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How Does Sustainability Become Professionally Relevant? Exploring the Role of Sustainability Conceptions in First Year Students

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Abstract: One of the main objectives of higher education for sustainable development is to nurture holistic conceptions of sustainability in students, so that they can use sustainability as an approach to analyze and solve complex problems in their future professional fields. Existing studies have shown that students differ substantially in how relevant they consider the concept of sustainable development to their future careers. Previous studies have identified socio-demographic characteristics, disciplinary background and past experiences with sustainability education as potential influencing factors. To date, the relationships between one's own "understanding" of sustainability (sustainability conception) and the importance students attach to sustainability has hardly been investigated. This case study offers a first systematic examination of how the perceived professional relevance of sustainability is influenced by different individual characteristics and sustainability conceptions. Based on data from a recent survey of n = 1364 first year undergraduate students from 14 different major subjects, our findings indicate that in addition to the previously reported individual characteristics like sex and academic affiliation, sociocultural sustainability conceptions are an important influential factor for the perceived importance of sustainability for their professional contexts. However, the regression analysis shows that the model based on predictors found in the literature lacks incremental power. This paper unveils that further research is needed on the underlying factors that explain the strength of perceived relevance of sustainability in students and that these influences need to be taken more into account in curriculum development.

Keywords: higher education for sustainable development; learning outcomes; conceptions; understanding; perceptions; professional practice

1. Introduction

Universities and other higher education institutions (HEIs) have been shown to play a critical role in engaging future professionals and decision-makers with sustainability in order to educate a new generation of change agents for sustainable development (SD) [1]. After early periods of experimentation, orientation and pilot development, efforts to implement and mainstream sustainability as a guiding idea for the design of teaching, research, operation and community outreach have intensified over the period of the UN Decade of Education for Sustainable Development and the follow-up Global Action Program [2] (p. 51). The growing importance of sustainability in the private sector [3], the emergence of associations for sustainability professionals [4], and the increased profile of sustainability on the international political agenda through the Sustainable Development Goals (SDGs) [5] suggest that the demand for students with sustainability credentials is likely to increase further.

Although sustainability is increasingly recognized as an important principle for the design of higher education, the actual large-scale implementation of Higher Education for Sustainable Development (HESD) is still largely lacking. Effective mainstreaming is complicated not least by the fact that there are very different ideas about how HESD could and should be implemented. There are different proposals, for example, on the questions of the learning outcomes to be aimed for and the pedagogies and educational philosophies to be used for them [6], the intensity of the integration of sustainability (from additive "bolt-on" to integrative "built-in" approaches) [7] (p. 58), as well as the contents and understandings of sustainability itself to be conveyed [8]. Despite the diversity of approaches it seems valid to say that a shared goal of different HESD approaches is to support students in developing an understanding of sustainability that they can then use to analyze specific problems and act on.

However, being *able* to act as a change agent for sustainability and actually *acting* like one are two separate outcomes of HESD. Shephard, Rieckmann and Barth [9] rightfully point out that it is critical to distinguish between cognitive (e.g., knowledge and its application) and affective learning outcomes (e.g., motivational factors and values). In this perspective it seems critical to not just understand how students can be enabled to engage with sustainability challenges (that are often times not just known problems in narrowly defined fields of action, but comprise a variety of ill-defined problems in different domains of life), but also explore what makes learners want to use what they have learned when confronted with such challenges. The explicit focus of sustainability education programs on acing on and solving problems "along the lines of sustainable development" [10] (p. 22) suggests that how learners understand sustainability plays a significant role in how they can and want to respond to domain-specific problems and demands. The extent to which learners regard their conceptions of sustainability as relevant when confronted with concrete domain-specific problems and demands, can thus be considered a potentially promising intermediate step from understanding to using sustainability as a concept that is informing professional action. Surprisingly, however, the interdependencies between students' conceptions of sustainability and their perceived relevance of sustainability for coping with the demands they are facing in their current and future professional contexts have not yet been systematically investigated.

This paper addresses this research gap. It empirically analyses the relationship between students' sustainability conceptions and their perceived professional relevance (PPR). Following Borg, Gericke, Höglund and Bergman [11] (p. 546), we refer to *sustainability conceptions* as "the degree to which individuals associate a particular set of ecological, sociocultural, and economic aspects as integral parts of the concept of sustainable development". Empirical data was collected as part of the LISHE (Longitudinal study on the Integration of Sustainability in Higher Education) case study at a midsize university in Northern Germany. It was obtained from a survey of two cohorts (commencing in the academic years of 2014 and 2015) of first-year students from 14 major subjects from four professional fields that was administered before classes began. LISHE pursued three aims: first, to shed light on how relevant first-year university students consider sustainability to be, both for their current studies ($PPR_{CURRENT}$) and, in future, as professionals in their jobs (PPR_{FUTURE}); second, to explore which sustainability conceptions and other characteristics first-year students already bring to campus when they begin their undergraduate studies; and third, to describe how sustainability conceptions and other factors interrelate with the current and future relevance that students attribute to sustainability. Thus, three research questions (RQs) are examined:

1. Which relevance do first year students ascribe to sustainability for their current and future professional career?
2. What is the nature of first year students' sustainability conceptions?
3. Which roles do these sustainability conceptions play in comparison to socio-demographic and prior experience-related factors for first year students' perception of the professional relevance of sustainability?

The paper is structured as follows: In the first two sections, we give an overview on research of our two main constructs PPR of sustainability and sustainability conceptions. In the next sections, we clarify our methodological approach, present our findings and discuss them in relation to existing literature. We conclude by providing theoretical as well as practical implications for future work on approaches to address and further advance students perceived professional relevance of SD and their relationship towards professional contexts and teaching approaches in HESD.

