# 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.

### ~~Self-efficacy beliefs as desired Sustainability Competencies outcomes~~/ Potential role of Self-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.