

Albert-Ludwig-University Freiburg  
Faculty of Environment and Natural Resources

**Measuring What Matters: Towards A Comprehensive Approach to Measuring Students‘ Sustainability Competencies by Integrating Efficacy Beliefs**

Master-thesis submitted in partial fulfilment of the requirements for the degree of   
Master of Science Environmental Governance

by

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**List of abbreviations**

ESD Education for sustainable development

RQ Research question

SA Sustainability attitude

SB Sustainability behaviour

SC Sustainability competencies

TPB Theory of planned behaviour

**Overview of tables and figures**

# Introduction

Globally, we as humankind are facing many ecological and social crises at the same time. Despite extensive and continual efforts aimed at transitioning towards a more sustainable society, environmental and social challenges persist or have even exacerbated in various aspects (IPCC, 2023). In transition towards a more sustainable and just society, Education for Sustainable Development (ESD) is seen as one key aspect (BMBF, 2020). ESD is a holistic educational approach, focusing on the development of sustainability competencies which enable the learner to contribute to sustainable development through their competencies of knowledge, skills, motivation, attitudes, and values (Rieckmann & Barth, 2022). Following the Brundtland Report and the Agenda 21 conference in Rio, numerous programs for Education for Sustainable Development have been initiated (Hoffmann, 2020). However, the eligibility, impact, and effectiveness of ESD is often questioned (Ssossé et al., 2021). While ESD is widely accepted as a theoretical concept and goal dimensions, it remains without a universally agreed upon definition. Additionally, the complexity of the educational process makes it challenging to define outcomes and measure success accurately. Arguably, effective development of ESD requires evidence-based recommendation, to make real contribution to urgently needed changes in society. When looking at the empirical data on the impact and outcome of ESD interventions within educational settings is very little. Disentangling the goals, methods and outcomes of ESD and establishing effective education without instrumentalising education is an urgent issue. Currently, we only have a limited quantitative understanding on how education, such as ESD interventions, influence the development of sustainability competencies over time on the personal traits of the learners, such as knowledge, skills, attitudes and values. Despite the call for more encompassing test for measuring and operationalising ESD research, namely shifting form an input to an outcome orientation (Waltner et al., 2022), research has mostly focussed on traditional learning methods (BUGEN, REF MONI), or uncomprehensive study design (MONI). In this analysis, I concentrate on the implementation of ESD measures at the school level. While the students currently being educated in our schools are not today's decision-makers, they will ultimately become the decision-makers of the future. Recent theoretical advances of sustainability competencies, such as the triple A framework of self-efficacy beliefs (SW), together with the opportunity to capture long-term empirical data (Pauli) in a quasi-experimental design allow us to quantitatively test innovative ESD interventional effects on students’ sustainability competencies. Sustainability competencies measurement linked to effective ESD education can provide the information and educational design instructions needed for better educational policy making in the light of our rapidly changing Anthropocene.

## Theoretical and conceptual context

Education for Sustainable Development (ESD) aims to empower individuals to contribute effectively to sustainable development by fostering critical engagement with societal complexities and contradictions. This educational approach, endorsed by UNESCO, is divided into two streams: ESD 1, an instrumental approach promoting specific sustainable behaviours as defined by experts, and ESD 2, an emancipatory approach that equips learners with the tools to critically evaluate and identify sustainable practices themselves (Vare & Scott, 2007; Wals, 2011). While ESD 1 focuses on measurable behaviour changes, ESD 2 emphasizes the development of sustainability competencies necessary for navigating and influencing complex, ambiguous issues. Both approaches can complement each other, particularly in educational settings where ESD 1's behavioural focus is justified due to the shared educational and parental responsibilities in schools (KMK, 2018). However, the emphasis in older learners should be on ESD 2 to cultivate critical thinking and autonomous action (Rieckmann, 2021b). This shift aligns with the broader educational trend towards competency-based learning, which prioritizes skills and abilities over specific content knowledge, thus increasing the likelihood that students will internalize and apply sustainable practices (de Haan, 2006; Pant, 2016). ESD 2 approaches are yet even more complex to measure with the questions on defining relevant sustainability competencies to be measured. This complexity is evident in the ongoing debate surrounding ESD and other transformative educational approaches. ESD, as an intentional educational intervention, has the potential to challenge existing social, economic, and political systems that perpetuate injustice and inequalities, aligning it with critical pedagogy and interpretivist or constructivist epistemological paradigms (Liddy, 2011). While these paradigms would align themselves well with mixed methods approaches, that allow the existence of multiple realities and experiences that may be viewed differently (Moustakas 1994) complex nuanced findings (Dumas and Anderson 2014), much of the research is still based on predominantly positivist epistemologies (O’flaherty), with quantitative measures, such as pre/post surveys being commonly used to assess educational interventions. Due to resource constraints, I also decided to choose a solely quantitative approach, thereby reflecting a positivist epistemology. When aiming to improve ESD, many complex considerations need to be accounted for – yet effective ESD interventions can benefit if designed based on measurable sustainability competencies, and the continuous development thereof.

### Goals of ESD

Sustainability competencies need targets against which they can be measured. While for every ESD intervention, there might be project-specific goals, the question remains about the overarching understanding of goal dimensions. On an international stage, the goals are set by for example the Agenda21 (REF). They provide a normatively well-founded framework, but there is no operationalisation of the ESD output. On the local scales regional education plans exists, for example the one from Baden Württemberg: (LEVAE OUT?) “Education for Sustainable Development enables learners to make informed decisions and act responsibly for the protection of the environment and for a functioning economy and a just world society for current and future generations” (Ministry of Education Baden Württemberg, 2016), yet they also remain without operationalisation. Educational goals, which are personal characteristics to promote in learners, should include a normative test and an empirical test (UHL). Critical analyses of prominent ESD goal recommendations proposed sustainability competencies, as „cognitive abilities and skills as well as associated motivational, volitional, and social readiness needed to be able to solve sustainability-relevant problems and shape sustainable development in private, social, and institutional contexts. (WEINERT)”. Although some ESD learning goals exist, there is still a lack in terms of operationalisation of ESD output (RIESS/MISCHO) to be translated into measurement models and tools. Drawing on empirically verified measuring instruments and approaches from related disciplines, allows to integrate operationalised facets of competencies into ESD context. As such, ESD learning goals need to be structured and related to each other. One prominent framework is the tripartite frame-model for sustainability competencies (RIESS) which comprise of cognitive, affective motivational (also attitudinal) and the behavioural aspects (e.g., Rieckmann, 2018; Waltner et  al., 2019) related to sustainability. The cognitive dimension of sustainability competencies spans knowledge from basic concepts of sustainable development and the SDGs to an understanding of physical, ecological, social, cultural, economic, and political systems related to sustainability. The affective-motivational (or attitudinal) facets include values, needs, and motivation-related competencies, such as acceptance of intergenerational justice and attitudes towards consumption and mobility. The behavioural dimension involves fostering sustainable practices and helping learners translate their understanding into concrete actions. The framework has the advantages of including the behavioural dimensions (Lambrecht et al), being adaptable to different contexts (REF) and counteracts criticisms of the dominance of cognitive dimensions (REF). When aiming to measure sustainability competencies, it is sensible to benchmark against the specific goal dimensions of sustainability knowledge, sustainability behaviour (SB), and sustainability attitude (SA).