2. Theoretical Background

2.1. Research on Perceived Professional Relevance (PPR)

The turn towards competence-based learning outcomes in HESD has been noted to emphasize that teaching and learning programs in higher education should be designed "to equip graduates with the knowledge, skills and values that enable business, government and society as a whole to progress towards more sustainable ways of living and working" [12] (p. 285). A prominent line of inquiry in (H)ESD research focuses on pedagogies that are conducive to these objectives (see e.g., [6]). Several ESD scholars distinguish between instrumental or transmissive and transformative or transgressive approaches [13,14]. While the former set of approaches has been described as operating on the assumption that information, concepts, and ideas need to be transferred to learners (instructive mode), the latter is more concerned with the process of inquiry and deliberation (constructive mode) [15]. While it has been acknowledged that both approaches are not in fundamental opposition but can actually complement each other [16]. ESD scholars like Arjen Wals and Bob Jickling [17] have called for greater emphasis to be placed on the construction of meaning around sustainability in classrooms. We know from other fields, such as research on constructivist learning theories, that pedagogical approaches need to account for and adapt to existing experiences and conceptions of learners as they represent a crucial starting point for any transformative learning [18]. For instance, learners' formal and informal educational experiences with ESD in school is suggested as the foundation for later learning at HEIs and to influence the quality of their learning processes [19]. There is evidence that these existing conceptions can remain unaffected by education and pedagogical approaches when the design of these learning settings fails to adequately address what students bring to the classroom [20]. Thus, we argue that the question of what students perceive as useful and important at the beginning of their academic learning process should be reflected in the design of HESD programs. To not consider students' views on the usefulness and relevance of sustainability bears the risk of counteracting and undermining the accumulation of inert knowledge. Surprisingly, though, only few studies have investigated explicitly what we call PPR of sustainability at all. Most studies also frame the importance students ascribe to sustainability during their education as perceptions or perceived importance of or interest in sustainability. One of the pioneering works exploring PPR of sustainability was Davis et al. [21]'s qualitative case study at two campuses in the US. The researchers conducted qualitative interviews with 31 students and asked them about the experiences they had made in engaging with the concept of sustainable development in their studies. The students stated that their engagement had raised their awareness of social and environmental benefits as well as for sustainability trade-offs that they had found useful to consider in their fields of study and future work contexts. Two comprehensive quantitative surveys come to a similar conclusion. First, results from a worldwide study on engineering students suggested that despite a lack of general knowledge of sustainability and understanding, students were in favor of the concept [22]. Bone and Agombar [23] found in an online survey of n = 5.763 first-year students in the UK that most students perceived sustainability to be relevant at least to some extent for their studies and future working contexts, irrespective of their study backgrounds. According to their results, the generally perceived importance of the topic seems to be stable even after graduation. For instance, research on post-graduates in the UK (n = 98) revealed that students generally acknowledge the relevance of sustainability for their career but have reservations about existing approaches to deliver ESD in HEIs [24]. A number of studies suggest

different individual characteristics that might influence students' PPR of sustainability. These include academic affiliation (major subject) [25,26], sex [26,27], age or year of studies [22,25], as well as formal and informal educational experiences [25,28]. Moreover, researchers argue that increasing students' understanding of sustainability concepts increases their PPR [21,29,30].

In sum, existing studies yield empirical insights into how students assess the professional relevance of sustainability and provide some first cautious indications of possible influencing factors. So far, however, there is no comprehensive study available that allows conclusions to be drawn about how the perception of the relevance of the concept of sustainable development for professional contexts among students is influenced by the aforementioned individual factors or their own sustainability conceptions.

2.2. Research on Sustainability Conceptions

The most widely used definition of SD is that provided by the Brundtland commission, describing it as "meeting the needs of the present without compromising the ability of future generations to meet their needs" [31] (p. 43). Despite its prominence, the definition has been met with severe criticism, e.g., for its anthropocentric focus, its uncritical affirmation of environmental conservation and economic growth or for its indetermination with regard to specific goals and approaches to achieve SD [32]. Consequently, more than 100 alternative definitions of SD have been proposed, highlighting e.g., ethical [33], social [34,35], or cultural [36,37] aspects of the concept. So far, no consensus has been reached in the scholarly debate [38]. There has been a lot of confusion in the literature over the definition of SD, over the way it is used and how it is conceptualized [39]. Different conceptualizations are mirrored for instance by the different shapes of the models, which take the form of pillars, nested circles, triangles [40] (p. 7ff) or even doughnuts [41]. Thus, individual conceptualizations of the term vary widely [42]. Another complexity of this discussion concerns the question whether the notions of sustainability and sustainable development can or should be used interchangeably [43]. Three arguments to distinguish the two terms are commonly found in the literature:

1. Idea vs. political program: Sustainability is seen as a historically evolved idea that describes certain principles of justice and ideals for the future. Sustainable development, on the other hand, is located more strongly in a political context that is particularly influenced by the work initiated by the Brundtland definition and carried out by the United Nations since the 1980s;
2. State vs. process: In line with the previous distinction, sustainability is used as a term expressing a desirable future state, while sustainable development is used to refer to the process leading to that terminal condition;
3. North vs. South: A third distinction stems from the criticism, mainly from the Global South, that the concept of SD is intended to promote Western development models. In line with this, critics from the post-growth or degrowth community have advocated that sustainability strategies should aim to overcome the growth logics inherent in the concept of development.

Against the background of the controversies described above, the interest of this study relates to how students represent sustainability on a general level: The focus is not on theoretical concepts such as strong/weak sustainability, or concrete strategies to achieve a more sustainable future, but rather on semantic connotations of the root term. Since the connotation profiles of the terms "sustainability" and "sustainable development" are very similar among the German population [44], we use both terms synonymously in this study. In order to express that we are more interested in general associations with the idea of sustainability than in concrete sustainability strategies, we speak of sustainability conceptions in the following.

In addition to different definitions of sustainability, there are also different ways to conceptualize the construct. Traditionally, three dimensions of sustainability are distinguished: economic, environmental and social [40]. These three dimensions and similar terms can also be found in UNESCO's ESD Implementation Scheme [45]. This document identifies a number of key sustainability issues underlying the three dimensions of SD. Sub-themes of the environmental dimension are natural resources (water,

energy, agriculture and biodiversity), climate change, rural development, sustainable urbanization, disaster prevention and mitigation. Those reflecting the social dimension are human rights, peace and human security, gender equality, cultural diversity and intercultural understanding, health, HIV/AIDS and governance. Part of the economic dimension are poverty reduction, corporate responsibility and accountability, and market economy [45] (pp. 18–22). National target agreements with universities in Germany and funding guidelines for higher education policy have been developed on the basis of UNESCO's ESD Implementation Scheme, which consequently had a substantive on how the idea of sustainability was conceived in teaching and research at universities. The Implementation Scheme has also been successfully used as a guiding framework for the assessment of school students' views on ESD [46]. For these reasons, we are using the above-mentioned key issues as the basis for assessing sustainability conceptions in this study.

