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Meaning-making in higher education for sustainable development: Undergraduates` long-term processes of experiencing and learning

Abstract

Despite the increase in teaching approaches designed to integrate sustainability into higher education, the connection between students' learning experiences and their learning outcomes remains incompletely understood. The present multi-case study complements the discussion by investigating undergraduates' long-term meaning-making processes using the theoretical lens of significant learning and process analysis of students' learning experience. Based on in-depth narrative interviews with 10 students at the end of a three-year study program, we analyzed how and why learning experiences become significant, differentiating perceived personal impact and the subjective value assigned to these experiences. We identified three types of sustainability-related meaning-making processes, ranging from *no sustainability-related meaning-making* to *meaning-making as self-realization*. The differentiated view on how meaning-making mediates students' sustainability-related learning experiences and their learning outcomes enhances our understanding of the specific dynamics that may shape the how and why of significant learning. It thus supports the tailored curriculum design for integrating sustainability into higher education.

Key words

Significant learning, higher education for sustainable development, meaning-making, narrative interviews, process analysis, learning experiences

1. Introduction

Higher education for sustainable development (HESD) aims to support students' competence development to become future change agents who can critically and responsibly contribute to a more sustainable society. Educators design learning opportunities in higher education for students to gain awareness of sustainability-related challenges and to develop sustainability competencies (Jones, Selby, and Sterling 2010). At the same time, these formal learning opportunities (curriculum-as-planned) pair with informal ones, forming an experiential space (curriculum-as-lived) where students` learning experiences cannot be fully predicted (Aoki 1993).
The curriculum-as-lived allows students to have intended and unintended learning experiences learning opportunities do not necessarily result in anticipated learning outcomes (Lundholm, Hopwood, and Rickinson 2013). Consequently, it seems crucial to uncover whether students learn and how the impact of sustainability-related learning experiences is perceived and why students assign subjective value to their experiences. In the context of this work, we denote these processes as meaning-making—the way of interpreting learning experiences (Mezirow 1997). Learning experiences shape these meaning-making processes, and these meanings, in turn, shape what we perceive as significant and what we ultimately learn (Heimlich, Mony, and Yocco 2013). In addition, we base our research on the assumption that certain sustainability-related learning experiences may be perceived more significant than others and that individuals vary in their responses to identical sustainability-related learning opportunities (Merriam and Clark 1993). Understanding the human patterns of subjectivity can play an important role in developing context-specific and significant ways of integrating sustainability into curricula and study programs (Bruhn 2021). This multi-case study aims to better understand meaning-making processes that link sustainability-related learning experiences and learning outcomes throughout a higher-education curriculum. The following research questions drove the analysis:

1. Concerning the dimension of perceived impact of significant sustainability-related experiences: How do students make meaning from their formal and informal sustainability-related learning opportunities in a three-year undergraduate program?
2. Concerning the dimension of assigning value to this perceived impact: Why do students consider sustainability-related learning experiences significant?

To answer these questions, we interviewed 10 students from a three-year undergraduate study program in their third year who had participated in a mandatory sustainability-related module during their first semester. We expected them to have had the full range of possible sustainability-related learning experiences at this point in their studies. Thus, by asking them about their experiences as learners and actively engaging with their reflections, we intended to gain insights on how such experiences could be further integrated into curriculum design processes. Our analysis used process analysis of narrative interviews and conceptual maps to uncover possible types of meaning-making processes that could inform further research and curriculum development. This article starts by summarizing the theoretical background, which integrates key ideas on meaning-making from socio-constructivist learning theories. Next, previous results and related research gaps on students' meaning-making in HESD are summarized. The third section provides an overview of the multi-case study approach that allowed comparative process analysis. The results section presents three types of students' meaning-making using the dimensions of personal impact (how) and subjective value (why). This article ends by discussing the findings against the background of research on meaning-making in HESD and the design of significant sustainability-related learning opportunities.

2. Theoretical Framework

2.1. Learning as meaning-making

Central to our understanding of learning is that it always involves an interaction with the world (learning experience) and a transformation of this experience via assignment of significance and meaning. The transformation is suggested to require mental energy that drives the meaning-making process via feelings, emotions, and motivations (Illeris 2018, 4).

According to socio-constructivist learning theories, these learning experiences are individually constructed (Chaiklin 2003; Garrison 1998). Hence, in learning processes, each individual makes meaning from experiences based on prior knowledge, beliefs, values, and experiences while drawing on cultural and societal influences (Zittoun and Brinkmann 2012). In transformative learning theory, these propositions serve as a frame of reference for new experiences (Mezirow 1997, 7). Experiences and critical reflection may transform the frame of reference, thereby rendering learning meaningful. From Mezirow's point of view, reflection, contemplation, and discourse with authorities and peers are integral to the process of meaning-making (Mezirow 1997). Two recent extensions expanded the understanding of meaning-making underpinning this research: the critical idea that meaning-making processes are not only individual but also socio-contextual (Merriam and Heuer 1996) and the emphasis on the affective dispositions of the learner such as emotions and value judgments (Jarvis 2018; Merriam and Kim 2011) as well as expectations and motivations (Illeris 2018).

These theoretical considerations do not yet explain at what point and which kind of learning experiences can develop transformative potential. Jarvis suggested that no learning will occur if a learning experience is too congruent or incongruent with the frame of reference (Jarvis 1987). Merriam and Clark (1993, 136) emphasized that a learning experience must be "subjectively valued by the learner and have an impact on the learner involving an expansion of skills, sense of self or life perspective or a transformation" to be significant. Subjective value refers to assigning individual importance to this change or development. We acknowledge that this framework for meaning-making processes and significant learning does not account for the full complexity of individual learning processes. Nevertheless, the framework offers great potential for our study to deliver valuable insights into learning experiences and outcomes.

2.2. Previous research on meaning-making in HESD

Previous research on meaning-making in environmental and (higher) education for sustainable development has thus far focused on meaning-making in formal, individual seminars and courses (Lundholm 2004, 2005) or on school students in environmentally-themed classes (Caiman and Lundegard 2014, 2018; Lundegard and Wickman 2007; Manni, Sporre, and Ottander 2017). Most fundamentally, Ohman and Ostman (2007) found evidence for the importance of prior experiences in meaning-making. Many studies that are building on this body of research point to the relevance of values, emotions, and value judgements for meaning-making regarding environmental learning opportunities. In a synthesis of their work, Rickinson and Lundholm (2008, 345) identified three significant challenges of students' meaning-making processes in environmental formal learning experiences: "different emotional responses to the content, different opinions about the content as compared with the teacher, and different views of what should be studied in a subject". However, these studies cover relatively short-term and formal learning experiences and do not consider the experiences students have in the dynamic curriculum-as-lived over an extended period. Longitudinal biographical studies identified processes of emancipation over time in some students and dependence of others on external authorities, supporting the notion of highly individualized

meaning-making over time (Barber, King, and Baxter Magolda 2013). Finally, studies covering more informal learning experiences in higher education have shown that adults also make meaning from extracurricular experiences (Gramatakos and Lavau 2019). Against this background, it seems fruitful to further illuminate students' long-term individual meaning-making processes to gain a more holistic picture in a curriculum-as-lived.

