoiding plastic bags) are unlikely to significantly address environmental problems, even if practiced widely. In other words, when actions are too simple, the potential success may not lead to a sense of collective efficacy. This could be an indication, that the aim of making the school emit less CO2 emissions, led by a student initiative was considered too difficult a task by the students and/or might have required more support and positive reinforcement from their environment. Furthermore, the so-called participative efficacy can play a role, as moderating between personal and collective efficacy and is about how well a group can achieve their goal together, being influenced by group size and group cohesion (REF). Furthermore, the question arises in how far collective self-efficacy beliefs were the goal from this specific project and thus supported and reinforced by the school and the project partners. My findings highlight the relevance of collective efficacy as an outcome indicator of ESD interventions both in ESD intervention design, but also as a relevant goal sustainability competency measurement indicator.

### Aim-focussed efficacy beliefs as outcomes

In line with my predictions, I found that the involved students reported statistically higher aim-focused efficacy beliefs than the control group (Figure XX). This indicates that the involved group demonstrated their formation of an intention. At the same time, the lower scores on action-focused efficacy beliefs of the involved group might also point to some interesting implications. Action-focused self-efficacy refers to the belief in one's ability to perform specific actions, while aim-focused self-efficacy pertains to the belief in one's ability to achieve desired outcomes. These two facets are interconnected; effective actions often lead to the attainment of aims, and the belief in achieving aims can motivate individuals to perform necessary actions. Given the indication that action-focused self-efficacy is more related to capturing actual constraints such as time, money, and social resources, this finding highlights the potential external barriers the involved students encountered, which moderated their beliefs in their ability to conduct their actions. Methodologically, it could also be that the actions chosen for the survey were not relevant for either group. This aspect could not be tested and identified in a pilot study. As the Triple-A framework allows for combining actions that are very concrete with very abstract (collective) aims, testing those concrete actions becomes more relevant. Little empirical research on aim- versus action-focused efficacy beliefs exists. Hornsey et al. (2006) discovered that the content of the aim significantly influenced how self-efficacy predicted action intentions among members and non-members of a protest group. This indicates that the relevance and desirability of the aim are crucial for understanding how efficacy beliefs translate into intentions and actions (Fishbach and Ferguson, 2007). To assess the effect of the ESD intervention on aim- or action-focused efficacy beliefs, it would have required measuring efficacy beliefs over time. Assessing self-efficacy beliefs over a longer period and in relation to the development and realisation of the project would be an interesting future research direction. Furthermore, distinguishing links between agents, actions, and aims enables better predictions about which characteristics of self-efficacy make it more or less predictive of relevant social and environmental outcome variables. This differentiation could also inform ESD design depending on the desired outcome of more action- or aim-focus. My findings highlight the relevance of differentiation between action- and aim-focussed efficacy beliefs as an outcome indicator of ESD interventions to inform ESD intervention design, and also to understand potential outside factors encountered by the individuals.

## Study limitations

Analyses of sustainability competencies of students can be limited by insufficient sample size, restricted temporal and geographic scope of the data, and limited empirical validation of the theoretical frameworks used. The lack of data, which prevented me from answering one of my original research questions regarding the participative nature of the project, highlighted the need to collect data more comprehensively. The generalisability of the empirical findings is severely constrained by the small sample size of the involved students at the third measurement point (n=7). The low sample size also affects the statistical power and reliability of the results. Larger sample sizes generally provide more accurate and generalizable results, reducing the margin of error and increasing confidence in the findings. Furthermore, I argue that the scales used to operationalise sustainability attitude and sustainability behaviour had limited fit to the context. Yet, they provided the opportunity to collect longitudinal empirical data. Unfortunately, there was no previous data available for the scales on efficacy beliefs, which would constitute an interesting future direction. Non-western contexts, theories, and empirical findings were underrepresented, limiting the applicability in other contexts. Lastly, the Triple-A framework, being newly developed, still lacks strong empirical evidence for the distinctions it makes, with potential moderators of the relation between various efficacy links still missing (REF). Recognising heterogeneous effects, including the complex modes of behaviour and analysing what is already practiced, highlights previously overlooked research questions and helps researchers make more strategic decisions in the study of efficacy beliefs. Analysis of students’ sustainability competencies and their attribution to ESD interventions can benefit from a more comprehensive study design and scope of data, as well as broader theoretical and empirical contexts.

## Future directions

Measuring students’ sustainability competencies and their attribution to ESD interventions requires advancing beyond previous studies, which are based on limited study designs, have focused on traditional learning methods, or are limited in their relevance to measure what matters. Exploring ESD interventions in a quasi-experimental design and collecting long-term empirical data will provide a more differentiated view of the effectiveness of ESD interventions. Focusing on promising innovative learning and teaching methods could provide the evidence needed to challenge existing learning approaches, which so far have proven insufficient to address global challenges. Understanding better which sustainability competencies can make a real impact, while not instrumentalising students, will lead to more human agency. For example, measuring efficacy beliefs over time could be an interesting future direction. Consequently, the development of indicators and outcomes is more complex and relates to the researcher/educators’ definition of development education, as addressed earlier. This product outcome focus misses the distinctiveness of ESD, where the learning outcomes may be in the form of questioning and activism, rather than immediate or short-term goals. Continuous development of relevant indicators is necessary. Qualitative methods of ESD research could start to address these challenges by integrating different research fields, such as environmental psychology, environmental sociology, science teaching, and empirical educational sciences. Analysing sustainability competencies with a comprehensive study design will allow the development of better educational policies.

# Conclusions

My analysis revealed complex relationships of students’ sustainability competencies and innovate ESD interventions with the

*My research adds to a growing understanding of SCs, their development, and the sustainability and educational governance through policymaking. On this basis, appropriate evidence based recommendations for the further development of ESD research and the implementation of ESD in school practice can be formulated. Through the possibilities of measurement presented and the data already generated, further insights into the successful implementation of ESD in schools and the associated conditions for success can be gained.*

* Need for closer collaboration between practicioners, interdisciplinary research and society
  + Achieving SDGs cannot remain at normative, vague statements/ target formulations
  + Ideally stimulate benchmarking processes
  + International monitoring system for ESD implementation efforts

Therefore my results can be interpreted as . While changes of sustainability competencies and their attribution to innovative ESD interventions is somewhat limited with my method, I still observed an impression on the long-term effects captured across levels of involvement of the students.