



Assessment on Education for Sustainable Development: Developing scales to measure students' perceived competencies, perceived curriculum, and intentions as practitioners and investigating its interrelations.

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Abstract

Education for Sustainable Development (ESD) has the potential to transform societies towards sustainability through education. The curriculum, ESD-related competencies, and the intention of future practitioners to apply these competencies are impactful components of ESD-related interventions in Higher Education. However, there is a lack of strong instruments to evaluate the implementation of these ESD-related aspects. Thus, I present the systematic development and validation of new ESD-related scales that cover the Perceived Curriculum (8 items), the Perceived Competencies (8 items), and the intention to apply these competencies, i.e., Intention as Practitioner (8 items). Based on extensive validation, the scale quality was evaluated as high, i.e., as reliable, and valid ($N = 232$). As a first application, these ESD scales are used to assess the interrelations of Perceived Curriculum, Perceived Competence, and Intention as Practitioner. As hypothesized the Perceived Curriculum was positively related to the Perceived Competence and to the Intention as Practitioner. Other than expected the Perceived Competence was not positively related to the Intention as Practitioner, thus Perceived Competence did not indicate to mediate the relation of Perceived Curriculum and Intention as Practitioner. For future use, the scale can evaluate the implementation of ESD into curricula and investigate influencing factors of competencies and the intention to apply them. Additionally, the scale can be used as a process indicator of ESD and to compare study programs and universities. Overall, the study presents a strong tool to measure Higher ESD and to evaluate its implementation.

Keywords: Education for Sustainable Development, Scale Development, Self-assessment, Key Competencies

Assessment of Education for Sustainable Development

There is an urgent need for professionals who can contribute, and at the same time want to contribute to the societal transformation toward sustainability (Gordon et al., 2019; Redman et al., 2021). To address climate change and related societal changes (e.g., UNESCO, 2023) it is crucial to provide learners with competencies to contribute to sustainable transformation (Holst et al., 2020). Students are future decision-makers; thus, sustainability needs to be anchored in Higher Education to foster environmentally aware attitudes, skills, and behaviors in students (Holst et al., 2020). This requires Higher Education Institutions (HEI) to use the enormous leveraging effects Higher Education has by implementing ESD in the curricula (Barth & Rieckmann, 2016). Accordingly, international strategies were set up to implement ESD at HEI, among them the Roadmap *Education for Sustainable Development (ESD for 2030)* (UNESCO, 2020). *ESD for 2030* includes SDG 4.7., to ensure that by 2030 the knowledge and skills needed to promote Sustainable Development are acquired broadly.

This acquiring of knowledge and skills (i.e., SDG 4.7) is only seen as accomplished when the learners who can engage in sustainable development due to successful ESD-implementation strategies also intend to work with these competencies and to engage in sustainable transformation (Gordon, 2019, Redman, 2021). A literature review by Edwards et al. (2020) and national ESD monitorings indicate that the UNESCO target to implement ESD is behind agreed-upon goals and is not consolidated on the national or international level (Sule & Greig, 2017; Holst et al., 2020). This is problematic because SDG 4.7 and therefore ESD is considered a prerequisite to achieving all other SDGs (Kohl et al., 2022).

To make sure ESD can a) be implemented on political and institutional levels and can b) be evaluated and therefore c) further developed, ESD must be embedded in strong theoretical models and operationalized at a high scientific level (Rode & Michelsen, 2008). However, it lacks strong tools that operationalize and measure ESD (Redman et al., 2021).

This paper addresses this gap and develops three specific scales in the domain of ESD: The extent to which students perceive their curriculum to cover ESD (Perceived Curriculum), the students' perceived ESD competencies (Perceived Competence), and the extent to which students intend to deal with ESD-related competencies as practitioners (Intention as Practitioner). I argue that these constructs are especially important because they cover a) one of the subjects that can most easily be influenced on institutional level at HEI, i.e., Perceived Curriculum (Tedesco et al., 2014), b) the extent to which students perceive they have acquired the construct of interest, i.e., Perceived Competence (e.g., Holst et al., 2020), and c) the overall societal necessity of future professionals engaging in sustainable transformation, i.e., Intention as Practitioner (Gordon et al., 2019, Redman et al., 2021). Despite the importance of ESD for sustainable transformation (Holst et al., 2020, UNESCO, 2020), no theoretically sound scales exist in the field of ESD to measure these ESD-related constructs (Redman et al., 2021, Barth & Rieckmann, 2016). Therefore, three scales that measure the three described constructs of interest (Perceived Curriculum, Perceived Competence, Intention as Practitioner) must be developed and systematically tested and validated, which leads to the following Research Question:

1. How can Perceived Curriculum, Perceived Competencies, and Intention as Practitioner be assessed at Higher Education Institutions in the context of ESD?

In addition to the scale development, I first apply the developed scales with the aim of a) showing potential ways of using the scale and b) investigating the relation of the three identified ESD constructs in more depth. This leads to the second Research Question:

2. How are the constructs of interest (i.e., the Perceived Competence, the Perceived Curriculum, and the Intention as Practitioner) associated with each other?

This second research question allows to gain deeper insights into how the main constructs in ESD-related interventions are interrelated and how respective interventions can be improved.

Education for Sustainable Development as Conceptual Basis

The overall aim of ESD is to contribute to Sustainable Development (UNESCO, 2020). Thus, ESD is considered a method to contribute to achieving specific sustainability-related goals through education and empowerment (e.g., UNESCO, 2020; Kohl et al., 2022). Additionally, ESD fosters learning processes that include the transfer of abilities, knowledge, and values (e.g., UNESCO, 2020; Baartman et al., 2007). These learning processes are supposed to support the implementation of the SDGs and thus must equip people with the capabilities required to co-create a sustainable future for all (Holst et al., 2020).

Higher Education for Sustainable Development (HESD) particularly aims to enable people to go beyond the acquisition of knowledge by reflecting on individual and societal responsibilities and decisions by taking future-oriented and global perspectives (Rieckmann, 2012). Additionally, HESD aims to raise awareness and empower people to shape necessary future developments (Barth & Rieckmann, 2016). Sterling (2001) differentiated in detail between education *about* sustainability which focuses on the transmission of factual information about sustainability processes, education *as* sustainability which aims at encouraging to adapt and develop sustainability principles, ethics, and values, and education *for* sustainability that focusses on experiential and interactive learning processes to make a greater understanding of sustainability possible (Sterling, 2001; Barth & Burandt, 2013).

However, HESD doesn't aim at convincing people to act in a specific (sustainable) way but aims at enabling people to deal with and participate in sustainable development in a value-based way and to question existing structures and institutions (Rieckmann, 2021; Vare & Scott, 2007). Thus, HESD is not only about individual behavioral changes but focuses on structural changes (Rieckmann, 2021).

Competencies in ESD

ESD is mainly operationalized through competencies, not through specific knowledge, as knowledge changes over time (e.g., Brundiens et al., 2021). Focusing on identifying relevant competencies and defining them in detail facilitated spreading the concept of ESD, making a transfer into the curricula possible and allowing the measurement of its success (Singer-Brodowski, 2016, Wiek et al., 2011).

Spady (1994) and Baartman et al. (2007) defined competencies as functionally linked complexes of knowledge, skills, and attitudes. These interrelated complexes are seen as a precondition for achieving successful performance in complex situations (Brundiens et al., 2021, Baartman et al., 2007). Weinert (2001) highlights that competencies linked to sustainable development must additionally include a volitional part, i.e., an intention to deal with them.

Wiek et al. (2011) further differentiate between competencies and key competencies. Key competencies in ESD are considered especially important when transforming societies explicitly towards sustainability (Wiek et al., 2011), but this does not mean that basic competencies (like critical thinking or basic communicative skills) or domain-specific knowledge are not important for sustainable development (Wiek et al., 2011). Key competencies related to sustainability are defined as a composition of several interconnected sustainability competencies (Barth et al., 2007) facilitating successful performance regarding sustainable development. When dealing with key competencies and including them in the curricula of Higher Education Institutions (HEI) it is crucial to consider that competencies cannot be taught but must be developed by learners themselves through using learning opportunities (Rieckmann et al., 2021).

Wiek et al. (2011) conducted a literature review on key competencies in ESD and derived key competencies (See Table 1) that form the baseline for the internationally most

widely used model on ESD by Wiek et al. (2011). These key competencies were further developed by Brundiens et al. (2021), see Table 1 for the definition of the respective key competencies. Given their outstanding elaborateness and their extensive and operationalizable definitions (e.g., Rieckmann, 2021), these competencies are used as the conceptual basis for the items of the developed scales.

Table 1

Key Competencies for Sustainability by Wiek et al. (2011) and Brundiens et al. (2021)

Competence	Definition	Proposed by
Systems-Thinking	“Ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks.”	Wiek et al. (2011)
Anticipatory	“Ability to collectively analyze, evaluate, and craft rich “pictures” of the future related to sustainability issues and sustainability problem-solving frameworks.”	Wiek et al. (2011)
Normative	“Ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets.”	Wiek et al. (2011)
Strategic	“Ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability.”	Wiek et al. (2011)
Interpersonal	“Ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving.”	Wiek et al. (2011)
Integrated Problem-Solving	Ability “to apply different problem-solving frameworks to complex sustainability problems and develop viable solution options” in order to “meaningfully integrate problem analysis, sustainability assessment, visioning and strategy building.”	Wiek et al. (2015), Brundiens et al. (2021)

Intrapersonal	“The ability to reflect on one’s own role in the local community and (global) society; to continually evaluate and further motivate one’s actions; and to deal with one’s feelings and desires (UNESCO, 2017).”	Brundiens et al. (2021)
Implementation	“Collective ability to realize a planned solution toward a sustainability-informed vision, to monitor and evaluate the realization process, and to address emerging challenges (adjustments), recognizing that sustainability problem solving is a long-term, iterative process between planning, realization, and evaluation.”	Brundiens et al. (2021)

Competence Models in ESD

To make sure these ESD-related key competencies can be assessed and further developed on a high scientific level, identified competencies must be embedded in strong models that relate the competencies to each other and allow empirical evaluation (Rode & Michelsen, 2008). This allows to further develop existing models and avoids the creation of arbitrary lists of key competencies (Rode & Michelsen, 2008). Many influential yet overlapping competence models in the domain of ESD exist.

UNESCO & OECD Models of ESD. Some of the most widely used models are the UNESCO Model of ESD (2017) and the OECD model (2005). The UNESCO model of ESD (UNESCO, 2017) uses the competencies of de Haan (2006), Rieckmann (2012), and Wiek et al. (2011) and summarizes them into a list of key competencies. Due to this approach, it cannot be considered a model but is rather an exhaustive list of competencies and cannot adequately be used to further operationalize and measure the competencies. The OECD Model (OECD, 2005), which also consists of a quite comprehensive list of competencies, does group the competencies into categories; a) using tools interactively, b) interacting in heterogeneous groups and c) acting autonomously, as proposed by Rychen & Salgaik (2003). However, no convincing theoretical rationale for the selection of the categories can be

identified. Therefore, these models are not suitable to advance the field and operationalize the respective competencies.