3. Empirical design

3.1. Comparing and analyzing individual meaning-making processes

In an exploratory study, we investigated processes of students' meaning-making using detailed descriptions of students' sustainability-related learning experiences that took place during a three-year undergraduate study program. A multi-case study approach was adopted to perform, on the one hand, a deep analysis of individual meaning-making processes, and on the other, to support contrasting the commonalities of these processes (Stake 2005). We decided to use a multi-case study design—due to the individual combinations of major and minor subjects and complementary studies. Additionally, the epistemological assumptions of the multi-case approach align well with the underlying understanding of meaning-making in this study (Yazan 2015). Above all, multi-case studies are suggested to provide more robust results because cases from diverse study backgrounds are directly compared as part of the analysis (West and Oldfather 1995). Thus, the case study is characterized by the units of analysis (students from diverse major and minor subjects) and not by the focus of the analysis (their meaning-making processes).

3.2. Multi-case study context

The present study was conducted at a mid-sized German university (approximately 10,000 students) whose undergraduate study program stands in the tradition of a *liberal education* approach. The three-year study program is characterized by a high proportion of interdisciplinary teaching in the first semester and the complementary studies accompanying major and minor subjects. After a first compulsory general first semester, students choose a major subject (e.g. Business Administration, Cultural Science, Industrial Engineering, and Sustainability Science) and combine it with a minor subject (e.g. Philosophy, Business Law, E-business, Educational Sciences, and Sustainability Science) (see Figure 1).

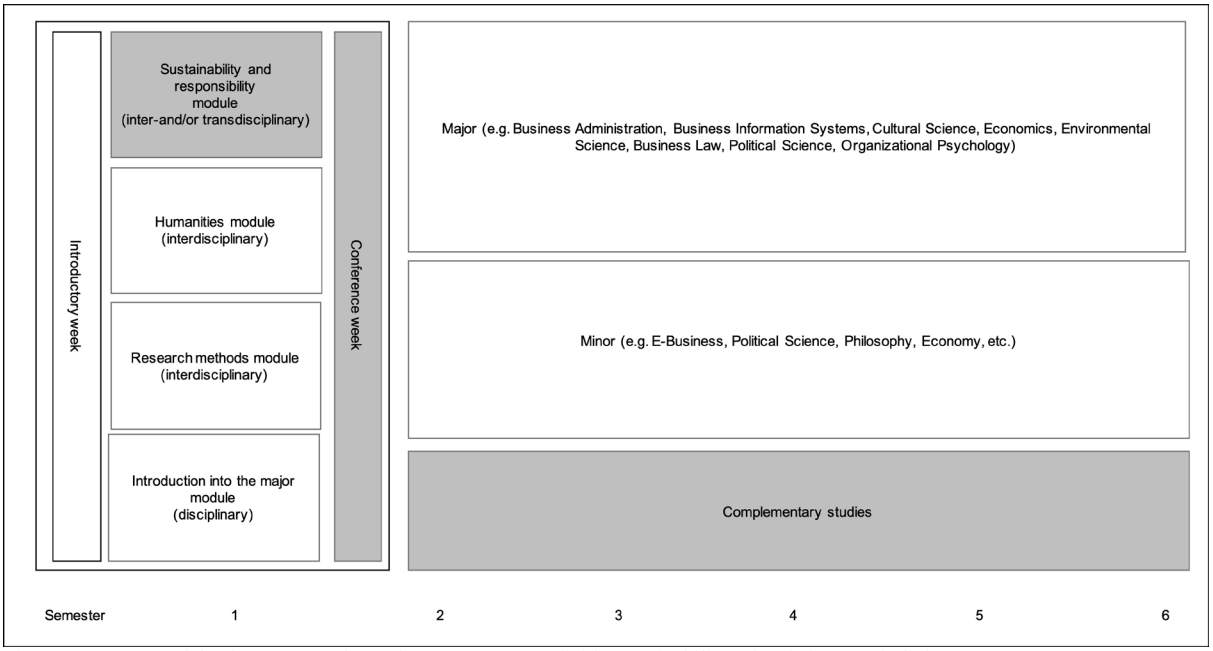

Figure 1. Structure of the three-year undergraduate program (explicitly sustainability-related elements in light grey).

The compulsory first semester consists of four modules: The most extensive module[1] aims to familiarize students with the concept of sustainability and the discourse on sustainability transformation. Figure 2 presents a detailed overview of the sustainability-related learning opportunities in the sustainability and responsibility module that accounts for one-third of the semester's workload. The module design follows sustainability learning objectives: inter- and transdisciplinary problem-solving, dealing with complexity, self-organized and collaborative learning, and competence development (Barth and Timm 2011). In addition to this module, there are two further interdisciplinary modules: one that introduces students to humanities perspectives and one that provides a general introduction to research methods. There is also an introductory major-specific module. The primary learning objectives in the first semester are:

- understanding complex real-world challenges against the background of their origins
- critically reflect different scientific perspectives in their cultural conditionality
- testing the basics of (contemporary) scientific work
- enabling interdisciplinary competence development

[1] A module in the three-year study program has the function of an organizational unit that combines individual courses, in this case a lecture, tutorials, and a project seminar from the subject area of sustainability