### Operationalisation ESD outcome

For measuring sustainability competencies, numerous attempts at operationalisation through scales exist. For empirical measurement, these competencies must be precisely defined. Such specificity allows for the appropriate operationalisation of the competency in question (see Klieme & Hartig, 2007). Despite existing efforts, there is still a need to develop adequate measurement instruments for the various dimensions of sustainability competencies (SC). Integrating ESD research with well-established measurement procedures facilitates the incorporation of already operationalised facets (e.g., environmental attitude) into the broader construct of SC. Examples of measuring approaches exist in related disciplines for each of the three goal dimensions. For the cognitive dimension, instruments assessing specific aspects of sustainability knowledge (e.g., environmental knowledge) are available (e.g., Frick et al., 2004; Maloney & Ward, 1973; McBeth et al., 2011; Roczen et al., 2014). For the affective-motivational domain, tools like the Greenpeace Sustainability Barometer are used, and for the behavioural dimension, the General Ecological Behaviour Scale is a notable example. Recent research has tried to combine these scales and adapt them to the school context (BUGEN). At the same time, it remains uncertain to what extent indicators can capture the ultimate normative goal of ESD: the actual development of a more sustainable society through sustainable behaviour. Theories of action in psychology suggest that various forms of knowledge and motivational factors (including subjective and social norms, and attributions of responsibility) interact to form behavioural intentions, which then lead to sustainability-relevant behaviours (Ajzen, 1991). Additionally, external conditions (e.g., behavioural opportunities, situational contexts, social norms, and the lifestyle of the social environment) also influence sustainability-relevant behaviour. Promoting knowledge and motivational orientations can thus foster the desired behaviours. However, research has consistently shown a significant gap between knowledge, motivational orientations, and actual sustainability-promoting behaviour (Carmi & Arnon, 2014). Specifically, in the cognitive goal dimension, sustainability knowledge is positively related to sustainability attitudes (Arcury, 1990), but the prediction of actual behaviour is quite low (Frick et al., 2004). Knowledge serves as an indirect predictor of behaviour, providing a foundation but lacking the necessary motivational factors. This often-cited knowledge-behaviour gap is evident in various studies. Kagawa notes that "there are multiple factors which influence the process of behavioural change, and further investigation of the dissonance between students’ perception of sustainability and their individual actions needs to be explored" (Kagawa, 2007). This aligns with research on the attitude-behaviour gap (Olsson & Gericke, Kollmuss & Agyeman, Terlau & Hirsch) and cognitive dissonance (Kumar & Metin). For the affective-motivational and behavioural dimensions, numerous studies have demonstrated a very close connection. Affective goal commitment or a positively valued sequence of actions is central to motivation. An action is not performed if the perceived costs outweigh the affective goal commitment. The attitude-cost relationship is modelled in the Campbell paradigm (Kaiser et al., 2010), which suggests a strong link between a person’s attitudes and behaviour. Consequently, within the Campbell paradigm, behavioural self-reports are used as indicators of a person’s attitudes. When operationalising the sustainability competencies most relevant to real-world behaviour, using scales that capture sustainability attitudes and sustainability behaviours is most effective.

Operationalising sustainability competencies regarding behaviour can benefit from exploring underlying theories of behaviour. Empirically, some of the most frequently used models for sustainability-relevant behaviour are the Theory of Planned Behaviour (TPB) and the Norm Activation Model (Bamberg & Möser, 2007; Sopha, 2011; Klöckner, 2013). The TPB is one of the most prominent approaches from the from-within side (Ertz, 2016). The from-within approach focuses on individual decision-making. As this approach is more accessible for education, it will be pursued further in this paper. In the TPB, intention and perceived behavioural control (PBC) are seen as direct determinants of behaviour (Ajzen, 1991, p. 184). Intention, in turn, is also influenced by PBC, but also by two other factors: firstly, the attitude towards the behaviour in question and secondly, subjective norms influence behavioural intention (Ajzen). Behind these determinants are beliefs or convictions that relate to behaviour, norms, and control (Ajzen). TPB, being a rational choice theory, focuses on the self-interest of the person, who weighs the consequences of their actions (Kaiser et al., 2006, p. 2151). Kaiser et al. evaluated the explanatory power of the TPB for pro-environmental behaviour (2006, p. 2160). According to their study, the three determinants—attitude, subjective norms, and perceived behavioural control—explain 76% of the variance in behavioural intention, while these, in turn, explain 95% of the variance in a person's environmental protection behaviour (ibid.). However, in a meta-analysis by Armitage and Conner, this average is significantly lower, at 27% variance explanation (Armitage & Conner, 2001, p. 471). On the downside, the directions of effect between attitudes, subjective norms, and perceived behavioural control remain incompletely identified in the TPB (Kaiser et al., 2006, p. 2165). Furthermore, it is critiqued for focusing on internal factors, such as knowledge and attitudes, and failing to consider structural barriers, power relations, and inequalities that pose systemic barriers to individuals (Bamberg, 2021), as well as moral and normative considerations (Kaiser, 2006). For the operationalisation in the context of this study, the TPB was used due to previously existing data. Attitudes and subjective norms can be assigned to the affective dimensions, while PBC and intentions represent motivational aspects (Weber, 2008). These four variables on the first and second causal levels are summarised here as sustainability attitude dimensions, next to the sustainability behaviour dimension, which is derived straight from the self-reported behaviour. Therefore, sustainability competencies and the dimensions of sustainability attitude and sustainability behaviour can be operationalised with the components of the Theory of Planned Behaviour.