A related strand of inquiry focuses on investigating how students deal, perceive, and make sense of these differing and vague sustainability conceptions. Constructivists conceive learning as a process of creating new insights by validating existing conceptions and adapting emerging conceptions [47]. These (pre-)conceptions can be activated when a problem is framed and presented in a sustainability perspective and may act as a filter that selects and adapts any new information [48]. Sustainability conceptions have been researched and discussed in the HESD literature for some time. We focused our review of existing works on sustainable conceptions on articles published from 2008 to 2019 in order to continue the seminal work by Lipscombe [39], who gave an overview of studies between 2002 and 2007. We centered on studies from the field of HESD (excluding other fields, e.g., school education). Accounting for differences in the terminology, we used the terms *understanding*, *perceptions* and *conceptions*. Subjects of the empirical studies had to be university students. We included $n = 17$ studies with the following disciplinary backgrounds: management and business education [49–52], engineering education [24,53–55], teacher training [56–58], tourism [29,59], as well as five studies with the overall aim of integrating ESD into HEIs [25,60,61].

Three questions were of particular interest in the literature review: (1) Which terminology is used, (2) which study design is employed and (3) which results on dimensionality are reported. The following synopsis of the review is structured along these questions.

First, with regard to terminology, we found that the terms are often used interchangeably and inconsistently. Moreover, most articles use the term understanding, less conceptions and perceptions. As we noticed so far, only three authors provide explicit definitions of sustainability conceptions. Reid et al. [49] (p. 664) define conceptions as the outcome of a phenomenographic study, which is described as an "hierarchical set of qualitatively different but logically related categories." This definition is only useful in the narrow context of this research method and therefore not useful for large scale assessment. Cotterel et al. [29] (p. 2) use conceptualization and describe it as the "formation of an idea about something". Conceptions need to be distinguished from understanding which incorporates the application of knowledge in decision-making situations according to Carew and Mitchell [62]. Based on our critical reading of the literature, we decided to understand sustainability conceptions as "the degree to which students associate ecological, sociocultural, and economic aspects as integral part of sustainability" [11] (p. 546). This definition seems helpful as it encompasses the three core dimensions previously described, contains the possibility of measurement, and allows to show individual points of gravity in students' conceptions.

Second, the dominant research method is a survey with open-ended and closed questions followed by qualitative interviews and mixed method approaches where interviews and surveys are combined. One study used conceptual maps as a way to measure the complexity of the conceptions [53]. Another study analyzed students' reflective journals in order to gain insight into students' conceptual changes over time [51]. Most studies are case studies which describe differences between student groups within a confined setting. However, two studies use pre-post designs to show effects of ESD courses on students' conceptions and conceptual changes [51–53].

Third, the majority of studies draws on the traditional conception with three or four dimensions of sustainability. Some studies, however, distinguish between up to seven different sustainability dimensions [25,55–57,59]. A common distinction is made between naïve, simple or pre-structural conceptions on the one hand, and broader, more sophisticated, multi-structural or interconnected conceptions on the other. Almost all previous studies indicate a tendency among students to associate primarily environmental or ecological aspects with sustainability on the expense of sociocultural aspects or economic aspects. An exception is the study by Carmargo and Gretzel [59] report 15% holistic views among their tourism students in Latin America. Further, freshmen's conceptions seem to be more simplistic, in particular prior to their studies or without being exposed to interdisciplinary sustainability courses [51,52,55].

Taken together, these results suggest that students start their higher education career with pre- or unistructural conceptions that might then influence their perception of the relevance of sustainability for them and their professional future.

3. Materials and Methods

The empirical case study presented in this paper addresses two shortcomings that have been identified in the review of the literature on key concepts (Section 2): (1) The fragmented knowledge about students' sustainability conceptions and (2) the influences of these conceptions on PPRs of sustainability as antecedents of competence acquisition in comparison to other influencing factors (i.e., socio-demographic and prior experience-related factors). We used a cross-sectional and correlational design to examine the relationship between the variables. The study was carried out at a medium-sized university with a strong focus on sustainability in northern Germany (2012–2016). In this article, we use data that have been collected before the students started their first semester in a so-called starting week. The university pursues a whole-institution approach to HESD, thus incorporating HESD into its four core activities (education, research, operations, and community outreach).

3.1. Measures

The questionnaire consisted of six independent (IV) and two dependent (DV) variables. The first part of the questionnaire asked the respondents to provide information on socio-demographics that previous studies have shown to be influential (sex, age, major subject) as well as previous informal educational experiences and prior formal engagement with sustainability (see Section 2.1). The second part comprised measures of individual characteristics like students' sustainability conceptions and PPR for their major subject ($PPR_{CURRENT}$) and their future professional work contexts (PPR_{FUTURE}) (for an overview see Table 1).

Table 1. Summary of independent (IV) and dependent (DV) variables and response types.

	Variable		Question	Response Type
IV	SEX	Sex	Please indicate your sex.	Categorical item with three options: Female/male/no answer
	MAJ	Major subject	Which major subject did you choose?	Categorical item with 15 options
	AGE	Age	How old are you?	Open ended item
	IEE	Informal educational experience	What did you do between the end of the school and the start of your current study at the university?	Multiple response, 15 items (e.g., voluntary work, internship, vacation longer than 2 month)
	FEE	Formal educational experience	Do you have ever encountered the concept 'sustainability' or 'sustainable development' in the classroom?	Dichotomous categorical item (YES/NO)
	CSD	Sustainability Conceptions	Here we would like to know to what extent you associate the following aspects with the concept of sustainable development.	Seven-point Likert scale, 12 items (e.g., 'conservation of natural resources, efficiency').
DV	$PPR_{CURRENT}$	Current Perceived Professional Relevance	Do you perceive sustainable development as related to your major subject?	Dichotomous categorical item (YES/NO)
	PPR_{FUTURE}	Future Perceived Professional Relevance	Do you perceive sustainable development as related to your future professional career?	Dichotomous categorical item (YES/NO)

3.1.1. Independent Measures

Sociodemographic variables and formal and informal educational experience were assessed through single items (see Table 1 for details). Due to the unavailability of an elaborated measure of student sustainability conceptions (see Section 2.2), a new scale was developed for this study following Borg et al.'s definition of sustainability conceptions [11]. As this study presents only cross-sectional data from first-year students entering university, we use the term *(pre-)conceptions* to refer to the aspects students relate to sustainability prior to entering the university system.