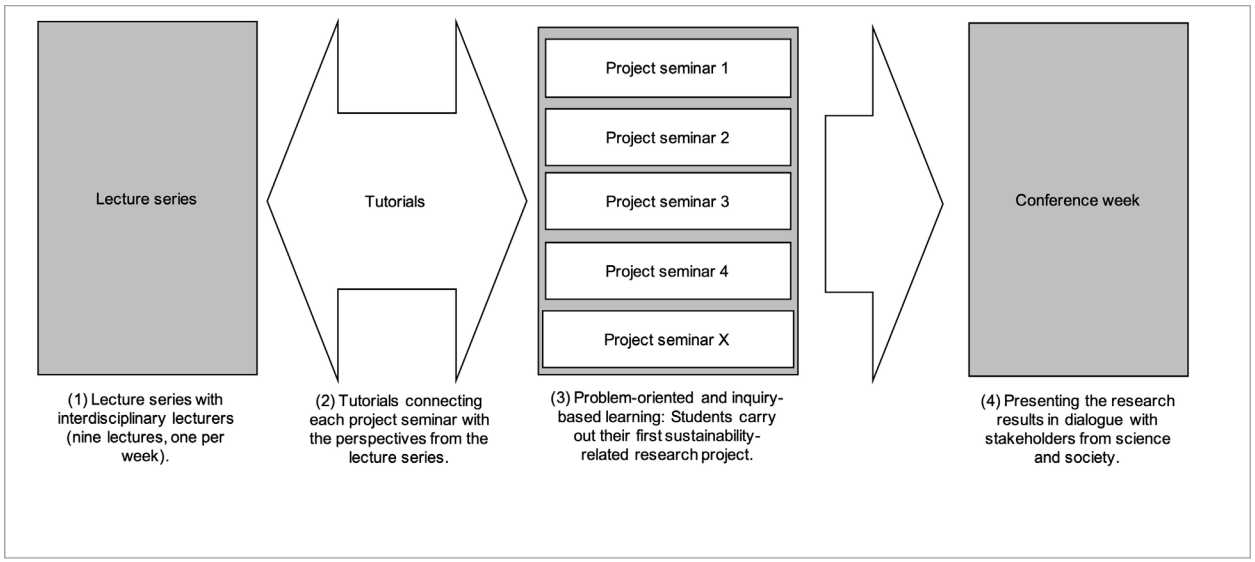

Figure 2. Sustainability-related formal learning opportunities in the sustainability and responsibility module in the first semester (explicitly sustainability-related elements in light grey).

The mandatory sustainability-related module is mainly structured by three formal learning opportunities: a project-based seminar[2], a lecture series on the basics of sustainability[3], and connecting tutorials[4]. The students can choose one out of 60 different seminars that focus on issues such as *Unconditional Basic Income: A program for more social sustainability?*, *Use of Biomass for Energy Production—A Critical View* or *Economy 2.0,* or *Growth, Products, and Profit in Transition!?*. The teaching and learning approaches of the seminars are based on the idea of inquiry-based learning (Mieg 2019). The students independently conduct a first research project concerning sustainability challenges in small groups. The lecture series provides insights on 'acting responsibly in the 21st century' from lecturers with different disciplinary backgrounds, including business ethics, environmental psychology, or governance. After this semester, students present and discuss their research results in a joint three-day conference in a festival-like atmosphere with their peers and guests from science, politics, and society. The conference's goal is to engage the students in a critical dialogue about the opportunities and challenges of societal change. Two assignments assess the students' performance at the end of the first semester: a collaborative presentation during the final conference and a written group report on the research project. From the second semester onward, further sustainability-related learning experiences are optional. Students may choose a major or minor subject in Environmental and Sustainability Sciences or attend seminars in the complementary studies that deal with sustainability. It is also possible for students—either intentionally or unintentionally—to not have any other formal learning experiences with sustainability (Michelsen 2013). In addition to the formal learning opportunities, campus management supports informal sustainability-related learning experiences by, for example, a sustainable music festival on campus, student initiatives, and close partnerships with the city's administration, civil society actors, and local businesses (Birdman, Barth, and Lang 2020).

[2] In this study, a seminar is a learning activity in a smaller group (up to 30 people), which serves the more interactive acquisition and/or production of knowledge. Learning objectives of seminars often go beyond the mere transfer of knowledge and tend to focus on competence acquisition.
[3] Lectures are understood as learning activities in which lecturers aim to transmit knowledge to students by means of speaking in front of an audience in a transmissive manner. These lectures are sometimes, but not always, supported by interactive elements such as questions to the plenum, discussion rounds or assignments.
[4] A tutorial is a supporting and accompanying course to a lecture or seminar, which serves to deepen and repeat content from the lecture and seminars with hands-on exercises. The tutors are students, who are more advanced in their studies.

3.3. Participants

We conducted interviews throughout one university semester in fall 2015. Participants were selected from a cohort that started studying in winter 2012 (n = 1,773) and was in their final year of the three-year undergraduate program in summer 2015 (n = 1,424). The recruiting process took place in two stages: First, students were asked to answer a short questionnaire in the seminars of the cohort in their third year. Forty-two students answered the questionnaire on their perceived (current and future) professional relevance of sustainability, age, and their study program (see Appendix A for results of the survey). All participants consented to the collection and processing of data by signing a data-processing and publishing contract prior to participation. Second, the goal of the subsequent stage of case selection was not to achieve possible representativeness but to strive for balance and diversity in the sample, which should guarantee that we can learn as much as possible from the cases (Stake 2005, 451). In qualitative case studies, conducting few interviews always has the potential for bias.

Concerning the two research questions guiding our study, the two-staged sample selection aimed to interview the possible range of meaning-making processes from students with diverse study backgrounds. The limitation to a few interviews focused on the depth and thickness of the individual narrative (Perey 2015). Nevertheless, this type of selection may still allow not to identify other types of meaning-making processes. Keeping these limitations in mind, we paid particular attention to the comprehensibility of the data analysis and the plausibility of the conclusions (Merriam 1995) by strictly following Stake's (2005) advice to use protocols. Finally, 10 students were selected one after another based on their answers to the survey questions on a) perceived professional relevance of sustainability for their study program and their future professional life in the questionnaire and, b) variation in study programs and genders to be able to assess a variety of meaning-making processes (Table 1). However, we did not interview students indicating that sustainability was relevant for their major subject but not for their future professional life. The share of female students was representative of the university (approx. 60%). The final sample included students from all four university departments.

Table 1. Case characteristics of the multi-case study.