### Measurement approaches

Operationalising sustainability competencies and attributing them to an ESD intervention can be assessed using various methods. Quantitative research projects can significantly contribute to the normative debate by providing empirical insights and offering ESD stakeholders, including teachers, a valuable information base (cf. DIPF, 2007; Oekes, 1989). It is essential not to rely solely on plausible and normative considerations and assumptions. Some effects of educational measures, such as teaching or the whole institutional approach, might only become empirically verifiable in the long term or may not be clearly attributable to a specific measure due to the complexity of interacting variables affecting, for example, sustainability awareness. These considerations highlight that shifting the focus from input to output orientation of ESD measures may require more long-term assessments and diverse methodological approaches to evaluate the impact effectively. Currently, empirical data on the long- and short-term impact of ESD initiatives within educational settings is limited, indicating a need for further research and comprehensive evaluation strategies. Measuring sustainability competencies benefits from looking at long-term empirical data.

When measuring sustainability competencies, the choice of measurement method also depends on the teaching and learning approach used. There is a strong demand for alternative and innovative approaches to conducting ESD. Promoting personal characteristics with high affective–motivational components, such as attitudes toward sustainable development and intergenerational justice, requires methods that effectively engage complex human traits. Despite the inherent stability and resistance to change in attitudes, integrating principles from general motivation and social psychology may prove beneficial. Techniques like inducing cognitive conflicts, role-playing, simulation games, and experiential learning activities, including projects and internships in sustainability contexts, have shown potential in enhancing motivation and altering attitudes (REF). These methods facilitate deeper engagement with different perspectives and arguments, essential for fostering sustainable behaviours. Additionally, supporting the intrinsic motivation of students by enabling experiences of competence, autonomy, and social connectedness—such as choosing between different types of food in a school cafeteria and engaging in group learning—can significantly enhance the effectiveness of these educational strategies (Mischo, 2004; Deci & Ryan, 2008). Promoting sustainability-relevant behaviours necessitates a multifaceted approach that addresses both internal and external factors influencing individual actions. Psychological theories of action suggest that a mix of knowledge, motivational factors, subjective and social norms, and attributions of responsibility can lead to the formation of behavioural intentions and ultimately drive actual behaviour. However, despite the availability of knowledge and motivational orientations, there is often a significant gap between these elements and the manifestation of behaviours that promote sustainability. To bridge this gap, methods from volitional psychology are recommended. These methods include making individuals aware of and challenging their guiding assumptions and beliefs, forming concrete action plans, encouraging self-commitment, visualizing the outcomes of actions, and using reminders. In educational settings, teachers play a crucial role in promoting behavioural readiness by raising awareness about students' subjective theories and fostering self-efficacy, thereby enabling students to see the impact of their actions and motivating them to commit to sustainable practices. However, the existence of empirical data is limited to certain types of learning/teaching methods of ESD. The call for alternative and innovative methods for conducting ESD is not evidenced empirically. So far, innovative ESD intervention studies mostly comprise results in the form of self-reports, self-assessments, and expert surveys (REF MONI), which are non-experimental research methods. In contrast, quasi-experimental studies can be used to test hypotheses and thus provide evidence for the effectiveness of methods. To date, these robust scientific methods have primarily been applied to ESD intervention methods with a high degree of teacher guidance. Furthermore, the validity of quasi-experiments can be increased with experimental controls (e.g., pre–post or control-group test design, multiple treatment groups, control of potential confounding variables, and documentation of the reliability of the measuring instruments) (38, Handley). Due to the lack of empirical data, no conclusive statements about the “best” teaching/learning methods can yet be made, although recommendations do exist from empirical educational and teaching research. Given the mismatch between unevidenced-based learning recommendations and the availability of sound research methods, there is a need for measuring innovative ESD methods using quasi-experimental designs.

Measuring sustainability competencies requires validity criteria to ensure that the measurement instruments accurately capture the achievement of the goals - in this case, the competencies which enable learners (among other things) to contribute to real-world change. Ideally, one would obtain observational data to see whether actual behaviour changed. In reality, self-reports are more frequently used, as they are easier to obtain, especially in large quantities, and they also allow for a broader assessment of different behaviours (REF EWM). The challenge is that there is a gap between self-reported and objective behaviour. To overcome this, measurement indicators have to be validated with real-life behaviour outcomes. One reason for this gap could be the tendency of respondents to provide socially desirable answers (REF). There are different options to perform scale validations. One option would be to perform an ad hoc scale validation, comparing the items used in this study to well-established measurement instruments that have been tested for their predictive power of real-world behaviour. Another option would be to validate using a criterion outside the measurement process (Whitley, 1977), that is regarded as a valid proxy for actual behaviour and is assessed using a simple dichotomous approach (e.g., Kaiser et al., 2003; Kormos & Gifford, 2014). The newly developed Triple A framework of self-efficacy beliefs complements the TPB-based scales in terms of its predictive power for behaviour and behavioural intentions (REF). One study found that the TPB could benefit from incorporating aspects of the Triple A framework to enhance its explanatory power (Bamberg et al., 2015, see also Huijts et al., 2013). The Triple A framework, with its high degree of differentiation, broadens the possibility of assessing different behavioural outcomes. Therefore, an interesting option is to compare the TPB-based scale to one that is based on self-efficacy beliefs. Surveying both a TPB-based scale and one based on self-efficacy beliefs provides the opportunity to validate each scale mutually, ensuring higher quality of measurement.