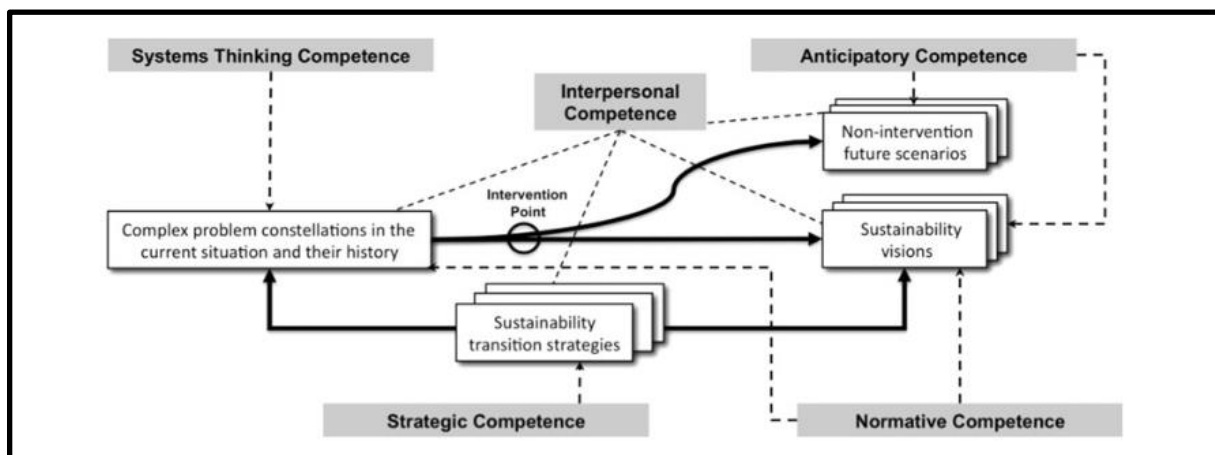
Key Competence Model by Wiek et al. (2011). The Competence Model by Wiek et al. (2011) is currently the most influential competence model on an international level and is advancing the implementation of ESD (Rieckmann, 2021). It is particularly suitable for HESD since the competencies were placed in an adequately complex problem-solving process (Singer-Brodowski et al., 2016). Wiek et al. (2011) conducted a literature analysis on key competencies for Sustainable Development, to summarize and group existing competencies. The five identified competencies serve as a reference point for imparting the knowledge and skills students need, to become change agents for sustainable development and are the competencies the model is built upon. These interrelated key competencies are a) systems-thinking competence, b) anticipatory competence, c) normative competence, d) strategic competence, and e) interpersonal competence (see Table 1 for a detailed definition of the competencies).

The model of Wiek et al. (2011), as compared to all others, relates the competencies to each other and integrates them into a problem-solving process as follows: To solve sustainability problems, it is necessary to understand those problems within present and past systematic dependencies - this requires systems thinking competence. People must be able to envision what visions for a sustainable world would look like and how sustainability problems would develop if no interventions were made - this requires anticipatory competence. Evaluating sustainability problems and future scenarios, both desired and undesired, requires normative competence. And finally, people must be able to develop and adapt strategies on how to transition from current problem situations to a sustainable vision. This requires strategic competence. Throughout the process, interpersonal competence is

necessary because all these strategies must be implemented collaboratively (Wiek et al., 2011). Figure 1 illustrates the model.

Figure 1

ESD Competence Framework by Wiek et al. (2011)



Note. The five key competencies in sustainability (shaded in grey) and how they are linked to a sustainability research and problem-solving framework (shaded in white).

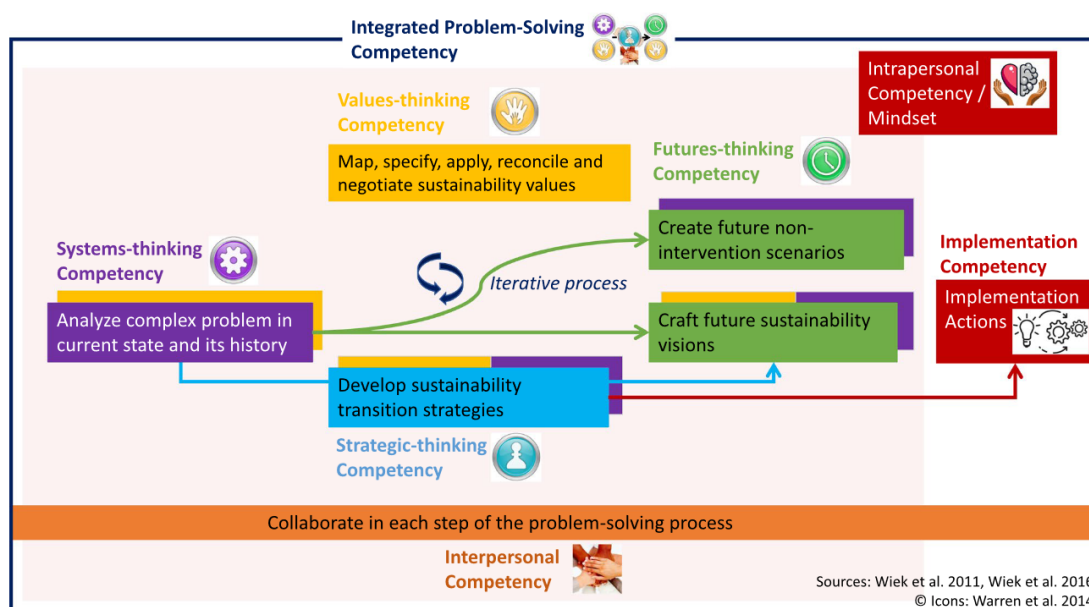
ESD Reference Framework by Brundiers et al. (2021). The model by Wiek et al. (2011) was evaluated and further developed by Brundiers et al. (2021). In this study, expert groups concluded that the competencies proposed by Wiek et al. (2011) already cover the most important ESD-related competencies. Additionally, the expert groups proposed to include the problem-solving competence defined by Wiek et al. (2015) and the newly defined intrapersonal competence and implementation competence (see Table 1 for the definitions of the added competencies, see Figure 2 for the extended model).

The model by Brundiers et al. (2021) is the more elaborated existing model on key competencies in sustainability (e.g., Rieckmann, 2021). Therefore, this model, and its underlying competencies (see Table 1 for extensive definitions) are used as the underlying model to develop the Perceived Curriculum Scale, the Perceived Competence Scale, and the

Intention as Practitioner Scale. This means that the extent to which students perceive their curriculum covers these competencies (Perceived Curriculum Scale), the extent to which students perceive they have the ability to use these competencies (Perceived Competence Scale), and their intention to use these competencies once they become professionals (Intention as Practitioner Scale) are all conceptually based on the model of Brundiens et al. (2021).

Figure 2

Competence Model by Brundiens et al. (2021)



Note. Extended Key Competence Model of Wiek et al. (2011) by Brundiens et al. (2021).

Measurement of Education for Sustainable Development

Regarding measurement, the field of ESD is not yet highly elaborated (Barth & Rieckmann, 2016). Only slowly a predominantly theoretical-conceptual discussion is changing into an empirical and comparative discussion (Barth & Rieckmann, 2016). UNESCO itself, however, defined monitoring and evaluation as a key strategy to advance *ESD for 2030* (UNESCO, 2020). Indicators to measure the success of SDG 4.7 are “the extent

to which [...] ESD is mainstreamed in (a) national education policies; (b) curricula; (c) teacher education and (d) student assessment” (UNESCO, 2020). The emphasis on student assessment, as an important indicator of SDG 4.7 (Kohl et al., 2022; UNESCO, 2020), points to the necessity of strong measures that capture students’ perceptions in the domain of ESD.

Beyond this, elaborate measures of ESD can better assess what students are dealing with and which interventions have the desired outcomes to precisely improve specific interventions (Edwards et al., 2020; O’Flaherty & Liddy, 2018). Additionally, strong measures can reorient ongoing ESD-related programs, and increase the understanding of ESD-related progress on institutional and individual levels (Tilbury, 2007).

Reviews of existing ESD-Scales

Even though elaborated measurements of ESD are considered essential to advance the field of ESD (e.g., Tilbury, 2007; Holst et al., 2020; Rieckmann, 2021), no widely accepted or validated instruments to assess the success of implementing ESD competencies at the student level exist so far (Redman et al., 2021).

However, several tools to measure the success of implementing ESD on the student level, among them student self-assessment scales of key competencies, exist (e.g., Cebrian Bernat et al., 2019). Redman et al. (2021) identified 121 tools that were developed to assess students’ sustainability-related competencies, grouped into eight different types of tools (scaled self-assessment, reflective writing, scenario case/test, focus group/interview, performance observation, concept mapping, conventional test, regular course work). To make studies comparable they need to assess the same competencies. Only the model of Wiek et al. (2011) was used by enough tools to do so (Redman, 2021), highlighting its outstanding importance. Studies selected by Redman et al. (2021) indicate that existing assessment tools were oftentimes not well-developed methodologically and were inappropriately used, e.g., the specific items’ theoretical background was not reported. This is problematic given that the

students' self-assessment is defined as one of the key instruments to measure the success of ESD and to achieve SDG 4.7 (UNESCO, 2020). Thus, a theoretically sound scale to measure competencies and related constructs to advance the field of ESD must be developed.

With $n = 42$ of $N = 121$ tools the scaled self-assessment is the most widely type of tool used in ESD (Redman et al., 2021). Strengths are that they are broadly applicable since they are easy to administer and analyze (Redman et al., 2021), additionally, they can be used to complement more complex survey types (Kanbar, 2012) and produce data that can be used to analyze and model competencies of ESD (Faham et al., 2017). Self-assessment scales are considered key tools to assess ESD if they are theory-driven, created transparently, and clearly addressed as self-assessment (Migliorini & Lieblein, 2016).

Constructs of the Developed Scales

Consequently, I developed self-assessment scales that fulfill the purpose of assessing the implementation of ESD at HEI, namely Perceived Curriculum, Perceived Competence, and Intention as Practitioner. The Perceived Curriculum is one of the subjects that can most easily be influenced on an institutional level at HEI (Tedesco et al., 2014), the Perceived Competence is the construct of interest most interventions in ESD aim at (e.g., Holst et al., 2020, Redman et al., 2021) and the Intention as Practitioner is the overall societal necessity of future professionals intending to engage in sustainable transformation (e.g. Gordon et al., 2019, Redman et al., 2021). Thus, investigating these three specific constructs in more depth and adequately operationalizing them can advance the field of ESD and improve respective interventions (Rode & Michelsen, 2008). This is supported by the fact that in other educational fields, investigating these three constructs has significantly advanced the respective fields, e.g., in Entrepreneurship Education (Thomas, 2023; Saaed, 2014; Kraaijenbrink et al., 2010), in Sustainable Management (Grafe, 2018), and in the domain of Scientific Skills (Jung, 2018).

Due to the importance of strong theoretical foundations of ESD measures (e.g., Rode & Michelsen, 2008), the ESD model by Brundiens et al. (2021) and the respective competencies (see Table 1) are used as the theoretical foundation for each of the three constructs of the developed scales since it is the most elaborated and most widely used model in the domain of ESD (e.g., Rieckmann, 2021).

Perceived Curriculum

Perceived Curriculum measures to what extent students perceive their curriculum to cover the competencies of Brundiens et al. (2021) and can thus assess the success of policies aiming to implement ESD-related competencies into the curricula. Measuring Perceived Curriculum is especially suitable to advance the field because Curriculum Change is one of the components of Higher Education Development that can most easily be influenced on an institutional level (Kranthi, 2017; Medland, 2016), and is at the same time one of the most impactful existing interventions in Education to foster change (Tedesco et al., 2014). In Entrepreneurship Education the curriculum is oftentimes measured dichotomous, assessing the formal absence or presence (e.g., descriptions in course catalogs) of specific topics or competencies (Thomas, 2023). Thomas (2023) and Kraaijenbrink et al. (2010), however, have highlighted the strength of measuring the perception of the curriculum since this leads to more realistic insights into the actual implementation into the curricula, thus I focus on the *Perceived Curriculum* in ESD.