The development of the conceptions of sustainable development (CSD) scale is based on a threefold model of sustainability that comprises environmental, sociocultural and economic dimensions that has been used in prior research on students' sustainability conceptions (e.g., [58]). Each of the dimensions includes a set of independent, rather conservative objectives and principles of sustainability. The items in our questionnaire were developed and categorized to represent most commonly addressed sub-themes of these three dimensions. Participants were asked to indicate how much they associate certain aspects (e.g., 'conserving natural resources') with the term sustainability on a six-point Likert scale from 6 ('*I strongly associate this aspect with sustainability*') to 1 ('*I do not associate this aspect with sustainability*'). The related comprehensive item pool is based on Barth and Timm's [25] measurement of understandings and follows a rational scale development resulting in a list of 23 items (see Table 2). Initially, the item pool was tested in a pilot study with (n = 832) students as recommended by De Vellis [63] (p. 144–146). Additionally, students could add aspects they missed in the scale and comment on the scale. These items were then analyzed according to their psychometric aptitude and also revised and expanded based on the pre-study (see Table 2 for the scale summary and factor loadings across studies). Next, a revised pool of 23 items was created and the number of answer categories was

changed from six to seven, because a) the quality of the measurement increases when the number of answer categories increases and b) a central category to avoid forced, systematic answer biases has been added [64]. Now, the answer categories are ranging from 7 (‘*I strongly associate this aspect with sustainability*’) to 1 (‘*I do not associate this aspect with sustainability*’).

The revised 23 items were again tested for capturing the three dimensions of sustainability conceptions. In order to analyze the factor structure, a principal factor analysis was performed on the 23 items with promax oblique rotation. All items with factor loadings over 0.4 were included. With the cut-off set at 0.4, we considered the items with high loadings and content validity to keep the scale balanced [65]. A Kaiser-Meyer-Olkin value of 0.89 verified the sampling adequacy for the analysis.

The resulting instrument consists of 12 Likert-type items. Table 2 provides a full overview of the items used in the present study and Table 1 gives an example how the questionnaire was designed. Eleven items had to be deleted as they were redundant, had no content validity or were covered by another measure. Some have been rephrased. For theoretical reasons, we fixed the number of factors to three in a follow-up analysis, with the three factors representing an environmental (env_con), a sociocultural (soccul_con) and an economic (econ_con) dimension of sustainability conceptions. This factor solution explains 43% of the variance. This supports construct validity. Regarding scale reliability, Cronbach’s alpha for 12 items is $\alpha = 0.74$, indicating that a heterogeneous attribute is measured, which is reasonable against the background of existing definitions. Alpha coefficients for subscales between $\alpha = 0.70$ and $\alpha = 0.76$ (see Table 2) demonstrate that the developed instrument has an acceptable consistency and results can be considered reliable [66]. The mean inter-item correlations are between $r = 0.38$ and $r = 0.45$, which can be considered optimal [67]. For each factor, we built separate indices by averaging the factor items.

3.1.2. Dependent Measures

The conception of relevance underpinning this study has its focus on the vocational dimension, in which academic qualification (in the major subject), career orientation and preparation for future working demands are of pivotal interest [68]. PPR is operationalized in two measures: with regard to their current professional contexts ($PPR_{CURRENT}$), students were asked whether they see a relationship between their major subject and sustainability; regarding their future professional contexts (PPR_{FUTURE}), students were asked about a corresponding relationship between their future professional work and sustainability (see Table 1).

Table 2. CSD-Scale summary (factor loadings across studies).

Item	Pilot Study	Study
Factor 1: Sociocultural conception	**c = 4.00**	**c = 4.43**
Human rights	0.77	0.74
Justice between industry and developed countries	0.77	0.71
Life quality for all people around the world	0.65	0.60
Participation of all people in decision making	0.58	0.59
Social security	0.55	0.61
Protection of different cultures in the world	0.53	0.45
Deceleration	0.47	0.39
Bad compromise	0.30	-
Justice between rich and poor	-	0.82
Factor 2: Environmental conception	**c = 2.07**	**c = 2.13**
Responsible behavior	0.66	0.60
Conservation of natural resources	0.57	0.74
Environmental program	0.52	0.56
Protecting ecosystems for future generations	0.53	0.75
Relationship between the Ecological, economic, and Social	0.34	0.39
Durability/longevity	0.48	0.54
Societal learning process	-	0.33
Factor 3: Economic-technical conception	**c = 1.13**	**c = 1.07**
Economic performance	0.90	0.75
Economic growth	0.85	0.75
Technological progress	0.622	0.55
Efficiency	-	0.40
Factor 4: Skeptical conception	**c = 0.83**	
Buzz word	0.71	-
Empty phrase	0.57	-
Utopia	0.53	-

Note: Entries calculated with SPSS24. Rotated factor loadings. Rotation: oblique promax (Kaiser on). c = eigenvalues.

3.2. Data Collection and Data Analysis

The online questionnaire based on LimeSurvey™ was administered over a period of three weeks in October 2013 and 2014, before semester beginning. The sampling approach was convenience-based. Participation was anonymous, voluntary and based on informed consent. This means that the questionnaire was not part of the formal assessment of the students and that students have been invited via an online link to take part in the study. Students have been informed about their right not to answer the questionnaire and that their answers are pseudonymized. We used the LimeSurvey™ settings in a way that no link between answers and participants was possible. Items in item batteries were presented in randomized order to avoid primacy and recency effects [64]. Two independent logistic regression analyses between the independent variables and the dependent variables $PPR_{CURRENT}$ and PPR_{FUTURE} was conducted as we expected that the relationships between the personal characteristics could be different for the two outcomes. The likelihood of perceiving sustainability as relevant for their major subject or for their future professional work is represented in the form of odds ratios (*ORs*). The approximate *OR*s were calculated by exponentiating the logistic regression coefficients. *OR*s > 1 indicate that respondents have a greater likelihood of perceiving sustainability as relevant relative to the reference group employed. Conversely, an *OR* < 1 has the opposite interpretation.

Regression models were tested using a bootstrapping procedure [69]. Bias corrected 95% confidence intervals were conducted using 1.000 bootstrap samples. Furthermore, interaction terms of continuous predictors and their log-transformation were analyzed for collinearity, but no significant interaction terms were found ($p > 0.05$). The observed tolerance values for predictors are between 0.89 and 0.95 and VIF values are between 1.16 and 1.27 and therefore indicate no causes of concern [70].

No cases with concerning leverage, Cook's distances or standardized DFBetas were found. Residuals were analyzed for outliers above the limits of ± 3, with no cases found.