### Potential role of Efficacy Beliefs in sustainability competencies

Sustainability competency measurement can benefit from a high degree of differentiation based on the new theoretical development of the Triple-A framework of self-efficacy beliefs. The Triple-A Framework offers a structured approach to enhance the somewhat fragmented field of self-efficacy research, particularly in the context of collective social and ecological aims. This framework is essential for addressing social and ecological crises more effectively through understanding how individuals and collectives can experience greater self-efficacy. The framework builds on the foundational theories of self-efficacy, including Bandura, Ellen Skinner, and Turner et al., and is structured around three core components—agents, action, and aims. The “self-categorised agent” can be an individual (personal self) or a collective group (an ingroup), where the group is part of an individual’s self-concept influenced by social and emotional group memberships. The distinction allows for the exploration of both individual and collective self-efficacy (despite the term being used very uncommonly, here I will do so). Individuals can flexibly shift from categorising themselves as individuals to members of groups (Cocking, Fritsche, Tajfel), reflecting different underlying social identities. The agentic aspect signals the possibility of being able to effect change. The second aspect of the framework, intentional action, highlights that self-efficacy involves deliberate, measurable actions aimed at achieving specific outcomes. These actions are defined not just by their intentionality but also by their self-determined nature, level of abstraction, and content. This component underscores the proactive nature of self-efficacy in influencing and altering ecological and social conditions. Finally, the Triple-A framework focuses on aims, which are cognitive representations of desired outcomes, whether personal or collective. Aims are essential as they direct attention, motivate, and foster persistence and skill development (Locke & Latham, 2002). The framework stresses the bidirectional influence between self-efficacy and aims, where efficacy perceptions influence the selection of aims, and conversely, the nature of these aims affects the development and sustenance of self-efficacy beliefs. This also highlights the importance of the desirability of the aim. Overall, the Triple-A framework not only clarifies the structure of self-efficacy beliefs but also enriches the theoretical discourse by distinguishing the three self-efficacy links (agent-action, agent-action-aim, agent-aim), explicitly applying to both personal and collective contexts. This approach promises to advance the practical application of self-efficacy theory in addressing broader social and ecological challenges, emphasizing the interconnectedness of beliefs, actions, and objectives in achieving sustainable change. Given the advantages of the framework of self-efficacy beliefs, it constitutes an interesting complement to sustainability competencies measurement.

Sustainability competencies are not only dependent on the individual. In 1997, Albert Bandura already described a collective sense of powerlessness in an increasingly interdependent world and claimed that there is a growing need for not just individual but also collective agents in the face of multiple crises. Many people do not act together against climate change or social inequalities because they feel they or their group cannot make a difference. Understanding how people come to feel that they can achieve something (a perception of self-efficacy) is therefore crucial for motivating people to act together for a better world. The nature of the ecological and social crisis also demands collective action. Correlational studies have found individual self-efficacy to predict private behaviours and collective efficacy to predict activist behaviour (Hamann & Reese, 2020; Morton et al., 2011). Although the pathways and interlinkages between personal and collective efficacy beliefs are not yet fully understood, research can contribute to practical interventions based on this differentiation. Some research suggests a path from collective to individual self-efficacy to private behaviour (Jugert et al., 2016), although not causally replicable yet. Experimental studies indicate that ingroup efficacy interventions outperform personal self-efficacy interventions in influencing actions (Jugert et al., 2016). Research could focus on which ingroup efficacy agents are more or less important in specific social and ecological crises, informed by social identity theory (Tajfel, 1978), which characterizes various ingroup efficacy agents. Collective efficacy was found to be a better predictor of pro-environmental behaviour than self-efficacy (M-F Chen, 2015). Furthermore, through specific collective and self-efficacy perceptions, sustainable intentions were gauged—even when controlling for attitudes and social norms—suggesting collective efficacy beliefs to be particularly relevant for attaining environmental goals (Reese & Junge). Incorporating collective self-efficacy beliefs as an outcome indicator in measuring sustainability competencies could be highly beneficial. Sustainability competency measurement can benefit from incorporating self-efficacy beliefs as an outcome goal at both individual and collective levels.

Sustainability competencies are not only dependent on internal factors. Differentiating action- and aim-focused self-efficacy beliefs is interesting and relevant because it provides a clearer understanding of how beliefs about personal and collective capabilities translate into behaviour and goal attainment. Changes in sustainability competencies, particularly self-efficacy beliefs, are dependent on feedback from the environment. The Triple-A Framework allows for a distinction between action and aim-focused self-efficacy links, with agent-action self-efficacy being more connected to actual behavioural costs, socioeconomic circumstances, and impactful behaviour, while agent-aim self-efficacy is more closely related to attitudes, goals, visions, and intentional behaviour (Bain et al., 2013; Bamberg & Rees, 2015). Perceived behavioural control in the theory of planned behaviour (Ajzen, 1991) predicts intention and moderates intention-outcome relations, suggesting that action-focused self-efficacy might function similarly by capturing constraints like time, money, or social resources that may prevent intention follow-through. In contrast, aim-focused self-efficacy is more involved in intention formation and less influenced by these constraints. The field of collective social and ecological aims is especially prone to an aim-focused understanding of self-efficacy due to the complex nature of collective crises (Zomeren, 2019). For collective aims, the challenge lies not in performing actions (e.g., going to a protest) but in achieving social change through these actions. Given the fact that to achieve an ecological or social aim, many actions are possible, but potentially also not successful, recognising the looser action-aim contingencies emphasises the importance of distinguishing between action- and aim-focused self-efficacy. Individuals have limited control over collective outcomes, with many barriers stemming from external factors and the actions of others (Hornsey et al., 2021; Jugert et al., 2016). Feedback is harder to obtain as aims are often distal (e.g., the impact of an awareness campaign on public opinion). Hornsey et al. (2006) found that, depending on aim content, self-efficacy predicted action intentions differently among protest group members and non-members. Studies that included diverse aims in their efficacy measures revealed that ignoring aim content could lead to incoherent findings and obscure underlying principles (Koletsou & Mancy, 2011). The desirability of an aim is crucial; if an aim is not desirable, self-efficacy measures may trigger defensiveness and only reflect the value of the aim (Castiglione, 2021). The relationship between action- and aim-focused self-efficacy is complex and interdependent. 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. For example, someone with high action-focused self-efficacy in environmental behaviours (like using public transport) may also develop high aim-focused self-efficacy in achieving broader environmental goals (like reducing carbon footprint). The Triple-A Framework integrates these concepts, suggesting that efficacy beliefs should consider both the actions and the aims to provide a comprehensive understanding of how individuals and groups approach and solve complex social and ecological issues. Measuring sustainability competencies changes on both action- and aim-focused levels allows for a greater understanding of the influence of external and structural factors on behaviour.

## Objectives and research questions

My aim is to quantify how ESD interventions influence students’ sustainability competencies. Specifically, I will focus on sustainability competencies, operationalised as sustainability attitude and sustainability behaviour, captured by scales based on the theory of planned behaviour. Additionally, I will assess efficacy beliefs through scales, operationalised based on the newly developed triple A framework. To achieve this, I investigate the influence of an innovative ESD intervention at one school, in a quasi-experimental longitudinal study with a treatment-group control-group comparison, by analysing 206 self-reported surveys from three different measurement points of sustainability competencies indicators, addressing the following research questions (RQ):

1. How do sustainability attitude and sustainability behaviour of students change over time (including one year after the end of an ESD intervention)?
2. How is sustainability attitude and sustainability behaviour influenced by self-efficacy beliefs?
3. How do (individual and collective) efficacy beliefs (aim-and action-focussed) respond to levels of involvement of the students?