Perceived Competence

Perceived Competence is measuring to what extent students perceive they have acquired ESD-related competencies according to Brundiens et al. (2021) throughout their studies and thus to what extent policies like *ESD for 2030* or SDG 4.7. are successfully being implemented (Redman et al., 2021, Holst et al., 2020). These policies first and foremost aim

to increase the respective competencies among students (UNESCO, 2020; Holst et al., 2020). Thus, the assessment of Perceived Competence contributes to a better evaluation of the success of these policies. Additionally, Perceived Competence can measure the perceived cognitive change within the learners themselves, a prerequisite to sustainable transformation (Rode & Michelsen, 2008). While a few experts assessed actual competencies (e.g., Rost, 2008), competencies are primarily operationalized as perceived competencies (Redman et al. (2021).

Intention as Practitioner

Intention as Practitioner assesses the extent to which students intend to work with the competencies by Brundiens et al. (2021) and therefore the extent to which students intend to engage in the field of sustainable transformation once they become professionals. National ESD activities and strategies have highlighted the societal role of students' intention to participate in societal transformation toward sustainability. Thus, these strategies emphasize the necessity to focus on the willingness of future practitioners to engage in societal transformation toward sustainability when it comes to respective interventions and their evaluation (Gordon et al., 2019; Sule & Greig, 2017; Holst et al., 2020).

Assumptions and Validation of the Developed Scales

Considering the strong theoretical background of the competence model by Brundiens et al. (2021) and the conceptualization of the constructs being measured, I predict that the developed self-assessment scales (Perceived Competence, Perceived Curriculum, and Intention as Practitioner) are reliable and valid instruments to measure the respective constructs of interest related to ESD. As part of this:

- 1) The distribution properties of the scales are described.

2) The reliability of the scales is assessed by determining the internal consistency as an indicator of reliability with conventional cutoff criteria of Cronbach's $\alpha > .70$ and by determining inter-item correlations.

3) The validity of the scales is assessed by conducting quality checks on factor loadings and confirmatory factor analyses for each scale.

Application of the Scales

In addition to developing and evaluating the scales, I applied the scales demonstrating their applicability, and first assessed the interrelations between Perceived Curriculum, Perceived Competence, and the Intention as a Practitioner. Since many interventions in ESD aim at changing the curriculum to increase competencies or intentions to engage in sustainable transformation (Rieckmann, 2021; Barth & Rieckmann, 2016) I argue that by deeper understanding how the three constructs are associated with each other, interventions in the field can be improved. Due to the development of the three scales, these relations can first be analyzed reliably and in detail.

Thomas (2023) empirically showed that the positive relation of Perceived Entrepreneurship Education on the Intention to start a venture is mediated by the perceived entrepreneurial competencies of students. The underlying relations of this mediation were not yet investigated in ESD. To make sure current and future interventions to increase ESD-related competencies and to increase the intention to work with ESD-related competencies are designed in the most successful way, these relations must be investigated in more detail. Because Entrepreneurship Education and ESD are conceptually similar, and both focus on problem orientation and competencies (Strachan, 2018), I predict that in the field of ESD, the relation between Perceived Curriculum and Intention as Practitioner is also positively mediated by Perceived Competence. These positive relations have long been suspected by practitioners and policymakers in the field of HEI, as can be seen in international strategies

like *ESD for 2030* or national ESD strategies (UNESCO, 2020; Holst et al., 2020; Sule & Greig, 2017), but were not empirically tested yet. To understand the predicted relations and its importance for the field of ESD in more detail, the relations are described in more detail in the following.

Interrelations of the Constructs of the Developed Scales

Analyzing the relation of Perceived Curriculum and Perceived Competence in more depth can improve ESD-related interventions because the implementation of ESD-related competencies into courses and study programs mostly aims at increasing these competencies among students (Rieckmann, 2021). The empirically shown positive relationship between Perceived Curriculum and Perceived Competence in Entrepreneurship Education (Thomas, 2023, DeTienne & Chandler, 2004) leads to the assumption that both constructs are positively associated in the domain of ESD as well (Hypothesis 1a).

A positive relationship of Perceived Curriculum on Intention as Practitioner in the field of ESD is suspected by political strategies to implement ESD like *ESD for 2030* (UNESCO, 2020). This is indicated by the fact that UNESCO (2020) declared the implementation of ESD in all learning settings as a strategy to achieve all other SDGs, thus assuming that the mere ability to work on sustainability-related topics increases the willingness to do so (Kohl et al., 2022). A positive relation between perceived competence and the intention to apply these competencies was found in several meta-analyses in entrepreneurship education indicating small but significant positive relationships between (perceived) entrepreneurship education and entrepreneurial intention (Bae et al., 2014; Martin et al., 2013). Thus, a positive relation is predicted in ESD (Hypothesis 1b).

Empirical evidence of the relationship between Perceived Competence and Intention as Practitioner is, as well as for the other investigated relations, lacking in the domain of ESD. Thomas (2023) empirically showed a positive relation, but states that this relation is not yet

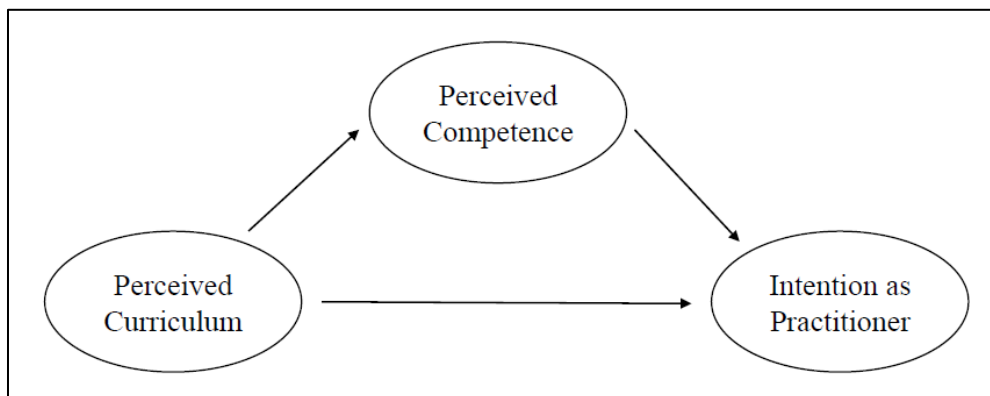
investigated in detail, and thus needs further investigation. Liñán (2008), however, showed a positive relationship between entrepreneurial skills and entrepreneurial intention, explained by increased perceived behavior control (the perception of the individual's own ability to perform a specific behavior; Ajzen, 1991). Given these findings, a positive relation between Perceived Competence and Intention as Practitioner is predicted in the domain of ESD as well (Hypothesis 1c).

Mediation Model of ESD-related Constructs

Consequently, a model with the three ESD-related variables (Perceived Curriculum, Perceived Competence, and Intention as Practitioner) results, including the aforementioned relations. This leads to a mediation model in which the relation of Perceived Curriculum and Intention as Practitioner is mediated by Perceived Competence, see Figure 3.

Figure 3

The developed model including the mediation of the three ESD-related latent variables



This application of the developed scales is first tested with the data collected in this study. Given the existing findings of the relations of these constructs in other educational fields the following Hypotheses are derived:

Hypothesis 1 The proposed model with the three competence-related factors (Perceived Competence, Perceived Curriculum, and Intention as Practitioner) demonstrates an acceptable fit to the observed data.

Hypothesis 1a: The higher students perceive their curriculum to cover ESD-related competencies, the higher the ESD-related perceived competencies are.

Hypothesis 1b: The higher students perceive their curriculum to cover ESD-related competencies, the higher their intention to work with the ESD-related competencies is.

Hypothesis 1c: The ESD-related perceived competencies positively mediate the relationship between ESD-related perceived curriculum and the intention to work with ESD-related competencies.

Methods

This master's thesis was approved as ethically sound by the Ethics Committee of the University of Groningen (EC-Number: PSY-2223-S-0246). The data analysis was conducted with R Core Team (2021), the R-package lavaan (Rosseel, 2012), and JASP Team (2023).

Development of the Scales

The main components of this study are the three developed scales with the latent variables a) Perceived Curriculum, b) Perceived Competencies, and c) Intention as Practitioner. Since no respective theoretical sound scale exists, I developed a scale based on the steps proposed by DeVellis & Thorpe (2021). This includes a) the conceptualization of what is being measured, b) the generation of the item pool, c) determining the response format, d) a revision of the initial item pool (by experts), e) cognitive interviewing, f) considering the inclusion of validation items, g) administering the items to a development sample, h) evaluating the items and i) optimize the scale length. In response to resource

constraints, I decided to deviate from the scale development process proposed by DeVellis & Thorpe (2021). Specifically, I decided not to conduct cognitive interviews, create specific items for scale validation, or optimize the scale length. All the conducted steps are explained in more detail below.

Conceptual Definition of the Constructs of Interest

The key competencies as defined in the model of Brundiens et al. (2021) (see *Key Competencies and ESD Reference Framework by Brundiens et al. (2021)* in the Introduction) formed the theoretical framework for the scale development process. Consequently, Perceived Curriculum measures to what extent students perceive their curriculum to cover these key competencies, Perceived Competencies measures to what extent students perceive they have gained key competencies according to Brundiens et al. (2021) throughout the course of their study program, and Intention as Practitioner measures the degree to which students intend to apply these competencies once they become professionals. Extensive content-wise definitions of the three constructs of interest can be found in the Introduction in *Developed Scales*.

Methodological Considerations. Due to the fact that all competencies included in the model of Brundiens et al. (2021) are integrated into one single problem-solving framework (see Figure 2) and since the interconnectedness of these competencies is an essential part of the model of Brundiens et al. (2021), I assumed Perceived Competence, Perceived Curriculum, and Intention as Practitioner to be unifactorial, i.e., all items are measuring only its respective underlying construct. I treated all three constructs - Perceived Competence, Perceived Curriculum, and Intention as Practitioner - as reflective variables. This approach assumes that the indicators used to measure each construct are influenced by an underlying latent construct itself. For Perceived Competence, this means that the self-assessed competence indicators reveal insights into individuals' perceptions of their ESD-related competence. Similarly, with Perceived Curriculum, the indicators reflect individuals'

subjective evaluations of the curriculum, while the indicators for Intention as Practitioner uncover students' internal intentions to apply sustainability-related competencies once they become professionals.

Selection of Response Format

Likert scales are widely used in self-assessments, to receive unambiguous answers it is however necessary to match the question and the specific response format (DeVellis & Thorpe). Thus, I chose a seven-point Likert scale and the Participants were supposed to answer to the final items (see Table 2) with the question: *How much do you agree with the following statements?* with the answer options *1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, and 7 = strongly agree* for each item of the developed scales.

Generating the Initial Item Pool

To generate the items, I carefully examined each of the extensive definitions of the eight key competencies by Wiek et al. (2011) and the further developed definition of Brundiers et al. (2021) which formed the conceptual basis for each item (see Table 1 for the definitions of the items). After the examination of each of these definitions, I paraphrased the definitions to extract the aspects I considered most important of each definition (see Appendix 1), as proposed by DeVellis & Thorpe (2021). Afterward, I transferred each paraphrased definition (i.e., each competence) into one initial item of Perceived Competence (DeVellis & Thorpe, 2021), see Appendix 2. If I considered the definitions of the competencies to be too general to create unambiguous items, I also included operationalizations proposed by Wiek et al. (2015) to create the items. I revised the developed items by checking for good item characteristics like avoiding exceptionally lengthy items while not sacrificing the meaning or avoiding double-barreled items (DeVellis & Thorpe, 2021). Throughout this process, I first

developed the items for the Perceived Competence Scale, and then slightly adapted these competencies to develop the items of the Perceived Curriculum Scale and the Intention as Practitioner Scale (see Appendix 2 for the initial item pool).