3.3. Sample

The online questionnaire was disseminated to all first-year students in 2013 and 2014 (N = 2730). The overall response rate of our study was 50% (see Table 3). In total, n = 1364 students responded (n_{2013} = 756 and n_{2014} = 608). We could not distinguish any external factors resulting in this rather high response rate, but not all respondents answered all questions. Due to lower response rates on some instruments in the survey, cases were excluded listwise before logistic regression analysis, resulting in $n_{\text{PPRCURRENT}}$ = 784 and $n_{\text{PPRFUTURE}}$ = 814 complete data sets in regression analysis. The share of women in the sample is 62%, which can be regarded as representative of the university surveyed. The number of female students there has remained relatively unchanged for years, with a total share of women of 60%. Students' ages ranged from 17 to 51 (M = 21.23; SD = 3.50; n = 1244). All 14 different major subjects offered at the university were represented (n = 1294).

Table 3. Sample distributions.

	Pilot Study		**Present Study**	
	N	**%**	**N**	**%**
Total Sample	1740	100.00	2730	100.00
Response (Rate)	913	52.00	1364	49.90
Sex				
Female	558	61.11	477	34.97
Male	304	33.29	258	18.91
Not indicated	51	0.06	73	5.35
Age	-	-	1244	91.20
Study program				
B.A. Teaching and Learning	111	12.16	242	17.74
B.A. Social Education	32	3.50	57	4.18
B.A. Business Education	27	2.96	48	3.52
Major subject				
Business Administration	156	17.09	214	15.69
Business Information systems	23	2.52	58	4.25
Cultural Science	202	22.12	198	14.52
Digital Media	-	0.00	25	1.83
Economics	20	2.19	34	2.49
Environmental Science*	105	11.50	179	13.12
Studium Individuale	16	1.75	33	2.42
Industrial Engineering	42	4.60	43	3.15
Business Law	70	7.67	43	3.15
Political Science	18	1.97	32	2.35
(Organizational) Psychology	73	8.00	88	6.45
Total	895	98.30	1289	94.50

Note: Age was not included in the pilot study. The major subject Digital Media has been introduced in 2014. Environmental Science including the students from Global Environmental and Sustainability Science.

4. Results

In this chapter, we first give an overview of descriptive statistics on all variables (4.1) and expand on the results regarding the role of individual characteristics on PPRs focusing in particular on the role of students' sustainability conceptions.

4.1. Descriptive Statistics for Independent Variables

Descriptive statistics on independent and dependent variables are displayed in Tables 4–6. In total, more than 46% of the sample (n = 633) indicated that they had prior encounters with sustainability in school (FEE). In addition, students experienced between zero and five informal educational experiences (n = 1287; IEE) before they entered university. Most of the students (74%) reported zero or one, and less than 1.50% had four or five informal experiences. Multiple answers were possible on this scale, so that the relative frequencies cannot be added together. If they had such encounters, most students did some casual work (26%) or completed a vocational training (23%) and/or they travelled longer than two months (21%), including Au-Pair services). Some also completed an internship (14%) after school. Often students did voluntary work (19%) and fewer participated in voluntary social, ecological or cultural services for about a year (11%). Around 12% of the undergraduates studied already before they started again at the university.

We then analyzed to what extent students associate different dimensions with sustainability. We found that the environmental dimension (Mdn = 6.5, n = 1156, IV: env_con) was most strongly associated with the concept of sustainable development, followed by the sociocultural (Mdn = 5.50; n = 1155; IV: soccul_con) and the economic dimension (Mdn = 5.00, n = 1154; IV: econ_con). Median values have been compared with Wilcoxon ranked sign test for paired samples because the scores for environmental (D (1.154) = 0.20, $p < 0.001$), sociocultural (D (1.154) = 0.11, $p < 0.001$) and economic dimensions of sustainability conceptions (D (1.154) = 0.10, $p < 0.001$) were deviating significantly from normal. All median values were significantly different ($p < 0.001$) and effect sizes varied from r = 0.57 to r = 0.36. The value for the environmental dimension indicated the possibility of a ceiling effect, which might reduce the variance.

4.2. Descriptive Statistics for Dependent Variables

We cross-checked QQ-plots and skewness and kurtosis to control for large sample size effects. As for the dependent variable, a total of 46% of n = 1364 students perceive sustainable development as relevant for their major subject ($PPR_{CURRENT}$). More than 52% think that sustainable development will be relevant for their future professional work (PPR_{FUTURE}). The drop out for $PPR_{CURRENT}$ is n = 563 and the drop-out for PPR_{FUTURE} is n = 530. In total, only n = 763 students answered both questions. The reason for the high dropout rates in the dependent variables might result from their position at the end of the questionnaire. Due to the relatively high drop-out rate in the dependent variables, we carried out a detailed analysis of the dropouts on $PPR_{CURRENT}$ and PPR_{FUTURE} as well as on all independent variables in order to find out whether values are missing at random and can be excluded listwise in the following steps of analysis. The MCAR-Test indicates that the pattern of missing values in quantitative variables is random (χ^2 = 9.43, p = 0.08) [71].

However, separate t-tests showed that missing values in the independent variable age and the dependent variable $PPR_{CURRENT}$ and PPR_{FUTURE} were significantly related. To control for possible effects on the generalizability of the data, age will be excluded from the logistic regression analysis.

Table 4. Frequencies for categorical IVs and DVs.

Variable	Name	Category	Frequencies	% (n = 1364)
IV	SEX	Female	477	34.97
		Male	258	18.91
		No answer	73	5.35
IV	FEE	ESD in School	633	46.40
		No ESD in School	254	18.60
DV	$PPR_{CURRENT}$	Yes	631	46.30
		No	170	12.50
DV	PPR_{FUTURE}	Yes	712	52.20
		No	122	8.90

Note: Entries calculated with SPSS 24.

Table 5. Descriptive statistics (means, standard deviations, minimum and maximum) for continuous IVs.

Variable	*M*	*SD*	Min	Max	*n*
AGE	21.23	3.50	17	51	1244
Econ_con	4.77	1.06	1	7	1154
Env_con	6.41	0.65	1	7	1156
Soccul_con	5.50	1.03	1	7	1155
IEE	1	-	0	5	1287

Note: Entries calculated with SPSS 24. For the ordinal scaled variable IEE we calculated the median.

Table 6. Spearman pairwise correlations for ordinal and interval scaled IVs.