## Research hypotheses and predictions

I hypothesize that sustainability attitude and sustainability behaviour will increase over time. The magnitude of sustainability competencies gains increases for the involved group. When looking at the relationship between sustainability attitude/ sustainability behaviour and efficacy beliefs, I hypothesize a strong correlation. I hypothesize that efficacy beliefs will vary within and across the involved and control group, regarding personal and collective, and aim- and action-focussed efficacy beliefs. Those hypotheses will be tested against the null hypotheses of no increase of SA and SB over time, no relationship between SA/SB and efficacy beliefs, and no differences of efficacy beliefs within and between the groups.

I predict greater higher SA and SB for the involved students, as innovative learning methods seem promising to achieve SA and SB. I predict the relationship between SA/SB and efficacy beliefs to be strong, as they are capturing the same latent construct. I predict higher collective and aim-focussed efficacy beliefs for the involved group, as they differ in the mastering experience and therefore in their learning (Figure 1).

If I find support for my null hypotheses, this will indicate that the scales used cannot sufficiently capture sustainability competencies resulting from an innovative ESD intervention, but also questions whether the current approaches to ESD interventions are adequate. If the results are in line with my alternative hypotheses, this will demonstrate the importance of innovative ESD interventions for fostering human agency.

1. Predictions

A diagram of a graph

Description automatically generated with medium confidence

1. Workflow

A screenshot of a computer

Description automatically generated

Figure 1: **Influence of an innovative ESD intervention on changes in sustainability competencies.** I analysed how an innovative ESD intervention can influence the sustainability attitude, sustainability behaviour, and self-efficacy beliefs of high school students at three different time points of the intervention: before the start (t0), straight after the completion of the intervention (t1), and one year after the end of the intervention (t2), comparing an involved group to a control group. **A** Conceptual diagram of my predictions, outlined with respect to sustainability attitude, sustainability behaviour, and self-efficacy beliefs. **B** Analytical workflow.

# Methods

In this study, I analysed how an innovative ESD intervention influenced students’ sustainability attitude, sustainability behaviour and self-efficacy beliefs as components of sustainability competencies over time. To quantitatively test the effect of the ESD intervention, I assessed long-term effects by using data measurements at three different measurement points (before, straight after intervention, and one year after intervention), using the same self-reported survey on sustainability behaviour and sustainability attitude. Furthermore, I complemented data collection with a survey on self-efficacy at the last measurement point. I used the data collected at the measurement point one and two from Pauli (2023). In total I analysed 206 self-reported surveys.

## Project description KlimaRatSchule

For analysing the changes of sustainability competencies over time, I chose the ESD intervention KlimaRatSchule (KRS). The KRS project aims to promote and establish an active climate protection culture in schools through democratic participation processes. The students deal with the carbon footprint of their own school and carry out a democratic participation process, the results of which are used to develop the school's own climate protection concept (KRS Projektbeschreibung, 2024). The project was piloted at two schools in Freiburg in January 2023. The project was designed by Solare Zukunft e.V., IZT, Energie- und Umweltzentrum am Deister e.V. and Green City e.V.. The project can be divided into 3 phases: in the first phase a group of volunteers (involved group) formed and collected data on the school’s emissions. In a second phase, a micro citizen report for schools was conducted with randomly drawn students from the school and in the third phase the project partners developed a roadmap with concrete aims and steps for the school to reduce their carbon footprint based on the work of the students in phase one and two. Although the project included the very interesting aspect of participation, unfortunately due to severe data limitations, the group, which were part of micro citizen report, had to be excluded from the analysis and thereby also the analysis of the participative aspect of the project. The ESD intervention aimed to achieve a real impact of CO2 emissions reductions while at the same time achieving climate and democratic education.

The ESD intervention can be classified as following regarding the learning and teaching methods and procedures. The involved group, which found themselves to be voluntarily participating, assessed different dimensions of the CO2 emissions of the school in a self-regulated and self-directed manner. Applying their knowledge and problem-solving skills in real world, group-work based, solution-oriented setting (REF KRS). Given all these learning methods and procedures, this ESD intervention can be considered as an innovative ESD intervention (in contrast to more traditional teaching-learning formats) (REF MONI).

## Study design and data collection

The research was designed to be an empirical, long-term, quasi-experimental study. To collect the data, a digital survey was compiled that mapped the constructs of the Theory of Planned Behaviour, which was the same one Pauli (2023) used for the first two measurement points. Accordingly, attitudes, subjective norms, perceived behavioural control, intention and behaviour with regard to climate protection were surveyed. Additionally, the survey was complemented by a scale that mapped the constructs of self-efficacy based on the triple A framework. Accordingly, individual and collective self-efficacy beliefs, and action- and aim- focussed self-efficacy beliefs were surveyed.

The survey was conducted at a secondary school in the Freiburg area, namely the ANGELL school, which is a Montessori centre in the city, which is state-recognised and run as an independent, non-profit organisation. Following a quasi-experimental design, two comparison groups were formed for the survey. The involved group was part of the voluntary KRS-expert group, conducting the CO2 measurements at the school and the control group did not participate at all. They were categorised into one of the groups by being asked in the survey whether they took part in the KRS school group. Both groups were surveyed at three different measurement points related to the intervention progress, see Table XX. At all three data collection points, the same self-reported survey was conducted with the idea of surveying the same students at three different time points. *This combination of longitudinal study and treatment group-control group comparison promises to provide particular informative value about the relationship between project participation and impact (N. Döring & Bortz, 2016, p. 1023; Ssossé et al., 2021, p. 9). (*The involvement of the three different groups of involvement was not possible due to too small sample sizes of group one in the data collection. I then excluded this group from all analysis.)

Conducting data at the third measurement point was subject to some limitations. Due to state regulations, the survey was only carried out at one of the participating schools of the KRS project. Conducting the survey at more than one school outside the same territory of a school authority would have needed a permit from the upper school supervisory authority (REF VERBINF FDB), which was not possible to be obtained due to time limitations. At the school where the survey was conducted, the disruption of the students had to be kept to a minimum. Given the challenge of trying to capture the same students as for the previous two data points, it was decided to survey the students of the grades 10 and 11. At the first two measurement points, at least 85% of the students were in the grades 9 and 10 (REF PAULI), therefore maximising the likelihood of surveying the same students again one year later.