The main difference between the three scales lay in the introductory context, which differed for each scale and was provided to the participants at the beginning of each item. The items of the Perceived Competence Scale, started with *When thinking of what I have learnt in the courses of my study program so far: I am able to*, the items of the Perceived Curriculum Scale, started with *My study program covers how to*, and the items of the Intention as Practitioner Scale started with *When becoming a practitioner after my studies, I envision myself*. Despite the differences in their introductory context, the items themselves exhibited a noteworthy degree of similarity (see Appendix 2). To ensure the practical usability of the scale and manage resource limitations, I predetermined that each competence would be represented by one single item. Given that Brundiers et al. (2021) proposed eight distinct ESD-related competencies, this led to 8 items for each Scale and to a total of 24 items.

Revision of the Initial Item Pool and Finalizing the Scales

I generated the finalized scales (see Table 2) by conducting an extensive revision process of the initial item pool (see Appendix 2). This included that the initial item pool was revised by five students from the Master Program Environmental Psychology of Leuphana University of Lüneburg and the University of Groningen by giving feedback regarding the clarity of the items. This feedback only included minor wording changes to decrease ambiguity and led to a second, revised item pool (see Appendix 3). I pretested this second item pool with $N = 9$ students from Groningen and Leuphana Universities. No floor or ceiling effects were found with means ranging from $M = 3.00$ to $M = 5.86$ and Standard Deviations ranging from 0.71 to 1.87. Histograms showed that the distribution of the items was left-skewed (see Appendix 4). Additionally, participants assessed the clarity of the items,

answering the statement *The question above was clear to me and I knew what to answer* on a Likert scale ranging from 1 to 7 (*strongly disagree* to *strongly agree*). With means ranging from $M = 5.33$ to $M = 6.50$ and Standard Deviations ranging from 0.54 to 1.73, the descriptives indicated that the items were clear and that participants knew what to answer, see Appendix 4 for the detailed descriptive statistics on item level. Due to the pretest results and the pretest participants' open feedback, I included in the study instructions that students do not have to be familiar with sustainability science to participate and stressed that sustainability includes social, ecological, and economic aspects (see Appendix 5 for the detailed Study Instructions). I reframed the Intrapersonal Competence items since the word "coping" led to confusion and was reported to be negatively connotated. I changed the instruction of Intention as Practitioner from *When becoming a practitioner after my studies, I envision myself to* into *When becoming a practitioner after my studies, I want to* since *envisioning* was reported to be vague. Additionally, I changed minor wording. This led to the finalized scales (see Table 2).

Table 2

Items of the Final Item Pool of the three developed scales (Perceived Competence, Perceived Curriculum, Intention as Practitioner)

Competence	Perceived Competence	Perceived Curriculum	Intention as Practitioner
	<i>When thinking of what I have learnt in the courses of my study program so far: I am able to</i>	<i>My study program covers how to</i>	<i>When becoming a practitioner after my studies I want to</i>

System Thinking	analyze sustainability-related issues considering different domains (society, environment, and economy) and at the same time different scales (global to local).	analyze sustainability-related issues considering different domains (society, environment, and economy), and at the same time different scales (global to local).	analyze sustainability-related issues considering different domains (society, environment, and economy), and at the same time different scales (global to local).
Anticipatory	create different sustainability-related future scenarios, while considering the past and the present.	create different sustainability-related future scenarios, while considering the past and the present.	create different sustainability-related future scenarios, while considering the past and the present.
Normative	consider and apply values, when dealing with sustainability-related issues.	consider and apply values, when dealing with sustainability-related issues.	consider and apply values, when dealing with sustainability-related issues.
Strategic	come up with and implement ideas that can lead to sustainability considering given circumstances.	come up with and implement ideas that can lead to sustainability considering given circumstances.	come up with and implement ideas that can lead to sustainability, considering given circumstances.
Interpersonal	work together with others to solve sustainability-related problems.	work together with others to solve sustainability-related problems.	work together with others to solve sustainability-related problems.
Problem Solving	apply knowledge and select strategies that allow me to solve sustainability-related problems.	apply knowledge and select strategies that allow me to solve sustainability-related problems.	apply knowledge and select strategies that allow me to solve sustainability-related problems.
Intrapersonal	deal with my personal feelings about sustainability-related issues.	deal with my personal feelings about sustainability-related issues.	deal with my personal feelings about sustainability-related issues.
Implementation	implement sustainability-related action plans and adapt them when necessary.	implement sustainability-related action plans and adapt them when necessary.	implement sustainability-related action plans and adapt them when necessary.

Administration of Items to a Development Sample

These items from the final item pool (see Table 2) were administered to a sample to statistically describe the scale and assess its reliability and validity.

Participants. Due to the focus on developing and testing a scale for Higher Education, the participants had to be students to participate in this study. The students of Leuphana University and the University of Groningen were recruited via SONA Systems of the respective universities. The remuneration was 30 Minutes of SONA credits. The only exclusion criterion was not being a student. The sample consisted of $N = 232$ students, among them $n = 210$ (90.52%) from Leuphana University and $n = 22$ (9.48%) from the University of Groningen. Their mean age was $M = 21.78$ years (range 18-47, $SD = 2.85$). Overall, $n = 163$ participants (70.26%) indicated to study psychology, and $n = 24$ (10.34%) environmental sciences.

Procedure. Participants could freely choose to participate by registering via SONA Systems. The Questionnaire was embedded in Qualtrics. Once participants agreed to the data processing and storage as proposed by the Ethics Committee of the University of Groningen, they received a detailed study description, see Appendix 5. The main component of the questionnaire was the items of the three developed scales. The order was 1) Perceived curriculum, 2) Perceived Competence, and 3) Intention as a practitioner for each of the eight competencies. The order of the competencies was randomly assigned to avoid order effects. After answering the items of the developed scales, the participants provided their demographics (Age, Study Year, Study program, University). Afterward, participants were redirected to SONA Systems to get remunerated. According to DeVallis & Thorpe (2023), a sample of $N = 300$ is appropriate to design a respective scale, thus this was the number of participants aimed for.

Analysis for Testing the Quality Criteria of the Scale

To describe the basic distributional characteristics of the final scales I determined the means, standard deviations, the median, and the mode of all items, as well as the means and standard deviations of the total scales. Additionally, the distributions of the items were assessed using histograms. The total scales were tested for normal distribution using a) graphical methods like histograms and Q-Q-plots, b) regular skewness and kurtosis indices (with kurtosis > 3 indicating a leptokurtic distribution, and kurtosis < 3 indicating a platykurtic distribution; and skewness > 0 indicating right skewness, and skewness < 0 indicating left skewness) and c) the Kolmogorov-Smirnoff test to check for normality and thus the assumptions of CFA (Massey, 1951). Given the sample size of $N = 232$, the Kolmogorov-Smirnoff test is likely to reject normality and thus is not considered the decisive indicator of normality. To determine reliability, internal consistency (as an indicator of reliability) was assessed using Cronbach's Alpha. Cronbach's Alpha $< .70$ was considered acceptable (e.g., Hair et al., 2010; Taber, 2018). Additionally, the inter-item correlations to identify the internal consistency of the scales and potential item redundancy were assessed, as well as corrected item-total correlations to additionally determine the discriminatory power of each item. Additionally, Cronbach's α if specific items were omitted was calculated. All correlations were assessed using Pearson's r . Quality checks on factor loadings and a confirmatory factor analysis were conducted to determine construct and factorial validity. For the CFA, conventional cut-off values were used (Hu & Bentler, 1995, Brown, 2015): Comparative Fit Index > 0.95 ; Tucker Lewis Index > 0.95 , RMSEA < 0.06 , SRMR < 0.08 , χ^2 -tests, indicating no significant difference between the model and the data with alpha = .05.

Application of the Scales

In addition to the development and validation of these scales, the scales were first applied by analyzing the relations between the latent constructs (i.e., Perceived Curriculum,

Perceived Competence, Intention as Practitioner) of the developed scales. The participants to conduct the application were the same participants as for the development of the scales.

Design of the application

For the first application of the scales, (i.e., to test the hypothesized relations), the study followed a correlational design with three variables. For the relation of Perceived Curriculum and Perceived Competence, as well as for the relation of Perceived Curriculum and Intention as Practitioner, Perceived Curriculum was considered the predictor variable (independent variable), and Perceived Competence and Intention as Practitioner were considered the respective outcome variables (dependent variables). For the mediation, Perceived Curriculum was considered the predictor variable (independent variable), Perceived Competence was considered the mediator, and Intention as Practitioner was considered the outcome variable (dependent variable).

Analysis of the Application

To test if the proposed model (see Figure 3) demonstrated an acceptable fit to the observed data (Hypothesis 1), I conducted a CFA for the proposed model (i.e., the structural model of the developed Structural Equation Model (SEM)). In case the initial measurement model fit was not acceptable, the model was adjusted. As described by Kline et al. (2015), the structural model could only be tested if the measurement models (i.e., the CFAs of each Scale to assess factorial validity) fitted to the data. To test the hypothesized relations of the constructs and the mediation (Hypothesis 1a-1c), I evaluated the respective regressions within the SEM. Only if the structural model showed an acceptable fit to the data could the regressions and the mediation be meaningfully interpreted. As well as for the measurement models I used the conventional fit indices for the model fit. The significance of the regression estimates was assessed using a predetermined alpha level of .05.

Since multivariate normality is a major assumption associated with SEM (Donaldson, 2015), I tested the data for multivariate normality with the Mardia-skewness and the Mardia-kurtosis tests (Mardia, 1970), before conducting the analysis related to the structural model (Hypotheses 1-1c). Kenny et al. (2015) showed that the RMSEA might not be an adequate fit index for relatively simpler models with few degrees of freedom since it can wrongly assume poor model fit. Since this is the case for the tested SEM, I did not consider the RMSEA as the decisive fit index. I considered modification indices to improve the model fit by greater than 10 and evaluated modification suggestions carefully in terms of theoretical justification.

Results

In the following, the results of the scale validation process are presented, followed by the results of the first application of the scales. In total $n = 1$ participant was excluded due to missing data in Qualtrics.

Scale Development

As part of the Scale Development process, the scales are described, and the reliability and validity of the scales are assessed.

Scale Descriptions

Responses of the items were distributed across the entire scale spectrum for all the scales (*Range* = 6). Mean scores (*M*) and Standard Deviations (*SD*) for all individual items ranged from $M = 3.81$ to $M = 4.66$ for the Perceived Competence Scale, from $M = 3.95$ to $M = 4.79$ for the Perceived Curriculum Scale, and from $M = 4.53$ to $M = 4.93$ for the Intention as Practitioner Scale. The Standard Deviations (*SD*) ranged between 1.45 and 1.60 for the Perceived Competence Scale, between 1.50 and 1.72 for the Perceived Curriculum Scale, and between 1.47 and 1.60 for the Intention as Practitioner. See Table 3 for all the means and

standard deviations of the items and the total scales. These descriptive statistics indicate that the item difficulty was appropriate and that the scales differentiated appropriately between individuals (DeVellis & Thorpe, 2021). The median ranged between 4 (*neither agree nor disagree*) and 5 (*somewhat agree*) for all three scales, and the mode was 5 for all the items of all the scales. The means were only slightly higher than 4 (the scale mid-point) for most of the items. This is desirable since it shows that the scale likely detects different pronunciations of the construct (DeVellis & Thorpe, 2021). There are no items that substantially differed from the others.