Student	Gender	Age (years)	Major subject	Minor subject	Perceived professional relevance of sustainability for		Interview length (minutes)
					Study program	Future professional life	
1	Male	24	Environmental Science	Spatial Studies	Very high relevance	yes	60
2	Male	24	Cultural Science	Digital Media	Rather low relevance	yes	70
3	Female	26	Organizational Psychology	E-Business	Rather low relevance	yes	105
4	Male	26	Environmental Science	Philosophy	Very high relevance	yes	60
5	Female	21	Organizational Psychology	E-Business	Rather low relevance	yes	63
6	Female	23	Organizational Psychology	E-Business	Low relevance	yes	65
7	Female	22	Business Law	Business Administration	Rather low relevance	no	80
8	Female	25	Cultural Science	Educational Science	Low relevance	yes	75
9	Female	24	Environmental Science	Educational Science	Very high relevance	yes	76
10	Female	23	Business Administration	E-Business	Rather low relevance	yes	72

3.4. Data collection

Data was collected via narrative interviews and conceptual maps. We used narrative interviews to ascertain students' perceptions of sustainability-related learning opportunities (Almers 2009; Manni, Sporre, and Ottander 2017). The interview guidelines were constructed to encourage storytelling (Rosenthal 2004). The interviews took place toward the end of the third year of the undergraduate study program, allowing students to look back at experiences and envision their future plans. Interviews began by instructing the students to reflect on sustainability-related learning experiences throughout their studies (see Appendix B for the interview guideline). We used semi-structured questions to focus, for instance, on the most significant changes in students' sustainability conceptions (Davies and Dart 2005). Before the interview, students were given the opportunity to recall their sustainability conceptions using a conceptual-map approach (Novak and Canas 2008). However, the conceptual maps do not play a central role in this article. The maps were primarily intended as a reflective task introducing the students to the interviews and only secondarily to explore their sustainability conceptions as a learning outcome. The transcripts, conceptual maps, and the coding schemes that support the findings of this study are available in pseudonymous form in German on request from the corresponding author [AS]. The data are not publicly available due to restrictions (e.g. containing information that could compromise the privacy of research participants).

3.5. Data analysis

Our interest in *how* and *why* students make meaning from their sustainability-related learning experiences served as the guiding principle behind the analysis. As an overall framework for data analysis, we used process analysis to understand better how students experienced the impact of dealing with sustainability and why they subjectively valued these experiences as being significant (Schütze 2016). The transcripts were analyzed in three phases (Figure 3). In the first phase, we determined the structure of the main learning narrative from the interview transcript. We further abstracted the narrative in the second phase by organizing the learning experiences chronologically and identifying the four main analytical themes. Finally, in the third phase, we contrasted the four themes identified in each case. The analysis of the conceptual maps drawn at the beginning of the interviews took place in a process that was eventually largely separate from the results presented in this article. However, we compared the perceived impact of the learning experiences and sustainability conceptions prevalent in each of the three types of meaning-making processes with the structural and content-related complexity of the maps, which further complemented our results.

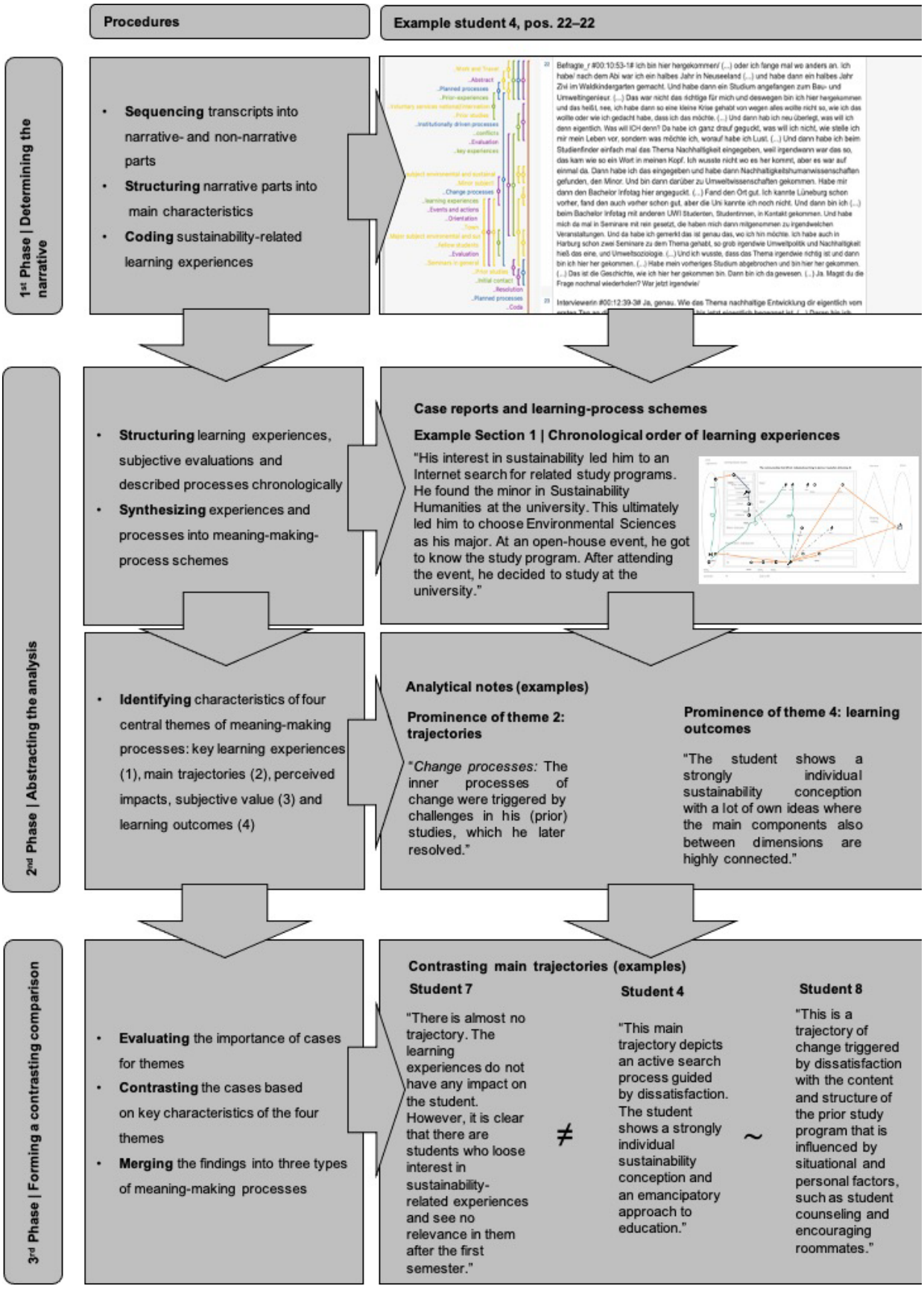

Figure 3. Data-analysis flowchart showing how one paragraph (student 4, pos. 22–22) is processed in three phases following a process analysis approach.