Table XX: Overview data collection at the school at three different measurement points.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **# Measurement points** | **Intervention phase** | **Data of data collection** | **Classes surveyed** | **Data collector** | **Presence of investigator** | **N data collected (control group/involved group)** |
| First measurement point | Project start | 09.02.2023 | 7-11 | Data collected by Pauli | Yes | 76 (56/20) |
| Second measurement point | End of the active phase of the project | 10.05.2023 | 7-11 | Data collected by Pauli | Yes | 81 (63/18) |
| Third measurement point | Approximately one year after the intervention | 13.05.2024 – 06.06.2024 | 10-11 | Data collected by Gargya | No | 49 (42/7) |

### Survey tools

All the following information is regarding the third measurement point. The survey was conducted in German, see the German questions used in Appendix XX. The items of a scale were asked together in a block. The items were all in the form of statements and were to be answered on a 4-point Likert scale (0 = strongly disagree, 1 = somewhat disagree, 2 = somewhat agree, 3 = strongly agree). An "I don't know/ No response" option was given for each item. The completed survey was entered into the online survey application Sco-Scie and was answered online by the students. Proposed testing time was 10-15 minutes. Following the state’s educational research and data guidelines, parental and the school principals’ consent were obtained prior to the assessment (see Appendix XX). Participation was voluntary, i.e., students did not get any credit or monetary reward. Participants were assured of full confidentiality and anonymity. Unfortunately, at the third measurement point, the investigator could not be present herself. Therefore, a slide was prepared with the essential information (see Appendix XX).

#### Sustainability attitude and sustainability behaviour

To ensure comparability of data to the first two measurement points and allow for long term assessment, at the third measurement point, the exact same questions were used, based on Pauli (2023). The scale was designed based on the theory of planned behaviour and included elements of attitudes, subjective norms, perceived behaviour control, intentions, and behaviour, see Table XX. Pauli (2023) gathered the questions from different literature sources and partly adjusted them to fit a high school context.

Table XX: The scales used regarding the sustainability attitude and sustainability behaviour based on the theory of planned behaviour. Attitude, subjective norms, perceived behaviour control and intentions combine themselves to sustainability attitude; and self-reported behaviours to sustainability behaviour. The scales were copied one-to-one from Pauli (2023).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # | Scale | Item | Theoretical classification | Question (drawn from original sources in English) | Source |
| 1 | Attitudes towards climate-protecting behaviour | AT1 | Sustainability attitude | The environment in Germany is in danger because of global climate change. | Masud et al. 2016 |
| 2 | AT2 | Current global warming is a natural not manmade phenomenon. |
| 3 | AT3 | Climate change damages the natural environment and wildlife in Germany. |
| 4 | AT4 | I'm willing to pay a certain amount to reduce the im-pact of climate change. |
| 5 | Subjective Norms | SN1 | My family often discusses climate change or global warming. | Lin 2013 |
| 6 | SN2 | My peers often discuss climate change or global warming. |
| 7 | SN3 | My classmates might criticize me if I don't take action to protect the climate. |
| 8 | Perceived Behavioural Control | PBC1 | I believe I can contribute to mitigating the effects of climate change. | Pouya und Niyaz 2022 |
| 9 | PBC2 | I can help reduce carbon emissions through the actions I take in my daily life. |
| 10 | Intentions | IN1 | It is my responsibility to encourage my neighbours to notice climate change. | Pouya und Niyaz 2022 |
| 11 | IN2 | I am willing to adopt and apply eco-friendly practices in my daily life. |
| 12 | IN3 | I am ready to do anything to reduce the impact of climate change. |
| 13 | Behaviours | B01 | Sustainability behaviour | I have reduced my intake of meat over the last month. | Lin 2013 |
| 14 | B02 | I buy fruit produced in Germany and avoid buying imported fruit (e.g. bananas, kiwis). |
| 15 | B03 | I often store food in my refrigerator that is past its use-by date. |
| 16 | B04 | I am more concerned about price when I purchase electrical appliances. |
| 17 | B05 | I purchase electrical appliances that have energy saving labels. |
| 18 | B06 | I turn lights and water taps off as much as possible. |
| 19 | B07 | I unplug appliances that are temporarily not in use. |
| 20 | B08 | I mainly drive or am driven by a car or a motor-scooter. |
| 21 | B09 | I use elevators and rarely use stairs. |
| 22 | B10 | I support an increase of fuel tax to reduce the use of fossil fuels. |

#### Self-efficacy beliefs

The scales for the self-efficacy beliefs were based on the questions by Hamann et al. (2024). Further adjustments to adapt to this context for operationalisations were based on their recommendations. For all questions I included the marker words “if I/we want to”, to avoid the risk of capturing the desirability of the aim, instead of their self-efficacy beliefs. I considered two agents, as social identities, to be central to the context of the study. Next to the individual, I also considered “we as students” to be a relevant social identity in this context, given the nature of the project about shaping the school environment, their main occupation being a student, as well as fitting to the educational goal of the intervention. To be able to compare individual and collective self-efficacy beliefs, I picked three questions and repeated them with the same wording, except changing the agent from “I” to “we, as students”. In the questions, I included both action- and aim-focused links (see Table XX). I partly adjusted some of the questions to the school context, by specifying decision-makers or organisations to be “school directors or schools” (for original questions, see Hamann et al. (2024)). Due to time limitations, I could not conduct pilot studies to test for desirability of actions and aims, so I kept the questions as they were suggested by Hamann et al. (2024), see Table XX for all questions.