Table 3

Means and Standard Deviations of the total scale and all individual items

Construct/Scale	Perceived Curriculum		Perceived Competence		Intention as Practitioner	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Total Scale	4.38	1.63	4.20	1.54	4.75	1.53
System Thinking	4.50	1.72	4.13	1.60	4.52	1.60
Anticipatory	4.03	1.70	3.87	1.60	4.49	1.54
Normative	4.52	1.54	4.42	1.50	4.87	1.49
Strategic	4.49	1.62	4.30	1.56	4.89	1.54
Interpersonal	4.79	1.58	4.66	1.49	4.93	1.49
Problem-Solving	4.63	1.50	4.32	1.45	4.92	1.48
Intrapersonal	3.95	1.61	4.12	1.51	4.80	1.51
Implementation	4.13	1.61	3.82	1.52	4.56	1.56

The graphical analysis to check normality on item level showed a slightly left-skewed distribution for all the items of all the scales. Histograms of each item can be found in

Appendix 6. The distributions of the Total Scales (see Table 3) were tested for normal distribution. The respective histograms and the Q-Q plots of the total scales pointed at a slightly left-skewed distribution for all the scales (see Figure 4). The skewness analyses supported this, indicating that the distribution was only slightly left-skewed for all the scales (see Table 4). With values only slightly above and below three, the kurtosis analyses indicated slight kurtosis (see Table 4). Consequently, the distribution can be assumed to be approximately normally distributed even though the Kolmogorov-Smirnov-Test to check for normality rejected normality for the Perceived Curriculum Scale ($D = 0.93, p < .001$), for the Perceived Competence Scale ($D = 0.93, p < .001$) and for the Intention as Practitioner Scale ($D = 0.95, p < .001$) which might be explained through the high sample size.

Figure 4

Graphical Analysis (Histograms and Q-Q Plots) of the distribution of the Perceived Curriculum, Perceived Competence, and Intention as Practitioner Scales

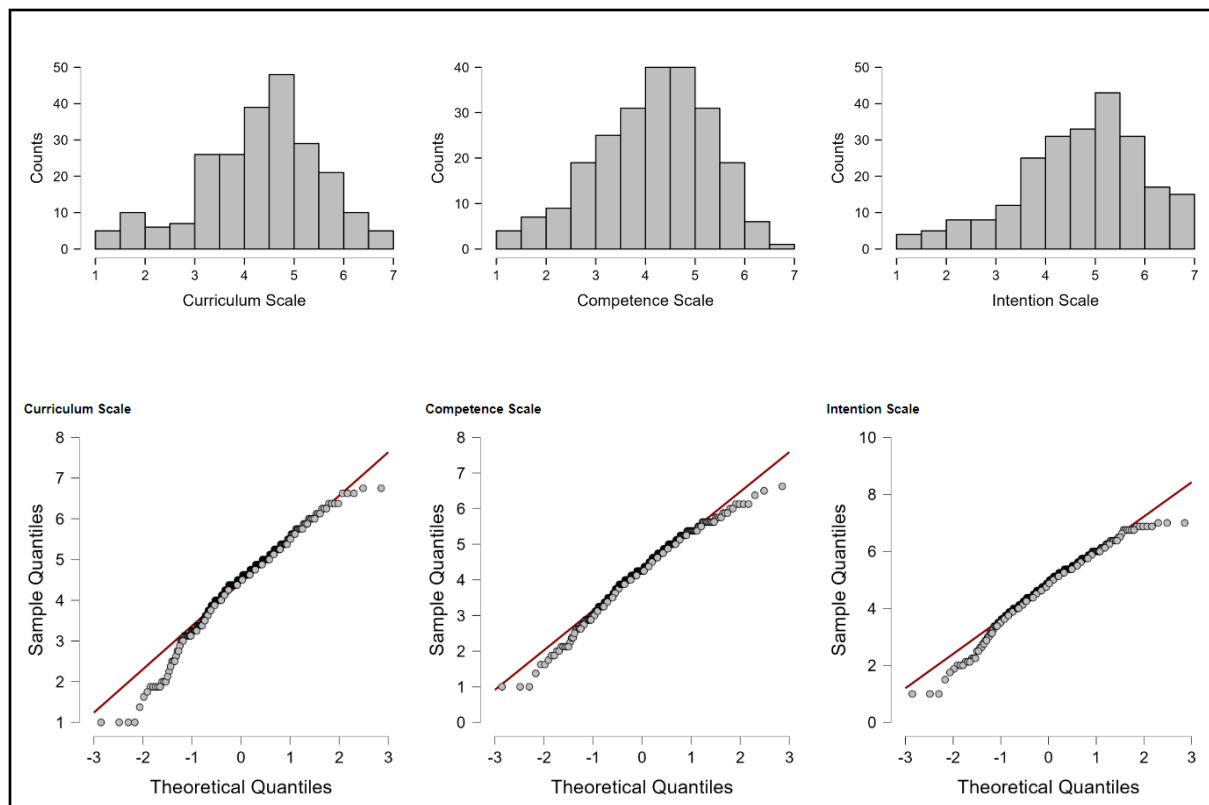


Table 4*Skewness and Kurtosis Indices for the Developed Scales*

	Skewness	Kurtosis
Perceived Curriculum	-0.58	3.20
Perceived Competence	-0.49	2.87
Intention as Practitioner	-0.60	3.13

Note. All kurtosis values are regular kurtosis values.

Reliability

The internal consistency, as an indicator of reliability, was assessed as higher than Cronbach's $\alpha = .70$ and therefore as good (e.g., Hair et al., 2010) with Cronbach's $\alpha = .89$, for the Curriculum Scale, Cronbach's $\alpha = .89$, for the Competence Scale, and Cronbach's $\alpha = .94$ for the Intention Scale (see Table 5). Additionally, the inter-item correlations were assessed to determine internal consistency and to detect potential item redundancy in more detail. The higher the correlations among items are, the higher the individual item reliability and the scale reliability are. Thus, high inter-item correlations are desirable (DeVellis & Thorpe, 2021). The inter-item correlations ranged from $r = .34$ to $r = .67$ for the Perceived Competence Scale from $r = .26$ to $r = .66$ for the Perceived Curriculum Scale, and from $r = .56$ to $r = .78$ for the Intention as Practitioner Scale, thus they were moderate to high for almost all items, indicating high internal consistency (DeVellis & Thorpe, 2021). All inter-item correlations of all scales were statistically significant with $p < .001$. The Inter-Item Correlation Matrices for Perceived Curriculum can be found in Table 6, for Perceived Competence in Table 7, and for Intention as Practitioner in Table 8. Given that high inter-item correlations are desirable since they indicate high item and scale reliability (DeVellis & Thorpe, 2021), it is noteworthy that the inter-item correlations of the Intrapersonal Competence were lower compared to all other

items, especially in the Perceived Curriculum Scale. The partly outstanding high inter-item correlations (especially in the Intention as Practitioner Scale) however, points to potential undesired redundancy among the items (Boyle, 1991; DeVellis & Thorpe, 2021).

Table 6

Inter-Item-Correlation Matrix of the Perceived Curriculum Scale

Item/ Competence	1	2	3	4	5	6	7	8
1. System Thinking	-							
2. Anticipatory	.51**	-						
3. Normative	.54**	.50**	-					
4. Strategic	.48**	.55**	.59**	-				
5. Interpersonal	.59**	.54**	.63**	.58**	-			
6. Problem Solving	.54**	.51**	.59**	.66**	.62**	-		
7. Intrapersonal	.26**	.28**	.46**	.28**	.37**	.40**	-	
8. Implementation	.51**	.56**	.55**	.61**	.49**	.59**	.31**	-

Note. All correlations were calculated with Pearson's r . ** $p < .01$.

Table 7

Inter-Item-Correlation Matrix of the Perceived Competence Scale

Item/ Competence	1	2	3	4	5	6	7	8
1. System Thinking	-							
2. Anticipatory	.58**	-						
3. Normative	.50**	.52**	-					
4. Strategic	.55**	.55**	.57**	-				
5. Interpersonal	.52**	.56**	.59**	.58**	-			

6. Problem Solving	.48**	.53**	.59**	.67**	.52**	-		
7. Intrapersonal	.34**	.38**	.40**	.40**	.47**	.41**	-	
8. Implementation	.49**	.56**	.47**	.56**	.41**	.58**	.35**	-

Note. All correlations were calculated with Pearson's r . ** $p < .01$.

Table 8

Inter-Item-Correlation Matrix of the Intention as Practitioner Scale

Item/ Competence	1	2	3	4	5	6	7	8
1. System Thinking	-							
2. Anticipatory	.69**	-						
3. Normative	.64**	.64**	-					
4. Strategic	.69**	.72**	.67**	-				
5. Interpersonal	.67**	.67**	.70**	.78**	-			
6. Problem Solving	.70**	.67**	.69**	.76**	.74**	-		
7. Intrapersonal	.56**	.59**	.56**	.58**	.64**	.64**	-	
8. Implementation	.65**	.69**	.67**	.72**	.73**	.73**	.57**	-

Note. All correlations were calculated with Pearson's r . ** $p < .01$.

The reliability of the scales could not be significantly improved by omitting specific items since the internal consistency if a specific item was omitted, ranged between $\alpha = .87$ to $\alpha = .89$ for the Perceived Competence Scale, between $\alpha = .87$ to $\alpha = .90$ for the Perceived Curriculum and between $\alpha = .93$ to $\alpha = .94$ for the Intention as Practitioner Scale, see Table 5. In the Perceived Curriculum Scale a slight improvement of the reliability from $\alpha = .89$ to $\alpha = .90$ was possible if the item measuring the Intrapersonal Competence was omitted. Overall, this further indicates high internal consistency for all the scales.

These findings of high internal consistency were also reflected in the high corrected item-total correlations. Corrected Item-Total correlations ranged from $r = .50$ to $r = .74$ for the Perceived Competence Scale, from $r = .42$ to $r = .75$ for the Perceived Curriculum Scale, and from $r = .68$ to $r = .84$ for the Intention as Practitioner Scale (see Table 5). This additionally indicated that the items' discriminatory power (i.e., the item's ability to differentiate between individuals) was moderate to high for almost all items and that almost all items were strongly associated with their respective underlying constructs.

Table 5

Cronbach's α of the total scales, Cronbach's α if specific items are omitted, and the item-to-total correlation for each item of each scale.

Construct/ Scale	Perceived Curriculum		Perceived Competence		Intention as Practitioner	
Total Scale	Cronbach's $\alpha = .89$, CI [.87, .91]		Cronbach's $\alpha = .89$, CI [.87, .91]		Cronbach's $\alpha = .94$, CI [.93, .95]	
	α if item omitted	r Item-Total	α if item omitted	r Item-Total	α if item omitted	r Item-Total
System Thinking	.88	.64	.88	.65	.94	.77
Anticipatory	.88	.65	.87	.70	.93	.79
Normative	.87	.73	.88	.69	.94	.77
Strategic	.87	.71	.87	.74	.93	.83
Interpersonal	.87	.73	.87	.69	.93	.84
Problem-Solving	.87	.75	.87	.71	.93	.84
Intrapersonal	.90	.42	.89	.50	.94	.68
Implementation	.87	.68	.88	.65	.93	.80

Note. CI = 95 % Confidence Interval [Lower Limit, Upper Limit], the Item-Total correlations are corrected and calculated with Pearson's r .

Validity

Quality Checks on factor loadings were assessed as indicators of construct validity. Factor Loadings of each item on the respective scale indicated that there was a substantial relationship between the indicators and the respective latent variable. All relationships were positive and significant with $p < .001$. The factor loadings ranged from .55 to .80 for the Perceived Competence Scale, from .46 to .81 for the Perceived Curriculum Scale, and from .72 to .89 for the Intention as Practitioner Scale. This indicated substantial relationships between the indicators and the respective latent variables, therefore indicating high construct validity and pointing at factorial validity. See Table 9 for all factor loadings of all items and the respective Confidence Intervals.