4. Findings

Our analysis revealed three different types of processes in which students assign meaning to learning experiences throughout their undergraduate studies, which differ concerning *how* and *why* they assign value to their sustainability-related learning experiences. In Figure 4, we present the main characteristics derived from the process analysis that distinguish the different processes, forming three distinct types of meaning-making. The three types of meaning-making processes (which are not necessarily fully exclusive) were identified as *no sustainability-related meaning-making* (type 1*), meaning-making as professionalization* (type 2*),* and *meaning-making as self-realization* (type 3). They differ in their key learning experiences, their type of trajectory, perceived impact, subjective value, and variations in sustainability conceptions.
The following sections illustrate the three process types following the characteristics as outlined in Figure 4: key learning experiences and trajectories, perceived impact (how) and subjective value (why), and finally, determined by describing their sustainability conceptions as a learning outcome.

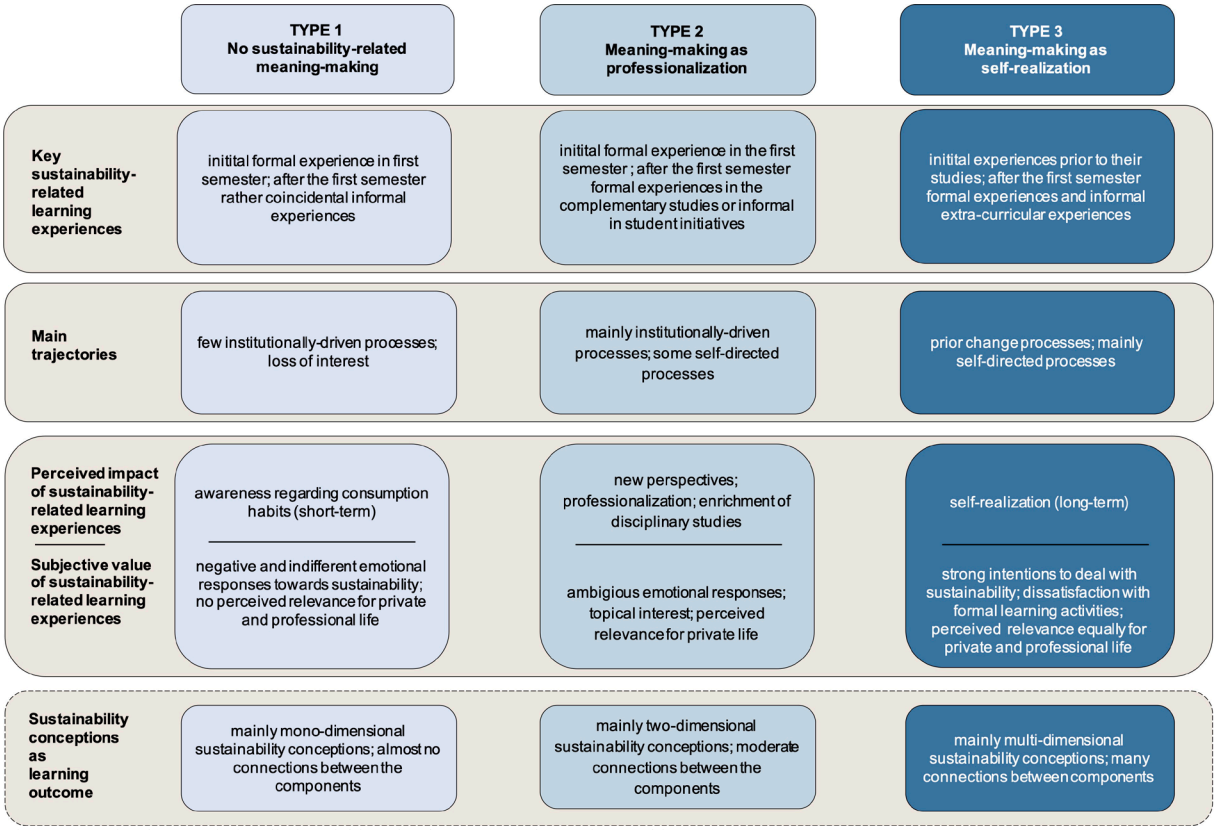

Figure 4. Main characteristics distinguishing the three types of meaning-making processes.

4.1. Type 1: No sustainability-related meaning-making

Type 1 meaning-making processes are characterized by only *institutionally-driven* sustainability-related learning experiences and a loss of interest in sustainability after the first semester. This type of trajectory can be seen, for example, in the fact that students of type 1 identified no or few significant sustainability-related learning experiences during their studies (student 6 and 7). After the first semester, students of type 1 described only those learning experiences as significant that match their disciplinary career goals and are not related to sustainability. Thus, students of type 1 experienced sustainability-related learning exclusively in formal contexts in the first semester,

without any further interest in the issue during their subsequent study programs (*loss of interest trajectories*)

Concerning their perceived impact of their learning experiences, students of type 1 perceived that sustainability-related learning experiences raised *awareness* about their consumption habits, in parts leading to arguments about unsustainable habits with friends and family (student 6). This is briefly mentioned by student 7. While the student admitted being negatively impressed by her own carbon footprint, she ultimately did not change her consumption habits. It seems that students of type 1 commonly perceived the impact of their sustainability learning experiences as detached from what they consider valuable.

Concerning the subjective value (why) of the perceived impact, students of this type only attached *negative* and/or *indifferent emotional responses* to their sustainability-related learning experiences in the first semester. In one case, student 6 experienced sustainability as strongly value-laden and instrumental, potentially causing overload and rejection expressed as the need "to puke" (pos. 11), whereas student 7 could not remember her first-semester experiences with sustainability. She remembered: "That was actually mainly in the first semester. […] So, you hear the term very often, but I could not say now (…) in certain courses we have implemented so and so." (student 7, pos. 20). All in all, although the students seemed to welcome the opportunities to develop awareness for sustainability issues in their first semester, they did not consider the perceived impact as relevant for their major subject, their future careers, or their private life. Additionally, the students' statements indicated a *solid expectation* to focus on their major subjects during their undergraduate studies. This expectation is well reflected in one student's statement: "But (…) in the end, I came here to study Business Psychology" (student 6, pos. 11). Similarly, student 7 expressed strong domain-specific epistemological beliefs about what a significant learning outcome of the first semester should have looked like. She said with regret: "Unfortunately, I can't really define it [sustainable development]. So, nothing has really stuck" (student 7, pos. 88).

This individual perception of student 7 is reflected in the conceptual maps of the two students of this type, which indicate mono-dimensional, economically-focused sustainability conceptions with few connections between components.