Table XX: The scales used regarding the self-efficacy beliefs based on the Triple-A framework (Agent-Action-Aim) by Hamann et al. (2024). The scales allow for differentiation between individual and collective self-efficacy beliefs and between aim- and action-focus.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **#** | **Scale** | **Item** | **Theoretical classification question** | **Question** | **Source** |
| 1 | Individual self-efficacy beliefs | SW01\_01 | Aim-focussed | I believe that my own actions can make a contribution to climate protection if I want to. | Hamann et al. |
| 2 | SW01\_02 | Aim-focussed | I believe that I can promote climate protection by educating people around me about climate change if I want to. |
| 3 | SW01\_03 | Action-focussed | I don't think I'm in a position to stand up for climate protection. |
| 4 | SW01\_04 | Aim-focussed | I believe that I am in a position to convince others to do more for climate protection if I want to. |
| 5 | SW01\_05 | Aim-focussed | I don't believe that I have any way of influencing climate change. |
| 6 | SW01\_06 | Action-focussed | I believe that I can influence how my school directors or my school acts in relation to climate protection if I want to. |
| 7 | SW01\_07 | Aim-focussed | I believe that I can support my school directors or school in campaigning for climate protection if I want to. |
| 8 | SW01\_08 | Aim-focussed | I believe that I can make a meaningful contribution to climate protection in collaboration with others if I want to. |
| 9 | Collective self-efficacy beliefs | CS01\_01 | Aim-focussed | We, as students, can make a contribution to climate protection through our actions if we want to. |
| 10 | CS01\_02 | Action-focussed | We, as students, can influence how our school directors or school acts in relation to climate protection if we want to. |
| 11 | CS01\_03 | Aim-focussed | We, as students, are in a position to convince others to do more for climate protection if we want to. |

## Data processing

I conducted all data processing and analyses in R v. 4.0.2. (REF R Core Team, 2021).

The data cleaning and data transformation involved several steps, see also Appendix XX. Given that my analysis was based on (cleaned and transformed) data by Pauli (2023), I conducted very similar steps for my data. I excluded incomplete surveys. I also excluded surveys with more than 25% answers of “I don’t know/ No response”. Given 32 items in total, that meant deleting cases with the unspecified answer of 8 or more times. This ensured that each scale could be calculated from as many items as possible. According to Döring and Bortz (2016), individual missing values in the data set are not a problem for further analysis. To avoid capturing data were students just clicked through the survey as fast as possible without answering the questions conscientiously, I excluded survey with a timestamp of less than 120 seconds. The answers on the Likert scale were coded into numerical values for each item: 0 = strongly disagree, 1 = somewhat disagree, 2 = somewhat agree, 3 = strongly agree, so that in the end a low value indicated a low level of SA/SB/ self-efficacy beliefs, and a high value indicated a high level accordingly. To ensure that this was the case for all questions, the items AT2, B03, B04, B08, B09, SW01\_03, SW01\_05 had to be inverted, as negative formulations were present here. Following Döring and Bortz (2016, p. 269), the measurement level of the Likert-scaled items was defined as metric, which enabled the calculation of mean values. After checking for the quality criteria of quantitative research, which is described in the following, the scales were calculated from the individual items, which reflect the five components of the TPB and the individual and collective self-efficacy beliefs. For all scales the mean values of the associated items were calculated.

## Data analysis

To quantify the relationship of components of sustainability competencies across level of involvement and over time, I used different statistical analysis methods. In the area of inductive statistics, methods from dependency analysis were applied. This being an explanatory study, for the inferential statistical evaluation the hypothesis test with classical significance test was applied (N. Döring & Bortz, 2016). The significance level α = 0.05 was used for the significance test (Döring und Bortz). If a p-value was below this threshold, this was labelled with one asterisk as ‘significant’, with two asterisks as ‘very significant’, or with three asterisks as ‘highly significant’ (cf. Krüger et al., 2014, p. 291), see Table XX.

Table XX: Overview labelling of the p-values in the significance tests

|  |  |  |
| --- | --- | --- |
| **Labelling** | **Designation** | **Threshold values** |
| \* | significant | 0.05 |
| \*\* | very significant | 0.01 |
| \*\*\* | highly significant | 0.001 |

To choose the appropriate statistical analysis methods, I first tested the distribution of my data. This was tested using the Shapiro-Wilk test, whose null hypothesis states that a normal distribution exists. Almost all scales were below the significance threshold of 0.05, STATE EXPEPTIONS?, see Appendix XX. This means that the null hypothesis had to be rejected for most of the scales. The data was therefore largely free of distribution. In order to ensure uniformity and thus also comparability, non-parametric tests were used for all scales despite metric scaling, as required by a distribution-free data basis (University of Zurich, 2024).

To answer some of my research questions (RQ1a and RQ2) by comparing the scale means between groups, I conducted the Wilcoxon test. This test is suitable for distribution-free, interval-scaled dependent samples and determines whether the central tendencies of two dependent samples are different (Uni Zürich, 2024). Given the lack of normal distribution in my data and the need to compare tendencies between groups, I deemed the Wilcoxon test appropriate for providing statistical answers regarding whether the central tendencies of the groups differ. This approach was applied to all scales relevant to my research questions: sustainability attitude (comprising scales of attitude, intention, perceived behavior control, and subjective norms), sustainability behavior (all based on the Theory of Planned Behavior), collective and individual self-efficacy beliefs, and action- and aim-focused self-efficacy beliefs.

To answer my research question (RQ1a) regarding whether sustainability attitudes (SA) and sustainability behaviors (SB) differed over time, I conducted the Kruskal-Wallis test. This test is suitable for distribution-free, ordinal-scaled independent samples and determines whether the central tendencies of more than two independent samples are different (Uni Zürich). Given the lack of normal distribution in my data and the need to compare three different time points for each SA and SB in each group, I deemed the test sufficient to provide statistical answers. I decided not to conduct any post-hoc tests, as the Kruskal-Wallis test showed no statistical differences between the groups.

To answer my research question (RQ1b) regarding the relationship between SA/SB and self-efficacy beliefs, I conducted the Spearman rank correlation test. This test is appropriate for distribution-free, ordinal-scaled samples and calculates the linear correlation between two variables (Uni Zürich). The rank correlation can range from -1 to +1, with -1 indicating a perfectly negative correlation and +1 indicating a perfectly positive correlation. If rs=0r\_s = 0rs​=0, there is no correlation (Tachtsoglou & König, 2017).

## Quality Criteria testing

In the case of a fully standardised questionnaire survey, this must be subjected to a number of checks in order to ensure the reliable quality of the results. To be able to draw conclusions about the population in the sense of inductive statistics, it must be ensured that the sample is representative of the population. This is an aspect of external validity (N. Döring & Bortz, 2016, p. 104). The KRS school groups came together at the school itself and thus became the involved group in the study, consisting of around 20 students, which fluctuated somewhat over the course of the school year. All classmates of the students in the KRS school group were defined as the basic population of the control group, as they are exposed to similar other conditions and thus comparability is guaranteed. No information is available on the exact size of this population, which is why an estimated value was entered in Table XX. The sample from this control group was determined by the willingness of the students approached to participate. Calculations of the ideal sample sizes based on 90% confidence interval and 10% margin of error (REF Qualtrics) show that for measurement point 3, neither for the control group, nor for the involved group, representative amounts were drawn from the population, allowing limited conclusions about the population.