Table 9

Quality Check on Factor Loadings for all the items of the proposed scales

Construct/Scale	Perceived Curriculum			Perceived Competence			Intention as Practitioner		
	Factor Loading	95% CI		Factor Loading	95% CI		Factor Loading	95% CI	
		LL	UL		LL	UL		LL	UL
System Thinking	.74***	.68	.80	.71***	.71	.77	.83***	.79	.87
Anticipatory	.74***	.69	.80	.78***	.78	.83	.83***	.79	.87
Normative	.80***	.74	.85	.77***	.71	.82	.82***	.77	.86
Strategic	.80***	.75	.85	.80***	.75	.84	.89***	.87	.92
Interpersonal	.80***	.75	.85	.85***	.70	.81	.89***	.86	.92
Problem Solving	.81***	.77	.86	.80***	.75	.85	.89***	.86	.92
Intrapersonal	.46***	.37	.55	.55***	.46	.64	.73***	.67	.79
Implementation	.76***	.70	.81	.73***	.67	.78	.85***	.82	.89

Note. CI = Confidence Interval, LL = Lower Limit, UL = Upper Limit, *** indicates $p < .001$.

To further determine factorial validity, as part of construct validity, CFAs were conducted for each of the scales separately. All CFAs demonstrated a good fit to the data according to conventional cut-off criteria (Hu & Bentler, 1995). The CFA for Perceived Competence demonstrated a good fit to the data with $\chi^2 = 46.29$ ($df = 20, p < .001$), CFI = 0.976, TLI = 0.966, RMSEA = 0.066, and SRMR = 0.036. This was also the case for the CFA of the Perceived Curriculum Scale that demonstrated a good fit to the data with $\chi^2 = 46.40$ ($df = 20, p < .001$), CFI = 0.978, TLI = 0.970, RMSEA = 0.063, and SRMR = 0.037. I rejected suggested model improvements by allowing covariance between Interpersonal and Implementation competence for both scales due to a lack of theoretical justification. The CFA for the Intention as Practitioner Scale also demonstrated a good fit to the data with $\chi^2 = 24.87$ ($df = 20, p = 0.207$), already indicating a non-significant difference between the data and the model. Fit indices supported this with CFI = 1.00, TLI = 1.00, RMSEA = 0.00, and SRMR = 0.017. Thus, factorial validity was confirmed for all three scales, with strong evidence of the proposed factorial structure based on the factor loadings and the CFAs. High content validity regarding the key competencies that were operationalized can be assumed due to the extensive examination of existing models and their respective key competencies in ESD and the decision to use the model of Brundiers et al. (2021) as the theoretical framework.

Application of the Scales

In addition to the validation of the scales, these were first applied in the field, by analyzing the interrelations of the constructs of the developed scales. This included testing the proposed structural model with three distinct factors (Hypothesis 1) and testing the hypothesized interrelations and the respective mediation model (Hypotheses 1a-1c).

Assumption Verification

To test the model for multivariate normality as a condition for conducting the CFA and the correlation analyses, I conducted the Mardia-skewness and the Mardia-kurtosis tests (Mardia, 1970). The null hypothesis was rejected with $p < .001$, indicating no multivariate normality and the violation of the assumption (see Appendix 7 for the respective Q-Q Plot). Consequently, I chose the maximum likelihood estimation method with robust standard errors and a test statistic corrected according to the formula of Satorra and Bentler (2001) to test the structural model (Rosseel, 2012). Not assuming normality, I used Spearman's coefficient to calculate the correlations (Caruso & Cliff, 1997).

Model Fit

The initial CFA, including the three latent variables, demonstrated a poor fit to the data, with $\chi^2 = 1410.392$ ($df = 249$, $p < .001$), CFI = 0.760, TLI = 0.733, RMSEA = 0.138, and SRMR = 0.075. After careful examination of the modification indices, I included covariances between all the items in the model, that were derived from the same underlying competence by Brundiers et al. (2021). The revised CFA model demonstrated an improved and acceptable fit to the data, as evidenced by $\chi^2 = 343.514$ ($df = 225$, $p < .001$), CFI = 0.989, TLI = 0.986, RMSEA = 0.031, and SRMR = 0.055.

The structural model fit is tested using the revised model. Since the model was a saturated model, the χ^2 -test and the fit indices were identical to the respective measurement model ($\chi^2 = 343.514$ ($df = 225$, $p < .001$), CFI = 0.989, TLI = 0.986, RMSEA = 0.031, and SRMR = 0.055). Thus, I assumed an acceptable fit to the data for the developed full structural equation model, including the measurement as well as the structural model. These findings confirmed Hypothesis 1 since the fit indices indicated that the proposed model with three competence-related factors demonstrated an acceptable fit to the observed data.

Hypothesized Relations

Given the acceptable model fit, I interpreted the hypothesized relationships (Hypotheses 1a-1c). Perceived Curriculum was positively associated with Perceived Competence ($\beta = 0.88, p < .001$), supporting the prediction that the higher the perceived curriculum is, the higher the individuals' perceived ESD-related competencies are (Hypothesis 1a). Perceived Curriculum was additionally positively associated with Intention as Practitioner ($\beta = 0.40, p = .009$), supporting the prediction that the higher the perceived curriculum is, the higher the intention to work with ESD-related competencies is (Hypothesis 1b). With $\beta = 0.12$ ($p = .459$) no association between Perceived Competence and Intention as Practitioner was found. Thus, contrary to Hypothesis 1c, the predicted mediation was rejected (see Table 10 for the respective standardized regression coefficients).

An R^2 of .78 for Perceived Competence and an R^2 of .26 for Intention as Practitioner indicated that 78% of the variance in Perceived Competence was explained by the model and 26% of the variance in Intention as Practitioner was explained by the model.

Table 10

Regression Analysis of the Relations of the Latent Constructs

Outcome Variable: Perceived Competence				
Predictors	<i>B</i>	<i>SE</i>	<i>z</i>	<i>p</i>
Perceived Curriculum	.88	.07	11.91	< .000
Outcome Variable: Intention as Practitioner				
Predictors	<i>B</i>	<i>SE</i>	<i>z</i>	<i>p</i>
Perceived Curriculum	.40	.16	2.61	.009
Perceived Competence	.12	.18	.74	.456

Note. R^2 of Perceived Competence = .78, R^2 of Intention as Practitioner = .26

Discussion

The main purpose of this study was to develop reliable and valid scales to measure Perceived Curriculum, Perceived Competence, and Intention as Practitioner in the domain of ESD to advance the field by better assessing these components of ESD. Additionally, a first application of the developed scales was conducted – showing the applicability of the scale and analyzing the relation between the three constructs of the developed scales.

The Item and Scale Analyses of the developed scales showed that the three scales are reliable and valid tools to capture students' Perceived Curriculum, Perceived Competence, and Intention as Practitioner in the domain of ESD at HEI. This was supported by high reliability measures (e.g., Cronbach's Alpha) and high construct validity and in particular factorial validity (e.g., Quality Check on Factor Loadings and CFAs) for all three scales. However, item analyses indicated that there might be some redundancy among the items, especially in the Intention as Practitioner Scale. Using the strong theoretical framework of ESD competencies by Brundiers et al. (2021) and its respective key competencies as the conceptual basis for the scale development, further contributed to the content validity regarding the competencies that were operationalized throughout the development of the scales.

Regarding the application of the scales, the oftentimes suspected but never empirically shown (UNESCO, 2020; Kohl et al., 2022) predicted positive relations between Perceived Curriculum and Perceived Competence as well as Perceived Curriculum and Intention as Practitioner in the domain of ESD could empirically be shown. However, the predicted positive relation of Perceived Competence and Intention as Practitioner was not found, thus the predicted mediation (i.e., Perceived Curriculum mediates the relation of Perceived Curriculum and Intention as Practitioner) was rejected. Even though the correlational study design does not allow drawing causal conclusions, the results point to a likely positive causal link between Perceived Curriculum and Perceived Competence in this specific ESD context.

The rejected mediation combined with the positive relation of Perceived Curriculum and Intention as Practitioner point to a likely causal link between Perceived Curriculum and Intention as Practitioner that, however, might be mediated through other constructs than only Perceived Competence itself.

Implications

The high reliability and validity of the developed scales show that the self-assessment scales on ESD-related competencies based on the ESD-competence model of Brundiers et al. (2021) can contribute to better and more precisely assess students' Perceived Competence, Perceived Curriculum, and Intention as Practitioner in the domain of ESD. Thus, the findings indicate that the developed scales are a strong tool to advance the field of ESD. The fact that the measurement models of each scale and the structural model (CFAs for each scale and the whole model) fitted the data well, supports the strength of the tool and empirically supports the strength of the model of Brundiers et al. (2021). The potential redundancy in the items could indicate that the items to operationalize the competencies were formulated too generally.

The Intrapersonal Competence differed from the other items in terms of inter-item and item-scale correlation in all the scales (e.g., noteworthy lower inter-item correlations ($< .30$) as compared to all other competencies). This indicates that this newly added competence in the model of Brundiers et al. (2021) as compared to the model of Wiek et al. (2011) needs further investigation conceptually and regarding its operationalization.

The successful application of the scales (i.e., analyzing the interrelations of the three constructs) highlights the practicability and usefulness of the scale in the field of ESD beyond its statistical quality criteria. The confirmed positive relation between Perceived Curriculum and Perceived Competence indicates that the scales can measure the success of curriculum interventions on competence transfer. This supports the evaluation that the developed scales

are strong tools to improve current and future interventions in the domain of ESD by further assessing a) the implementation of ESD in Curricula and b) the competence transfer of ESD among students. The rejected mediation, i.e., the rejected association between Perceived Competence and Intention as Practitioner is noteworthy given the aim of achieving all SDGs through mainstreaming ESD into HEI (UNESCO, 2020; Kohl et al., 2022). Given that positive associations between competencies and respective intentions were empirically found in other contexts (e.g., Entrepreneurship Education; Thomas, 2023; Liñán, 2008; Fretschner & Weber, 2013), this relation should get more attention in ESD, especially when designing new interventions that aim at increasing competencies and intentions in the domain of ESD or even aim at increasing the intention to work with ESD-related competencies through increasing respective competencies.

Limitations

While the developed scales show to be strong tools to measure the respective ESD-related construct and its application in the field was successful, the scale development and its application exhibit some limitations.

Scale Development

Even though self-assessment is considered appropriate to assess ESD-related constructs (Redman et al., 2021) as with all self-assessments, the items can easily be interpreted inconsistently (Migliorini & Lieblein, 2016). In the domain of competencies, this is complemented by the fact that students might not be able to assess competencies they never applied or experienced (Holdsworth et al., 2018).

While the main steps of scale development according to DeVellis & Thorpe (2021) were conducted to develop and test the Perceived Curriculum, Perceived Competence, and Intention as Practitioner Scale, I did not conduct cognitive interviews. Thus, the items were not evaluated by experts. Also, I did not include items of similar or distinct constructs for the

purpose of scale validation, thus convergent validity must yet be assessed. I decided a priori that only one item for each competence was generated. Consequently, no optimization of scale length took place. This might explain why the item and scale analyses indicated potential redundancy among the items. Moreover, the scale was by now only administered to one sample, thus test-retest reliability must additionally be assessed. Additionally, some of the items tend to cover multiple aspects at the same time, being a consequence of only developing one item of each key competence captured by the scale. This potential lack of clarity in the items can create ambiguity for participants regarding what to answer (Bishop & Heron, 2015). This could partly explain the high midpoint response rate.

The Intention as Practitioner Scale needs further conceptual considerations even though it shows to be a strong scale from a statistical perspective. It should be critically reflected on how well the intention to work in a complex field like sustainable transformation is reflected only by the intention to apply specific competencies. Existing studies focusing on the conceptualization of sustainable entrepreneurship intentions (e.g., Vuorio et al., 2018) could be used as a starting point to further address this topic.