4.2. Type 2: Meaning-making as professionalization

Compared to the loss of interest in type 1 processes, type 2 meaning-making processes feature several significant sustainability-related learning experiences in the first semester and beyond. After the first semester, students of type 2 remained partially engaged in more informal learning opportunities, such as students' initiatives, voluntary work abroad, and/or formal learning opportunities in the complementary studies. Thus, type 2 meaning-making processes are mainly institutionally-driven. However, in contrast to type 1 processes, the type 2 trajectories feature some *self-directed learning processes* after the first semester. Concerning the perceived impact of these experiences, students of type 2 perceived that their key sustainability-related learning experiences changed their *perspectives*. Student 2, for instance, prominently reflected on how the seminar experience helped him gain a more holistic perspective of sustainability. He noted on organizing the conference week:

> "That was interesting for me. It was a lot about sustainability [and] you were confronted with it somehow. If you didn't really know sustainability before, […] of course what one always gets from advertising [on sustainability], is ecology or the environment, and from that, you don't easily get the idea that you can or should and

> must also design a festival, or large cultural events sustainably." (student 2, pos. 10)

Other students perceived gaining new perspectives on sustainability issues through learning experiences that connected the issues with gender and developmental services (student 3), economy and social entrepreneurship (student 5), or organizing musical events (student 10). Additionally, it appears that students of type 2, similar to students of type 1, perceived awareness for personal unsustainable consumption habits as an impact of their learning experiences in the first semester. An indication for this perceived impact was statements of almost all students of this type about noticing increased conflicts over consumption habits with their peers and family. Referring to the subjective value, students of type 2 explained how the sustainability-related learning experiences of the first semester sparked their *personal interests,* such as in social entrepreneurship or female empowerment, and thus motivated them to engage with issues after the first semester. Student 3 declared: "I was always afraid of becoming such a blinkered specialist through my studies, in the sense that you know a lot about your own discipline, but you no longer look to the left or the right" (pos. 213). In contrast to students of type 1, students of type 2 appreciated acquired skills and knowledge from sustainability-related learning experiences as relevant in the light of their *professionalizatio*n (students 2, 3, 5, and 10). Student 2 explained, for instance, how organizing a part of the conference week sustainably impacted his "soft skills" and gave him a professional attitude for managing a festival (pos. 51). Yet, students of type 2 showed *ambiguous emotional responses* regarding their sustainability-related learning experiences. This ambiguous response is well reflected in student 3's summary of her first-semester experience: "I perceived it as positive […] however, sometimes the word brainwashing also comes up among students" (pos. 225). Nevertheless, the complexity of sustainability issues also seemed to overwhelm students of this type. Student 2 conveyed:

> "I think, […] when it comes to sustainable development, then you have the images of the cleared rainforest in your head somehow, I think (…) But I mean it is just at the same time also society, or I find it just difficult because it is just so complex." (student 2, pos. 61).

Thus, despite their personal interests in specific sustainability issues, the complexity of the coupled sustainability dimensions and/or confrontations concerning theirs' or others' unsustainable consumption behavior challenged them.

After the first semester, students of this type valued formal sustainability-related learning opportunities as an *enrichment* to follow their interests and enjoy interdisciplinary perspectives or feel less pressure to perform. Still, almost all students of this type rated their sustainability-related learning experiences as irrelevant in light of their major and minor subjects. Student 10 objected, for example:

> "It is of course, a bit difficult for business students. […] Because that's [sustainability] not really a topic in the lectures. (laughs) So you are shaped so beautifully in the first semester […] from time to time it could be integrated again, I think. Especially since it is the university's claim." (student 10, pos. 18).

Similar to the ambivalence in the emotions and valuations of their learning experiences, no clear picture of their sustainability conceptions emerges from the analysis of their conceptual maps. This ambivalence is expressed by student 3, who said "it's definitely still a squishy term and I rather feel like it's getting bigger, and squishier because you're just discovering more and more" (pos.

135). Overall, the conceptual maps reflected disciplinarily colored conceptions, which in some students already revealed the first beginnings of recognizing the dependency of the dimensions.

4.3. Type 3: Meaning-making as self-realization

Unlike the previous process types, type 3 processes are characterized by initial formal and informal sustainability-related learning experiences prior to commencing at the university. Students mentioned experiences such as previous study programs (Students 1 and 4), volunteering, traveling (students 4, 8, and 9), or growing up in a family with a strong sustainability orientation (students 4 and 8). Students' narratives indicated that these experiences led to *change processes* that had guided the students to their application to this particular study program. Students 1, 4, and 9 illustrated this point by claiming that their primary studies were too strongly focused on natural sciences, engineering, or organizational psychology instead of sustainability issues. Moreover, after the first semester, type 3 meaning-making processes were mainly characterized by conscious, self-directed plans to engage with sustainability, mostly in informal contexts (students 4 and 8), or active use of formal institutional sustainability-related experiences (students 1 and 9).

In contrast to type 1 and type 2 processes, gaining awareness does not seem to be an important impact of sustainability-related learning experiences for students of type 3. Instead, the characterizing perceived impact is *self-realization*. Self-realization captures the students' perception that engaging with sustainability issues changes their ability to enhance their self—in terms of knowledge, attitudes, or behavior. Students of type 3 appeared to understand the development of self-knowledge and autonomy in addressing sustainability issues as a perceived impact of their experiences. Student 4, for example, reflected on his perceived impact from an extracurricular seminar:

> "HOW are processes accompanied, how are processes guided, what is the cooperation at all? (…) What does it take for cooperation to produce results that are really meaningful [in terms of sustainability transformations]? And I found myself in that very much, and I'm still deepening that in my bachelor's thesis" (student 4, pos. 30)

At the same time, student 8 (pos. 23) even changed her major subject from Organizational Psychology to Cultural Science as she recognized how she wants to deal with issues in her further studies due to her exposure to sustainability-related learning experiences. She explained:

> "[I felt] that I actually have no desire for this (…) rational and predictable view of a topic. […] And I think that happened to a large extent because I shared a flat with Cultural Science students only, but also because I already noticed in this [sustainability and] responsibility module how it can also be to look at things and analyze them." (student 8, pos. 23)

Concerning the subjective value, students of type 3 showed from the beginning onwards *intentions* to deal with sustainability issues regardless of whether they study Sustainability Science: "But then I realized pretty quickly in the first semester that (…) if I want to study here, then I have to be able to identify with it somehow" (student 8, pos. 23). At the same time, statements such as "What I didn't find at university, I did at home" (student, 4, pos. 74) indicate an intention to delve even deeper into sustainability issues. Consequently, students of type 3 often expressed *dissatisfaction* with formal sustainability learning opportunities they experienced as superficial. This dissatisfaction was accompanied by a strong *need for reflection* that supports valuing self-realization as an impact of their experiences. Student 8, for instance, concluded:

> "And (…) that/so at the end of the studies it definitely shaped me, everything in the complementary studies so that I also (…) know for myself that I see the whole concept [Education for Sustainable Development] critically, totally critically." (student 8, pos. 27)