Table XX: Comparison of ideal and actual sample sizes in relation to the population

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Measurement point 1** | | **Measurement point 2** | | **Measurement point 3** | |
| **Group** | Control group | Involved group | Control group | Involved group | Control group | Involved group |
| **Total population** | 225 | 20 | 225 | 20 | 150 | 20 |
| **Ideal N (90% confidence interval + 10% margin of error)** | < 53 | < 16 | < 53 | < 16 | < 47 | < 16 |
| **Actual N** | 56 | 20 | 63 | 18 | 42 | 7 |

For reliability analysis, Cronbach’s α, which is the most common measure of scale reliability (Field, 2012 REF EWM DEV), was calculated to assess the internal consistency of the subscales. Reliability for measurement points 1 and 2 were calculated and confirmed by Pauli (2023). The results for measurement point 3 can be seen in the following Table XX.

Table XX: Reliabilities (Cronbach’s α) for sustainability competency scales at measurement point 3.

|  |  |  |
| --- | --- | --- |
| **Scale** | **Number of items** | **Cronbach’s α** |
| Attitude | 4 | 0.65 |
| Subjective Norms | 3 | **0.41** |
| Perceived behaviour control | 2 | 0.77 |
| Intention | 3 | 0.86 |
| Behaviour1 | 8 | 0.78 |
| Individual self-efficacy beliefs | 8 | 0.90 |
| Collective self-efficacy beliefs | 3 | 0.90 |

1 To calculate the cronbach’s α the variables B03 and B04 were omitted, because there were not considered fitting and essential. The content validity should not be jeopardised by this.

In literature, values of over 0.6 for Cronbach's alpha are considered good for short scales (≤ 6 items) (Krüger et al., 2014). For longer scales (8 items), values from 0.7 can be considered good (N. Schmitt, 1996). Almost all of the scales achieved satisfactory results in this test, except the subjective norms one. This lower reliability should be taken into account in further analyses, although the literature also points out that these threshold values should not be given too much significance (SchMIDT REF EWM DEV).

The full R script and the link to my GitHub repository can be found in the appendices.

# Results

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

Contrary to my predictions, I found that sustainability competencies remained the same or decreased one year after the end of an ESD intervention across 206 survey (see Figure X). I found no statistical differences between the time points within a group (see Appendix XX for statistical outputs).

In line with my predictions, I found that sustainability competencies differed depending on the involvement of the students, with partly statistically significantly reported higher mean scores for the involved group than the control group (see Figure X and Table X for statistical outputs). For the control group, reported sustainability competences remained the same or decreased, directly after the ESD intervention (time point 2), as well as one year after the intervention (time point 3). The involved group reported higher mean scores for all sustainability competencies at all time points, than the control group. Before the start of the intervention, and one year after the intervention, the reported behaviour, intention and cumulated TPB scores differed significantly between the groups. Straight after the intervention (time point 2), all reported sustainability competences differed significantly between the groups. Surprisingly, for the involved group, all reported sustainability competences peaked straight after the ESD intervention (time point 2) but decreased again one year after the intervention (time point 3).

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Figure XX: Components of sustainability competences differed between groups across the XX (nt1= XX, nt2= XX, nt3= XX) students surveyed using Wilcoxon test for significance (see Table XX for full testing outputs). Points represent calculated mean values from the self-reported survey. Error bars represent 95% confidence intervals. Stars indicate significance level resulting form the Wilcoxon test comparing the groups. See Table XX for meanings of number of stars. No significant differences were found between the time points using the Kruskal Wallis test.

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

Looking at the relationship between the scales used to capture sustainability competences with the underlying construct of the theory of planned behaviour and the underlying construct of (individual) self-efficacy beliefs, I found that there is a strong positive relationship (*r* (47) = .79, p < .001, Figure X, see Table X for statistical outputs).

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Figure XX: The scale based on the theory of planned behaviour and the scale based on the self-efficacy beliefs capture the same underlying construct, showing a strong positive relationship across the XX students surveyed, tested with the Spearman’s rank correlation (see Table X for full statistical outputs). Points represent raw data. Line represents calculated Spearman’s rank correlation.

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

### Personal and collective efficacy beliefs

Contrary to my predictions, I found no statistical differences between and within the groups for individual and collective self-efficacy (p > .05, see Table X,….) across the XX students surveyed at time point 3. The reported mean scores of the involved group were higher for both collective and individual self-efficacy beliefs than those of the control group. Interestingly, the control group scored higher in collective self-efficacy beliefs than individual ones, whereas for the involved group it was the other way around. Overall, I did not detect any statistical differences and the mean scores were all very close to each other. There were some differences between each question pair within the groups (see Figure XX in appendix X).

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Figure XX: Reported individual and collective self-efficacy beliefs did not differ significantly within and between the involved and the control group (see Table XX for full statistical test outputs) using the Wilcoxon sign ranked test. Bars represent calculated mean values from the self-reported survey. Error bars represent 95% confidence intervals.

### Aim and action focussed self-efficacy beliefs between and within groups

Looking at the relationship between aim and action focussed self-efficacy beliefs and group membership, I found that the involved group reported significantly higher scores regarding the aim focus, than the control group (W = 8, p < .05, Figure X, see Table X for statistical outputs). Although also for the action focus, the involved group scored higher, there were no statistical differences (W = 1, p > .05). I found no differences between the action and aim scores for the involved group (W = 1, p > .05) and the control group (W = 1, p > .05).

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Figure XX: The aim focussed aspect of self-efficacy beliefs were significantly higher for the involved group than the control group across the XX students surveyed using the Wilcoxon sign ranked test. The action focussed aspect and the comparison within the groups did not differ significantly. Bars represent calculated mean values from the self-reported survey. Error bars represent 95% confidence intervals.

# 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.

## 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.

# Appendices

## Declaration of consent by parents/ info etc

# Declaration of submission of the Master thesis

I hereby declare that I have written the submitted Master thesis independently, have not used any sources and aids other than those specified and have labelled all content taken from other works as such. The Master thesis submitted is not or was not the subject of another examination procedure, neither in its entirety nor in significant parts.

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Place, date Signature