Baggen et al. (2017) criticize that competence measurements are oftentimes not aligned with objective measurements like course programs. Thomas (2023) and Kraaijenbrink et al. (2010) however, point out the strength of assessing the *Perceived Curriculum*, since this more appropriately captures the actual curriculum. The fact that I used this self-assessment approach only, can be considered a limitation since including the actual curriculum would be a valuable complementary source to assess the curriculum.

Scale Application

As with all correlational designs the analyzed relations of the model don't allow the conclusion of causal paths. However, given theoretical considerations and existing literature

(e.g., Thomas et al., 2023) causality is assessed as likely for the empirically confirmed associations. Additionally, I did not conduct model comparisons to compare the goodness of fit of the proposed three-factor model to potential other (better fitting) solutions. This means that even though the fit indices indicated an acceptable fit to the proposed model other better-fitting solutions might exist.

Sample

A sample of $N = 300$ participants was aimed for, however, only $N = 232$ participants were reached. Given that all the CFAs could be computed, and the statistical analyses indicated the developed scales to be reliable and valid, this limitation is considered minor. The fact that most of the participants were students from Leuphana University however can lead to distortion and thus presents a limitation. Since Leuphana University generally focuses on sustainability in its curricula and might attract students who want to engage in sustainability (e.g., Michelsen, 2013), the sample from Leuphana University is likely to be more familiar with sustainability compared to the whole student population. This could lead to distortion in all three constructs of interest, increasing the Perceived Curriculum, the Perceived Competence, and the Intention as Practitioner scales. Thus, the data of this study could indicate that the scales are suitable to measure the constructs of interest while showing floor effects for the whole population.

Future Research

Future Research can build on the presented findings by applying and further validating the scales as well as more intensively investigating the interrelations of the proposed scales. Additionally, influencing factors on the intention to engage in sustainable transformation can be investigated on, using the developed scales as a starting point.

Future Use of the Scale

The scales can be used as a process indicator to capture developments of the Curriculum, Competencies, and Intentions in the domain of ESD at different levels (e.g., institutions, study programs, courses, and individuals) and to evaluate the success of specific interventions throughout time. Additionally, the scales can assess the status quo of the implementation of ESD in the curricula and the extent to which students perceive they already have specific competencies and intend to use them. In this context, university or study program comparisons are a meaningful application. Thus, the scales are equally helpful tools for researchers, practitioners, and teaching staff at HEI.

Future research can additionally use the scales to compare the impact of different approaches to include ESD competencies in Higher Education for example 1) developing study programs that deal with sustainable transformation in depth (e.g., Transformation or Sustainability Sciences) and 2) implementing ESD into all curricula, regardless of the subject. In this regard, it seems especially useful to compare to what extent these two approaches lead (or do not lead) to the intention of students to work in sustainable transformation, since this is the political aim and societal necessity of these approaches to develop Higher Education (Michelsen, 2015; Holst et al., 2020, Kohl et al., 2022).

Further Improve the Quality of the Scales

To further improve the quality of the developed scales, students from different disciplines and different universities should answer the developed scales to ensure that the scales are suitable across different samples. The scales can additionally be further developed by creating a bigger initial item pool and making them subject to the complete process of scale development proposed by DeVellis & Thorpe (2021). This way, the developed tool would become even more accurate in assessing the constructs of interest. Additionally, the convergent validity of the developed scales could be assessed in future research by

determining to what extent similar (as well as distinct) constructs relate to the developed scales themselves.

The distinction between reflective and formative measurements is a fundamental issue regarding measurement models (e.g., Diamantopoulos et al., 2018; Jarvis et al., 2003). Reflective measures assume that the observed indicators are caused by the underlying latent construct, while formative measures claim that the latent construct is created by the observed indicators. Thus, the assumption of reflectivity should be critically reflected in further research, especially regarding the Perceived Curriculum. A curriculum that is composed of theoretically derived components that altogether “create” the ESD-based curriculum, like an index, could be assumed. This would mean the construct was formative. Since it is the perception of this curriculum that is being measured, and the items are based on a competence model that assesses reflective competencies, I assumed reflectivity. Future research could also complement these theoretical rationales by measurement-theoretical approaches to differentiate between scale and index like dividing the sample into two subsamples and separately factor analyzing them (e.g., as proposed by DeVellis & Thorpe, 2021).

Further Investigate the Relations of the Proposed Constructs

Given that assessing predictors of the intentions of students to engage in sustainable transformation can increase the impact of many ESD-related interventions (Kohl et al., 2022; UNESCO, 2020), and given the rejected mediation model, the relationship between Perceived Competence and Intention as Practitioner needs further investigation. This includes the underlying mechanisms that could influence the proposed relation. Among them are reactance (i.e., students that feel they must deal with sustainability showing reactance; Brehm, 1966), climate anxiety (i.e., paralyzing forms of eco-anxiety; Pihkala, 2020), and increased intention due to increased behavior control (Ajzen, 1991) as empirically shown by Liñán (2008).

Conclusion

ESD at HEI aims to enable students with the capabilities to co-create a sustainable future for all and is considered a prerequisite to achieve the implementation of the SDGs (Holst et al., 2020; Kohl et al., 2022). However, strong tools to measure relevant components of ESD are lacking (Redman et al., 2021). Thus, this study set out to develop Scales in ESD at HEI that cover the Perceived Curriculum, the Perceived Competence and the Intention as Practitioner. The developed scales show to be strong tools to assess the current state of mainstreaming ESD into the curricula (Perceived Curriculum), to evaluate the success of ESD-related competence transfer among students (Perceived Competence), and to assess to what extent students intend to engage in sustainable transformations as Practitioners (Intention as Practitioner). The strength of the scales is supported by statistical indicators that indicated high reliability and validity and the strong conceptual basis of the scales (i.e., the ESD model of Brundiers et al., 2021). A first successful application of the scales showed a positive relation between Perceived Curriculum and Perceived Competence as well as a positive relation between Perceived Curriculum and Intention as Practitioner in ESD, demonstrating the applicability of the scales in the field. These results show that the scales can support researchers, practitioners, and policymakers in evaluating and improving ESD-related interventions. By further developing and broadly applying the developed tools in the field of ESD, the current state of mainstreaming ESD can be better assessed and respective interventions can be improved, thus acknowledging the responsibilities of HEI due to the enormous leverage effects Higher Education has (Barth & Rieckmann, 2016; Wals, 2014). Consequently, the broad application of the developed tools allows to improve interventions in ESD that strive for nothing less but empowering students to become change agents and to shape sustainable futures, thus contributing to SDG 4.7 (UNESCO, 2020; Kohl et al., 2022).

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Appendix

Appendix 1

Paraphrasing of the Key Competencies

Paraphrased key competencies derived from the definition of the key competencies of Wiek et al. (2011) and Brundiens et al. (2021)

Competence	Definition	Paraphrased definitions, focusing on the essential aspects	Derived from
Systems-Thinking	“Ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks.”	Analyzing Sustainability related issues in different sustainability domains and across different geographical scales.	Wiek et al. (2011)
Anticipatory	“Ability to collectively analyze, evaluate, and craft rich “pictures” of the future related to sustainability issues and sustainability problem-solving frameworks.”	Creating sustainable scenarios while considering different time scopes.	Wiek et al. (2011)
Normative	“Ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets.”	Considering and applying values in sustainability action and planning.	Wiek et al. (2011)
Strategic	“Ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability.”	Coming up with and successfully implementing sustainability related interventions.	Wiek et al. (2011)

Interpersonal	“Ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving.”	Being able to work together with others to drive forward sustainable solutions.	Wiek et al. (2011)
Integrated Problem-Solving	Ability “to apply different problem-solving frameworks to complex sustainability problems and develop viable solution options” in order to “meaningfully integrate problem analysis, sustainability assessment, visioning and strategy building.”	Being able to solve sustainability related problems by creating viable solutions.	Wiek et al. (2015), Brundiars et al. (2021)
Intrapersonal	“The ability to reflect on one’s own role in the local community and (global) society; to continually evaluate and further motivate one’s actions; and to deal with one’s feelings and desires (UNESCO, 2017).”	Dealing with feelings and emotions related to sustainability in a broader societal context	Brundiars et al. (2021)
Implementation	“Collective ability to realize a planned solution toward a sustainability-informed vision, to monitor and evaluate the realization process, and to address emerging challenges (adjustments), recognizing that sustainability problem solving is a long-term, iterative process between planning, realization, and evaluation.”	Implementing sustainability related action plans and adapting them throughout the process when necessary	Brundiars et al. (2021)

Appendix 2

Initial Item Pool

All items of the initial item pool of the proposed scales

Competence	Perceived Curriculum: My Study program covers...	Perceived Competencies: I feel able to...	Intention as practitioner: I envision myself
Systems-Thinking	How to analyze sustainability related phenomenon within my field of study considering different domains (society, environment, economy) and different scales (e.g., global to local)	Analyze sustainability related phenomenon within my field of study by considering different domains (society, environment, economy) and different scales (e.g., global to local)	Analyzing sustainability related phenomenon within my field of study by considering different domains (society, environment, economy) and different scales (e.g., global to local).
Anticipatory	How the past the present and potential futures relate to each other when dealing with sustainability related issues	To relate the past the present and potential futures to each other when dealing with sustainability related issues.	Considering the past the present and potential futures of sustainability related issues and relating them to each other.
Normative	How to assess the (un)sustainability of current and future states that hinder or promote just and sustainable futures.	Assess the (un)sustainability of current and future states that hinder or promote just and sustainable futures.	Assessing the (un)sustainability of current and future states that might hinder or promote just and sustainable futures.
Strategic	How to depict promising ideas that lead to sustainability and how to implement them by creating and following a respective action plan	Depict promising ideas that lead to sustainability and implement them by creating and following a respective action plan	Depicting promising ideas that lead to sustainability and implement them by creating and following a respective action plan
Interpersonal	How to work together with others to solve	Work together with others to promote	Working together with others to promote

	sustainability related problems	sustainability related problems	sustainability related problems
Problem Solving	How to choose and apply strategies that allow to recognize and solve sustainability related problems	Choose and apply strategies that allow to recognize and solve sustainability related problems.	Choosing and applying strategies that allow to recognize and solve sustainability related problems
Intrapersonal	How to cope with my personal the emotions and affections related to sustainability issues	Cope with my personal emotions and affections related to sustainability issues	Having the necessity to cope with my personal emotions and affections related to sustainability issues
Implementation	How to proactively implement interventions that lead to more sustainability	Proactively implement interventions that lead to more sustainability	Proactively implementing interventions that lead to more sustainability

Appendix 3

Revised Item Pool (used for the pre-test)

All items of the revised item pool

Competence	Perceived Curricula: My study program covers...	Perceived Competencies: (When thinking of what I have learnt in my study program so far.) I am able to:	Intended Behavior as practitioner: When becoming a practitioner after my studies, I envision myself
System Thinking	How to analyze sustainability issues considering different domains (society, environment, and economy) and different scales (global to local).	analyze sustainability issues considering different domains (society, environment, and economy) and different scales (global to local).	analyzing sustainability issues considering different domains (society, environment, and economy) and different scales (global to local).
Anticipatory	How to consider the past, the present, and the future when dealing with sustainability related issues.	consider the past, the present, and the future when dealing with sustainability related issues.	considering the past, the present, and the future when dealing with sustainability related issues.
Normative	How to consider and apply values, when dealing with sustainability related issues	consider and apply values, when dealing with sustainability related issues.	considering and applying values, when dealing with sustainability related issues.
Strategic	How to come up with and implement sustainability-related ideas, considering given circumstances.	come up with and implement sustainability-related ideas, considering given circumstances.	coming up and implementing sustainability-related ideas, considering given circumstances.
Interpersonal	How to work together with others to solve sustainability-related problems.	work together with others to solve sustainability-related problems.	working together with others to solve sustainability-related problems.
Problem Solving	how to apply knowledge and select	apply knowledge and select strategies that	I envision myself applying knowledge and selecting

	strategies that allow me to solve sustainability-related problems.	allow me to solve sustainability-related problems.	strategies that allow me to solve sustainability-related problems.
Intrapersonal	how to cope with my personal feelings about sustainability related issues.	cope with my personal feelings about sustainability related issues.	having to cope with my personal emotions and affections related to sustainability issues.
Implementation	how to implement a sustainability related intervention and adapt it when necessary.	implement a sustainability related intervention and adapt it when necessary.	implementing sustainability related interventions and adapt them when necessary.