Variables		AGE	Eco_con	Env_con	Soccul_con	IEE
AGE	*r*	1				
	p					
Eco_con	*r*	0.038	1			
	p	0.193	.			
Env_con	*r*	−0.030	0.128 **	1		
	p	0.306	< 0.001	.		
Soccul_con	*r*	−0.032	0.202 **	0.296 **	1	
	p	0.278	< 0.001	< 0.001	.	
IEE	*r*	0.200 ***	−0.062 *	0.041	0.104 **	1
	p	< 0.001	0.036	0.166	< 0.001	.

Note. * $p \leq 0.05$. ** $p \leq 0.01$. Econ_con = economic CSD. Env_con = environmental CSD. Soccul_con = sociocultural CSD. n = 1153.

4.3. The Role of Individual Characteristics for PPRs

In the first step of binary logistic regressions, we added independent variables in three different models in order to choose the most parsimonious for further analysis [72] (pp. 767–768). The logistic regression model was performed to describe the relationships between individual characteristics with undergraduate first year students' PPRs of sustainability. We added variables in three blocks with hierarchical analysis of each block. First, we tested a model only with sex and academic affiliation (major subject). Second, we tested a model with sex, major subject and the three dimensions of sustainability conceptions. In the third block, we added formal and informal educational experience. The models were tested independently for both DVs ($PPR_{CURRENT}$ and PPR_{FUTURE}). In what follows, we will first report the model test for $PPR_{CURRENT}$, and then for PPR_{FUTURE} (see Figure 1).

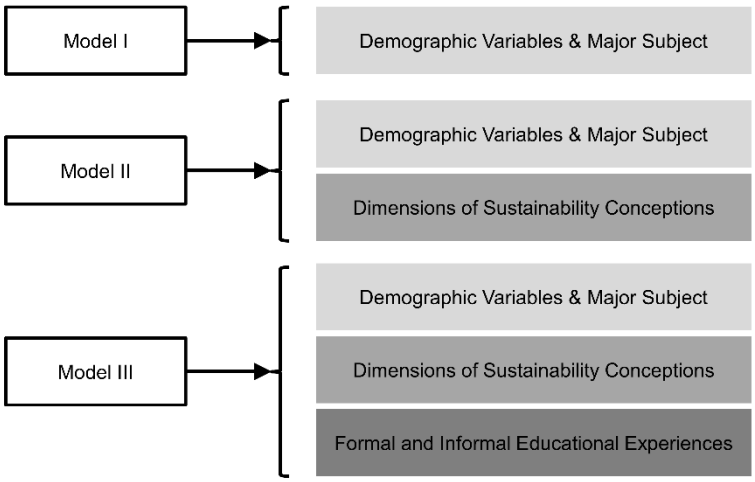

Figure 1. The three models tested in the first step of binary logistic regression to find the most parsimonious model for the prediction of current and future perceived professional relevance of sustainability.

4.4. Results for $PPR_{CURRENT}$

The logistic regression model II for $PPR_{CURRENT}$ was statistically significant, χ^2 (19) = 122.37, $p < 0.000$, and bootstrapping based on 1000 samples was applied. The final model III explained 22% (Nagelkerke R^2) of the variance in $PPR_{CURRENT}$ and correctly classified 80% of the cases.

Tables 7 and 8 show the results regarding the measures of relations of sustainability to students' major subject. Odds ratio (*OR*) for the outcome variable $PPR_{CURRENT}$ yielded several significant results. Four (sex, major subject, sociocultural dimension of sustainability and informal educational experiences) of the eight predicator variables had significant relationships with $PPR_{CURRENT}$. Planned simple contrasts were calculated to compare all major subjects to the biggest group of students: B.A. Teaching and Learning a teacher training program for primary, lower secondary and intermediate school. Next relationships will be explained in greater detail.

First, the odds of male students perceiving sustainability as relevant for their major subject were 1.73 times higher than for female students. This means that in our study the probability of perceiving sustainability as relevant for one's own academic affiliation was 73% higher for men than for women. Second, students of Environmental Science (*OR* = 19.30), B.A. Social Education (*OR* = 4.07) and Engineering (*OR* = 3.72) were more likely to perceive sustainability as relevant for their major subject than students who study the B.A. Teaching and Learning. Also, students of Studium Individuale (*OR* = 3.55), Cultural Science students (*OR* = 2.42), and Business Administration (*OR* = 2.02) perceived sustainability as more relevant for their major subject than teacher training students. In contrast, students enrolled in digital media (*OR* = 0.17) perceived sustainability less likely as important than B.A. Teaching and Learning students. Listwise deletion resulted in small samples for students from B.A. Social Education (*n* = 36), Digital Media (*n* = 17), Engineering (*n* = 23) and Studium Individuale (*n* = 23). These results should be interpreted with caution. Third, a stronger association of sociocultural aspects with sustainability resulted in a 1.53 greater likelihood of perceiving sustainability as relevant for their major subject ($PPR_{CURRENT}$). Fourth, odds ratio of the predictor IEE indicated that the more informal educational experiences students had gained before they start their studies, the greater the likelihood that they perceive sustainability as relevant for their major subject (*OR* = 1.37).

Finally, the economic and environmental dimensions of sustainability conceptions as well as formal learning experiences were not associated with $PPR_{CURRENT}$.

Table 7. Logistic regression predicting likelihood of current perceived professional relevance of sustainability ($PPR_{CURRENT}$) based on students' individual characteristics.