Another characteristic of type 3 meaning-making processes seems to be that the perceived impact of new sustainability-related learning experiences is constantly evaluated and reflected against the background of *prior sustainability-related experiences.* Student 4, for example, spent a great deal of time in his interview on his individual process of change and the role his prior experiences played in it, "I had a little crisis because everything didn't work out the way I wanted it to or the way I thought I wanted it to" (ibid, pos. 22). In his interview, he revealed his struggle when he noticed that his first study program did not cover his interest in environmental communication. Finally, he interpreted his application to study at this university as a solution to his "crisis". However, he then reflected and criticized during the interview that the experiences in this study program were also not sufficient for him and that he, therefore, took more extensive informal experiences outside of the university to develop himself. Thus, such reflections of prior experiences often indicate initial change processes in type 3 meaning-making. It seems to shape why students of this type assign significance to the perceived possibility for self-realization through sustainability-related experiences. This could mean, if formal and informal sustainability-related learning processes lead to self-realization, students of type 3 assign perceptions of relevance: For example, some students claimed to perceive that sustainability had a high degree of professional relevance for their future career goals (students 1 and 9) or relevance for both their private lives and their disciplinary studies as well as for their future career plans (students 4 and 8).

Finally, the vital need for dealing critically with sustainability issues and for self-realization is reflected in the holistic, multidimensional sustainability conceptions with highly interconnected components of students of type 3. Student 9, for example, verbalizes this reflexivity in her sustainability conceptions by explaining: "I would still emphasize ecology and socio-cultural aspects stronger than economics. Simply, […] because that is somehow more important to me personally and somehow everything ultimately has its origin in it" (student 9, pos. 72).

5. General discussion

This study examined the questions of *how* and *why* sustainability-related formal and informal learning experiences became meaningful in a three-year undergraduate program for students with different disciplinary backgrounds. We contribute to the literature in HESD by providing further evidence for variations in students' meaning-making processes, and by adding a long-term and differentiated perspective to support curriculum design and the development of effective teaching and learning approaches.

5.1. A differentiated view on meaning-making: Integrating how and why

Our results provide further evidence on the notion that meaning-making in HESD is highly individual. More importantly, this study integrates the *how* and *why* of meaning-making, thereby offering a differentiated perspective on the characteristics of different meaning-making processes. For example, this perspective allowed us to differentiate that while students of type 1 lose interest in sustainability issues after the first semester, students of type 3 attribute significance to sustainability-related learning experiences in complementary studies and informal contexts just from the

second semester onward, even though for students of both types the first-semester learning experiences had not been significant.

Regarding how students perceive the impact of dealing with sustainability, we found that the extent of the perceived impacts is a distinguishing characteristic of different types of meaning-making processes. The different perceived impacts of sustainability-related learning experiences are similar to those found in other studies. For example, previous studies showed that sustainability-related learning experiences are perceived as beneficial for sustainability awareness (Davis et al. 2003), employability (Azapagic, Perdan, and Shallcross 2005; Bone and Agombar 2011; Opoku and Egbu 2018), professional relevance (Abbonizio and Ho 2020), or professional specialization (Wyness and Dalton 2018). Interestingly, we were able to show that within one cohort with different study backgrounds, similar learning experiences in the first semester are attributed varying extents of impact. One possible explanation is that learners perceive only impacts congruent with their beliefs, attitudes, values, and knowledge. Other impacts, such as self-realization, that are probably incongruent with their beliefs and values (frame of reference) might be blocked entirely or not perceived at all (Ardoin and Heimlich 2021; Jarvis 1987).

Regarding the question of why (i.e. the subjective value that students did or did not assign to the perceived impact of their key sustainability-related learning experiences), the study emphasizes the role of emotional and motivational responses as a sign of assigned value. Similar to previous studies on meaning-making in environmental education/education for sustainable development (Dillon, Heimlich, and Kelsey 2013; Lundholm, Hopwood, and Rickinson 2013; Manni, Sporre, and Ottander 2017; Öhman and Östman 2007), our results show that students engaging with sustainability form diverse emotional responses. The present findings especially support Lundholm, Hopwood, and Rickinson's (2013) results, i.e. that sustainability-related subject matter often seems to challenge learners. In the case of type 1 and type 2 meaning-making processes, negative emotional responses seem to signify a barrier for assigning value to the perceived impact of sustainability-related learning experiences. However, the more negative emotional responses were more evident among sustainability novices. This result may be explained by the fact that these students' specific worldviews and values, such as conservatism, are threatened by the sustainability-related learning experiences (Ojala 2013; Park 2017). Consequently, students might defend their values and worldviews by losing interest in sustainability rather than reflecting on them and expanding their learning experiences. In contrast to negative responses, ambivalent emotional responses appear to indicate slight incongruence of the experiences and the frame of reference that still leaves room for some meaning-making (type 2 processes). Probably, they are experienced as stimulating and thus enhance meaning-making.

Further, our findings emphasize the role of prior sustainability-related experiences for facilitating type 3 meaning-making processes. These findings are in line with previous studies that found students assigning low significance to environmental subject matter if they expected it to be irrelevant for their major subject and their professional future (Rickinson and Lundholm 2008) or found that preconceptions regarding science and sustainability can be challenging for learning (Wyness and Dalton 2018). To some extent, this prominent role of prior experiences for type 3 processes could be explained by the notion that strong expectations can become self-fulfilling prophecies (Mezirow 2018). Evidently, by integrating the how and why of meaning-making, we found evidence that the two dimensions are essential for understanding the complexity of individual meaning-making processes in students with diverse backgrounds.

Additionally, the results support the assumption that problem- and inquiry-based learning approaches applied in the first semester can facilitate type 2 meaning-making processes. There is

already a large body of literature showing that participatory, active, and experiential learning is essential in fostering students' personal interest or engagement in sustainability issues (Birdman, Redman, and Lang 2021; Brandt et al. 2021; Konrad, Wiek, and Barth 2021). However, our results indicate that these teaching-learning approaches do not support meaning-making for all students in the same way. To prevent loss of interest (type 1 meaning-making processes) or dissatisfaction (type 3 meaning-making processes) with the formal institutionally-driven sustainability-related learning experiences, there should be more support for addressing diverse emotional responses. Although dealing with affective learning outcomes has already been described as an important element of HESD (Manni, Sporre, and Ottander 2017; Shephard et al. 2015), it is possible, for example, that not all teachers in the first semester are prepared for or comfortable with emotional responses and affective learning outcomes (Shephard 2008; Winter and Cotton 2012). Moreover, education for sustainable development is understood differently by different teachers (Wals and Jickling 2002). To address the different types of meaning-making processes, it could help to deal with diversity in emotional responses, already from the first semester on.