Appendix 4

Descriptives of the Pretest

Evaluation of the Perceived Curriculum Scale

Competence	<i>N</i>	<i>M</i>	<i>SD</i>	Min	Max
System Thinking	8	6.13	1.26	4	7
Anticipatory	9	5.56	1.42	3	7
Normative	8	5.50	1.31	3	7
Strategic	9	6.00	1.00	4	7
Interpersonal	8	6.36	0.74	5	7
Problem Solving	9	5.56	1.59	3	7
Intrapersonal	8	5.88	1.36	3	7
Implementation	9	5.67	1.73	2	7

Note. The question being asked was: *The question above was clear to me and I knew what to answer* on A Likert scale ranging from 1 to 7 (strongly disagree to strongly agree).

Evaluation of the Perceived Competence Scale

Competence	<i>N</i>	<i>M</i>	<i>SD</i>	Min	Max
System Thinking	8	6.50	0.54	6	7
Anticipatory	9	5.67	1.41	3	7
Normative	8	5.75	1.28	3	7
Strategic	9	6.00	1.00	4	7
Interpersonal	8	6.36	0.74	5	7
Problem Solving	9	6.33	0.71	5	7
Intrapersonal	8	5.75	1.39	3	7
Implementation	9	5.67	1.67	2	7

Note. The question being asked was: *The question above was clear to me and I knew what to answer* on A Likert scale ranging from 1 to 7 (strongly disagree to strongly agree).

Evaluation Intention as Practitioner Scale

Competence	<i>N</i>	<i>M</i>	<i>SD</i>	Min	Max
System Thinking	8	6.13	0.84	5	7
Anticipatory	9	5.33	1.66	3	7
Normative	8	5.63	1.30	3	7
Strategic	9	6.11	1.05	4	7
Interpersonal	8	6.25	0.71	5	7
Problem Solving	9	6.00	1.66	2	7
Intrapersonal	8	5.63	1.60	2	7
Implementation	9	5.89	1.17	4	7

Note. The question being asked was: *The question above was clear to me and I knew what to answer* on A Likert scale ranging from 1 to 7 (strongly disagree to strongly agree).

Appendix 5

Detailed Study Description, embedded in Qualtrics

Ethic Code: PSY-2223-S0246

Welcome to this Research project about competencies in the domain of sustainable Development! We are interested in your perception of your study program and your competencies in the domain of sustainable development.

It doesn't matter whether you think you know a lot about sustainable development or not! You can participate regardless of your study program, even if you feel that your study program is not linked to sustainability.

Involved researchers are Jorin Meyer and Dr. Gabriel Muinos from the University of Groningen and Prof. Alexander Freund from the Leuphana University of Lüneburg. Please note that you can only participate in this study if you are a student.

Do I have to participate in this research?

Participation in the research is voluntary. However, your consent is needed. Therefore, please read this information carefully. If you have any questions during the completion of the questionnaire, you can contact us by email at j.h.meyer.1@student.rug.nl

Only afterwards do you decide whether you want to participate. If you decide not to participate, you do not need to explain why, and there will be no negative consequences for you. You have this right at all times, including after you have consented to participate in the research.

What do we ask of you during the research?

We are interested in your perception to what extent your study program covers specific competencies linked to sustainable development. Additionally, we ask you to assess your perceived competencies and to which extent you envision yourself using specific competencies in the domain of sustainable development once you finished your studies. Please note that there are no right or wrong answers.

We also ask for some personal information to establish which students participated in this research. The entire questionnaire takes **a maximum of 30 minutes to complete.**

You can get 0,5 Versuchspersonenstunden (30 Minutes) if you participate through SONA System.

Participation is completely voluntary and strictly **confidential**. You can stop anytime by not (continuing) filling in the survey.

How will we treat your data?

No personal data can be traced back to you as a person throughout this study. This means you will no longer be able to ask for access to your data, or to withdraw your data from the study once you finalized the questionnaire. The survey data will be archived at secure servers for the length of 10 years conform to the University of Groningen guidelines. Only the University of Groningen research team (Dr. Gabriel Muinos Trujillo), and the master's student (Jorin Meyer) at the University of Groningen will have access to your data. Fully anonymized data and aggregated results will be made publicly available.

What else do you need to know?

You may always ask questions about the research: now, during the research, and after the end of the research. You can do so by emailing (g.muinos@rug.nl) or phoning ([+31 50 36 35329](tel:+31503635329)) one of the researchers involved.

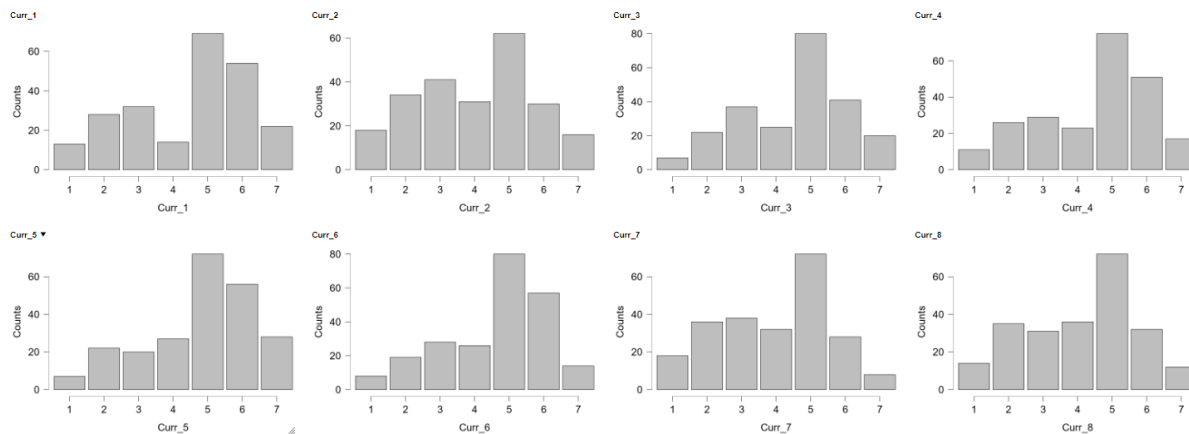
Do you have questions/concerns about your rights as a research participant or about the conduct of the research? You may also contact the Ethics Committee of the Faculty of Behavioural and Social Sciences of the University of Groningen: ec-bss@rug.nl.

Please continue to start with the survey.

Appendix 6

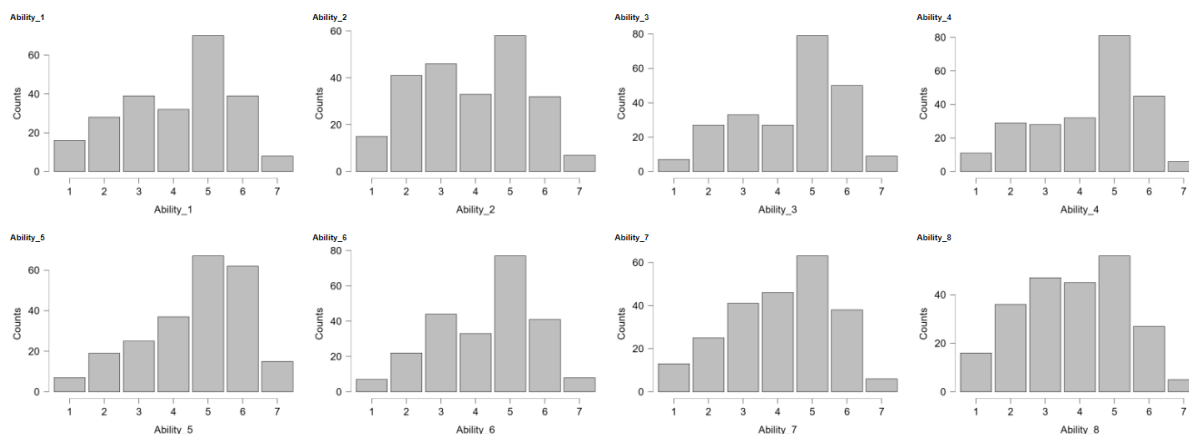
Histograms of the Items of the Developed Scales

Perceived Curriculum Scale



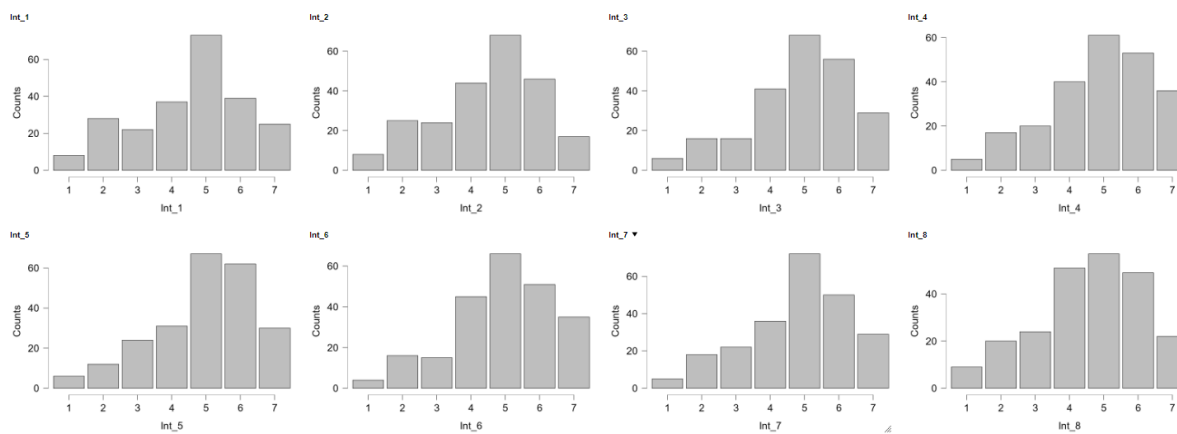
Note. Curr_ 1 = System Thinking Competence, Curr_2 = Anticipatory Competence, Curr_3 = Normative Competence, Curr_4 = Strategic Competence, Curr_5 = Interpersonal Competence, Curr_6 = Problem Solving Competence, Curr_7 = Intrapersonal Competence, Curr_8 = Implementation Competence.

Perceived Competence Scale



Note. Ability_1 = System Thinking Competence, Ability_2 = Anticipatory Competence, Ability_3 = Normative Competence, Ability_4 = Strategic Competence, Ability_5 = Interpersonal Competence, Ability_6 = Problem Solving Competence, Ability_7 = Intrapersonal Competence, Ability_8 = Implementation Competence.

Intention as Practitioner Scale



Note. Int_1 = System Thinking Competence, Int_2 = Anticipatory Competence, Int_3 = Normative Competence, Int_4 = Strategic Competence, Int_5 = Interpersonal Competence, Int_6 = Problem Solving Competence, Int_7 = Intrapersonal Competence, Int_8 = Implementation Competence.

Appendix 7

Multivariate Normality

Normal Q-Q Plot of the rejected Multivariate Normality