	Model I						Model II						Model III					
				95%*CI for OR*						95%*CI for OR*						95%*CI for OR*		
	B		*SE*	*LR*	*OR*	*UR*	*B*		*SE*	*LR*	*OR*	*UR*	*B*		*SE*	*LR*	*OR*	*UR*
Sex (reference = female)	0.31		0.23	0.88	1.36	2.12	0.54	*	0.24	1.07	1.72	2.76	0.55	*	0.26	1.07	1.73	2.80
Major subject (reference = B.A. Teaching and Learning)																		
B.A. Social Education	1.29	*	0.56	1.21	3.64	10.96	1.27	*	0.57	1.17	3.57	10.91	1.40	*	0.58	1.31	4.07	12.65
B.A. Business Education	0.06		0.44	0.45	1.06	2.52	0.03		0.45	0.43	1.03	2.50	0.12		0.46	0.46	1.13	2.76
Business Administration	0.40		0.29	0.85	1.49	2.62	0.60	*	0.30	1.01	1.82	3.26	0.70	*	0.30	1.11	2.02	3.67
Digital Media	−1.73	**	0.57	0.06	0.18	0.54	−1.67	**	0.58	0.06	0.19	0.59	−1.77	**	0.59	0.05	0.17	0.54
Industrial Engineering	0.99		0.66	0.74	2.69	9.81	1.22	*	0.68	0.90	3.38	12.75	1.31	*	0.68	0.98	3.72	14.06
Cultural Science	0.84	*	0.31	1.26	2.32	4.29	0.89	**	0.32	1.29	2.43	4.57	0.88	**	0.33	1.28	2.42	4.58
Political Science	0.95		0.65	0.72	2.59	9.31	0.91		0.68	0.66	2.47	9.28	0.85		0.68	0.61	2.34	8.91
Business Law	−0.51		0.46	0.25	0.60	1.48	−0.48		0.47	0.25	0.62	1.55	−0.43		0.48	0.26	0.65	1.65
Studium Individuale	1.08		0.65	0.83	2.95	10.49	1.29	*	0.67	0.98	3.62	13.35	1.27	*	0.67	0.96	3.55	13.15
Economics	−0.10		0.51	0.34	0.90	2.43	0.06		0.52	0.39	1.07	2.92	0.14		0.52	0.42	1.15	3.19
Business Information Systems	0.32		0.52	0.50	1.38	3.83	0.47		0.54	0.56	1.60	4.58	0.50		0.55	0.56	1.64	4.78
Organizational Psychology	0.04		0.36	0.51	1.04	2.12	0.20		0.37	0.59	1.22	2.54	0.25		0.38	0.61	1.28	2.67
Environmental Science	2.97	**	0.61	5.87	19.51	64.86	2.99	**	0.62	5.89	19.78	66.48	2.96	***	0.62	5.74	19.30	64.94
Dimensions of sustainability conceptions																		
Economic dimension							−0.03		0.10	0.80	0.97	1.18	−0.02		0.10	0.81	0.98	1.19
Environmental dimension							0.17		0.15	0.89	1.19	1.59	0.19		0.15	0.90	1.20	1.61
Sociocultural dimension							0.45	**	0.10	1.29	1.56	1.89	0.43	**	0.10	1.26	1.53	1.86
Educational Experience																		
Formal (reference = no FEE)													−0.18		0.21	0.83	0.83	1.25
Informal													0.31	*	0.12	1.37	1.37	1.74
Constant	0.72	***	0.19		2.05		−2.79	*	1.04		0.06		−2.88	**	1.10		0.06	
Observations	784						784						784					
(-2LL)	722.63						694.96						687.58					
Nagelkerke R^2	0.16						0.21						0.22					
Classification accuracy	79.70%						80.10%						80.00%					

Note: * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$. OR = Odds ratio. CI = Confidence interval. LR = Lower. UR = Upper.

Table 8. Logistic regression predicting likelihood of perceived professional relevance of sustainability (PPR_{FUTURE}) for future professional work based on students' individual characteristics.

	Model I						Model II						Model III					
				95%*CI for OR*						95%*CI for OR*						95%*CI for OR*		
	B		*SE*	*LR*	*OR*	*UR*	*B*		*SE*	*LR*	*OR*	*UR*	*B*		*SE*	*LR*	*OR*	*UR*
Sex (reference = female)	0.02		0.24	0.63		1.64	0.23		0.26	0.76	1.26	2.09	0.24		0.26	0.77	128	2.12
Major subject (reference = B.A. Teaching and Learning)																		
B.A. Social Education	1.09		0.76	0.67	2.99	13.35	1.02		0.77	0.61	2.76	12.42	0.98		0.77	0.59	2.68	12.08
B.A. Business Education	1.00		0.77	0.61	2.72	12.22	0.96		0.77	0.57	2.60	11.81	0.97		0.77	0.58	2.64	11.99
Business Administration	0.20		0.33	0.43	0.82	1.56	−0.05		0.34	0.49	0.95	1.84	−0.02		0.34	0.50	0.98	1.92
Digital Media	−1.14	*	0.56	0.11	0.32	0.97	−1.05	**	0.57	0.12	0.35	1.07	−1.02		0.57	0.12	0.36	1.11
Industrial Engineering	−1.12	*	0.52	0.12	0.33	0.90	−0.96		0.53	0.14	0.38	1.08	−0.96		0.53	0.14	0.38	1.09
Cultural Science	−0.02		0.35	0.50	0.98	1.92	−0.07		0.35	0.47	0.93	1.86	-0.07		0.35	0.47	0.93	1.86
Political Science	0.05		0.67	0.28	1.05	3.89	−0.08		0.68	0.24	0.93	3.54	−0.05		0.69	0.25	0.95	3.64
Business Law	0.15		0.67	0.32	1.17	4.30	0.23		0.67	0.34	1.26	4.68	0.25		0.67	0.34	1.29	4.82
Studium Individuale	0.16		0.66	0.32	1.17	4.29	0.24		0.67	0.34	1.27	4.74	0.19		0.67	0.32	1.21	4.53
Economics	−0.86		0.52	0.15	0.42	1.18	−0.73		0.53	0.17	0.48	1.36	−0.70		0.53	0.18	0.50	1.42
Business Information Systems	−0.75		0.53	0.17	0.47	1.33	−0.68		0.54	0.18	0.51	1.45	−0.67		0.54	0.18	0.51	1.47
Organizational Psychology	−0.51		0.40	0.27	0.60	1.32	−0.41		0.41	0.30	0.67	1.49	−0.39		0.41	0.30	0.68	1.52
Environmental Science	2.05	**	0.63	2.26	7.73	26.49	1.98	**	0.63	2.09	7.21	24.87	1.98	**	0.63	2.10	7.24	24.97
Dimensions of sustainability conceptions																		
Economic dimension							−0.12		0.11	0.72	0.89	1.09	−0.12		0.11	0.72	0.89	1.09
Environmental dimension							0.21		0.16	0.91	1.24	1.68	0.22		0.16	0.91	1.24	1.69
Sociocultural dimension							0.34	**	0.10	1.15	1.41	1.72	0.36	**	0.10	1.16	1.43	1.75
Educational experience																		
Formal (reference = no FEE)													0.27		0.24	0.81	1.30	2.09
informal													0.04		0.12	0.82	1.04	1.33
Constant	1.74	***	0.23		5.67		−1.00		1.08		0.37		−1.49		1.08		0.23	
Observations	814						814						814					
(-2LL)	631.56						616.04						614.68					
Nagelkerke R^2	0.10						0.14						0.14					
Classification accuracy	85.30%						85.50%						85.50%					

Note. * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$. OR = Odds ratio. CI = Confidence interval. LR = Lower. UR = Upper.