When taken together, these findings raise intriguing questions for future research, for instance on the extent to which the two dimensions of meaning-making become evident in other educational contexts and, on a larger scale, on the specific characteristics of key significant formal and informal sustainability-related learning experiences, or on the diversity of meaning-making processes three or five years after graduation. Although there is a need for further research in this area, we came up with practical implications for future design of curricula design based on the different processes, which are illustrated in the next section.

5.2. Implications for sustainability-related curriculum design

This study offers insights for curriculum designers, lecturers, and higher education institutions interested in expanding their efforts to engage students with different backgrounds in interdisciplinary sustainability-related learning. As suggested by our results, the sustainability-related learning opportunities in the first semester of the study program do not seem to lead to meaning-making processes for all students. The findings, in particular, have two important practical implications: Training the lecturers in the first semester to become more responsive to the students' emotional responses and adapting the study program even more to the different needs.

First, students' needs and challenges should be more strongly addressed and reflected upon in the first semester. Tutorials should function as an open and protected space for reflection on personal challenges with sustainability-related learning experiences. This reflective space would be beneficial in avoiding type 1 meaning-making processes and facilitating type 3 meaning-making. The tutorials would address the dissatisfaction with perceived superficiality and, at the same time, negative emotional responses by, for example, role playing or engaging with role models (Shephard 2008). The implication follows suggestions of a few students who valued the opportunity for reflection in the interview, and by recent studies suggesting integrating reflective tasks into the curriculum to cope with explicit challenges (e.g. negative emotions toward sustainability-related learning experiences) (Frank, Sundermann, and Fischer 2019; Lundholm, Hopwood, and Rickinson 2013). Second, an attempt could be made to create more learning opportunities in the first semester that explicitly frame the sustainability issues from disciplinary perspectives instead. The implication is supported by the findings of Sandri (2021), who recommends creating so-called entry points to sustainability issues tailored to the disciplinary backgrounds of the students. However, there is a risk of losing the interdisciplinary and problem-oriented approach of the first semester which, in turn, were presented by most students of types 2 and 3 as helpful for meaning-making.

The study program in its current form seems to offer the most significant potential to facilitate type 2 processes. Hence, our results provide further evidence that the combination of informal and formal learning experiences offers the opportunity for meaning-making for students with diverse backgrounds (Ballantyne and Packer 2005) but with a certain openness and curiosity towards issues outside their disciplinary major subject. The first semester seems to generate an initial interest ("opening the door") through subjectively valued professionalization in students of type 2. The electives in the complementary studies could further facilitate engagement with sustainability by offering a sustainability-oriented track of seminars for students who did not choose the minor Sustainability Science in the first semester ("keeping the door open"). Weaving sustainability-related learning opportunities in disciplinary major and minor subject content could further support type 2 and 3 meaning-making processes. Students of type 2 themselves expressed this desire for more coherence throughout their studies. Of course, weaving sustainability issues more closely with disciplinary content could be supportive for all students (Kohl et al. 2022). Based on our results: type 1 processes could probably be turned into type 2 processes if specific, major-related sustainability content gave students the impression of professional relevance in the first semester. However, our results suggest that more institutionally-driven learning opportunities would probably not facilitate type 3 meaning-making processes. It appears that type 3 processes are facilitated by prior change processes and independent, self-directed experiences. The mandatory introductory learning opportunities could thus have a rather deterrent effect on this type of meaning-making process. Our research reconfirms the findings of Gramatakos and Lavau (2019) that informal and elective learning experiences are precious if students already bring the intention to delve more deeply into specific sustainability-related challenges. For these students, freedom for informal learning experiences and elective options within the study program structure seem particularly helpful and supportive for their meaning-making processes. To support these students in the best possible way, it seems advisable to expand informal and extracurricular learning opportunities to create more spaces for experiential learning.

In summary, we responded to the call for deeper insights into the role of learning in empowering people to think and act reflectively, critically, and sustainably (Dillon, Heimlich, and Kelsey 2013). In light of the intense individual learning and meaning-making processes in a curriculum-as-lived, our findings enhance understanding of the specific dynamics that may shape *how* and *why* sustainability-related experiences are perceived as meaningful, which mediates the relation between (formal and informal) learning experiences and learning outcomes. A combination of mandatory and elective, formal and informal learning opportunities has shown potential in engaging students from diverse study backgrounds. However, it seems important to incorporate reflective and tailored learning opportunities in the first semester to facilitate meaning-making for all students equally. Looking into meaning-making processes from students' perspectives throughout a three-year undergraduate study program may thus serve as a starting point to further support the development of significant pedagogical means to improve competence development in sustainability.

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Appendix

Appendix 1

Preselection survey (n = 42).

Preselection characteristics	Absolute frequency
Gender (response option: female)	27
Major subject	
Teaching and Learning	4
Vocational education in social pedagogy	1
Business Education	4
Business Administration	2
Environmental Science (incl. Environmental and Sustainability Studies)	9
Engineering	2
Cultural Science	9
Business Law	2
Economics	3
Business Psychology	7
Perceived professional relevance for the future (response option: yes)	38
	Mean
Perceived professional relevance for future professional life (response options from very high relevance to no relevance)	3.83
Age	24.69

Appendix 2

Key questions from the interview guideline.

Question block	Key questions	Example follow-up questions
1	How do you understand the concept of sustainable development? We will now give you a sheet of paper with "sustainable development" written in the middle. We ask you to take 10 minutes and draw/present your understanding of sustainable development in the form of a mind map.	
2	How did you experience the issues of sustainable development at the university from the beginning of studies onwards? What experiences did you have with issues of sustainable development up to the present day in the study program?	You talked about experience XY, please describe your experience again in a little more detail. What was it like for you?
3	Let us take a look at your mind map again: How do you think of your understanding of sustainable development?	What does this concept exactly mean to you? Could you describe this concept in more detail?
4	Thinking about your course of study, what was the most significant change in your understanding of sustainable development?	Why did you choose this particular change? What was the main reason for this change?
5	To what extent do you perceive relations between your major/minor subject and issues of sustainable development?	Imagine you were allowed to further develop the study program: How would you create links between your major/minor subject and issues of sustainable development?
6	How do you envision your professional/private future?	To what extent will issues of sustainable development play a role in your future?
7	Is there anything that comes to your mind that you would like to mention, add, or emphasize regarding what you have already said?	