4.5. Results for PPR_{FUTURE}

In Table 8, the effects of the predictor variables (IV) and the second outcome variable PPR_{FUTURE} are displayed. In case of PPR_{FUTURE}, adding formal and informal educational experiences in model III did not result in a significant change in the χ^2-statistics. Therefore, we stayed with model II. In comparison to the model for $PPR_{CURRENT}$, only two of the hypothesized predictor variables had a significant relationship with the outcome. The logistic regression model was statistically highly significant, $\chi^2(17) = 65.12$, $p < 0.001$, and bootstrapping based on 1,000 samples was applied. The model explained 14% (Nagelkerke R^2) of the variance in PPR_{FUTURE} and correctly classified 86% of the cases.

We found, that academic affiliation and the sociocultural dimension of sustainability conceptions showed a significant relationship with PPR_{FUTURE}. Environmental Science students expressed a 7.21 greater likelihood to attach relevance of sustainability to their future professional work than B.A. Teaching and Learning students. Surprisingly, no further contrasts were found for other academic affiliations. In addition, a stronger association of sociocultural aspects with sustainability was correlated with increasing likelihood of perceiving relevance of sustainability for future professional work contexts ($OR = 1.41$). Finally, sex, the economic and environmental dimension as well as formal and informal education were not associated with PPR_{FUTURE}.

5. Discussion

This study explored how relevant first year students at a German university with an explicit sustainability profile consider sustainability to be for their current and future professional career (RQ1), what different sustainability conceptions they hold (RQ2), and in how far these conceptions inform their perceived professional relevance compared to other influencing factors (RQ3).

5.1. Findings

Regarding RQ1, our findings corroborate earlier works and show that almost half of all students considered sustainability as relevant for their major subject ($PPR_{CURRENT}$), and more than half for their future professional work contexts (PPR_{FUTURE}) prior to commencing their undergraduate studies. Already Azapagic et al. [22] and Bone and Agombar [23] have shown that undergraduate students conceive of sustainability as being important for their future career trajectory. Interestingly, Barth and Timm [25] showed that second and fourth semester students from the same university analyzed in our LISHE case study scored lower when they were asked to look back at how relevant they had perceived sustainability in the first semester (29%). However, the authors report that when they were asked how relevant sustainability is to them presently, this perception increased substantially, in particular for students in sustainability-related programs.

Regarding RQ2, this study found that although every dimension of sustainability was recognized by the students, differences were observed regarding the extent to which they associate economic, environmental and sociocultural aspects. Differences in median values reveal that students associate the environmental dimension to a greater extent with sustainability than other dimensions. Here, too, our findings support previous works highlighting environmental biases in sustainability conceptions (e.g., [25,51–53,55,57,59]). An important extension of previous works is that although students associate sustainability most strongly with the environmental dimension, this dimension is not significant as a predictor.

Regarding RQ3, our study has identified the sociocultural dimension of sustainability conceptions as a relevant factor influencing in how far students perceive sustainability to be relevant for the current major subject and future professional work. This is somewhat surprising as existing research found that the sociocultural dimension of sustainability is often disregarded by undergraduate and pre-university students [58,73] or neglected as an important dimension of sustainability conceptions at all [11]. More so, our study showed that it was not just considered by students, but also significantly correlated with the environmental dimension. A possible explanation for this is that students respond with more

positive emotions to sociocultural aspects of sustainability, as emotions and values have been shown to play a strong role in the ways that students make meaning of sustainability [74]. If this was the case, then this may provide an explanation for the predictive effect of sociocultural sustainability conceptions on both $PPR_{CURRENT}$ and PPR_{FUTURE} of sustainability among students. Another explanation could be that the share of students interested in social studies is high in this sample and has led to a stronger relation of this dimension to perceived relevance. However, these tentative explanations would require further exploration and substantiation.

Our study also confirms that students' academic affiliation and sex was associated with a greater likelihood of perceiving sustainability as relevant for current study contexts. Other findings confirming previously reported results are that environmental science students are more likely to consider sustainability relevant for their studies and their career than teacher training students. This finding is not surprising, given that sustainability is a key concept in environmental science students' major subject ($PPR_{CURRENT}$). Equally plausible is greater likelihood of PPR_{FUTURE} as it can be assumed that the students are already aiming for a sustainability-related position at the beginning of their studies. For teacher training students, the connection between their professional future and sustainability is probably less clear in this early stage of their studies.

Teacher training is one of several academic programs that our data showed to have some interesting nuances. In teacher training, students with a focus on vocational social education perceive sustainability to be more relevant to their studies than students for primary, lower secondary and intermediate schools. A possible explanation for that is that the B.A. Program for Social Education attracts students with a greater predisposition for social responsibility. Other noteworthy differences between major subjects can be identified for Engineering and Business Administration students who have higher scores in PPR than teacher training students. A possible explanation for this is that the fields of engineering sciences and economics at the case university have embraced sustainability more explicitly, which may have attracted students. However, this does not seem to extend to Digital Media students as they do not seem to be able to establish a link between their major subject and sustainability. However, it may also be that the field appears clearly defined and technically positioned that it is difficult to establish a relationship between the key topics of the academic affiliation and SD.

One unanticipated finding was that those students who identified themselves as being male had a greater likelihood to view sustainability as relevant for their major subject ($PPR_{CURRENT}$). This was surprising, as several other studies have shown that female students tend to display greater environmental concern [75], which we would have expected to result in stronger connections between their perceived relevance of sustainability and their major subject. A possible explanation is that in smaller samples, variance of answers can be reduced. This takes into account that probably only interested and motivated male individuals might have participated in the survey.

Finally, it is generally noteworthy that the explained variance in $PPR_{CURRENT}$ and especially for PPR_{FUTURE} was rather low. Obviously, the suggested predictors lacked incremental power, especially for describing the relationship of the factors and PPR_{FUTURE}. We see three possible explanations:

1. **Lack of studies looking into antecedents of relevance:** Most studies on relevance and conceptions in the field of HESD describe students' conceptions rather than analyzing the determinants and antecedents of these constructs. Overall, our results show that the predictors drawn from the literature lack incremental power and seem to be rather unspecific. Thus, we suggest looking into values [46] and more specific aspects why students might relate sustainability to their particular major subject, given that previous research has shown that the perceived importance of peoples' goals is strongly related to their values [76];
2. **Lack of quality in previous sustainability-related education:** Recent evidence from a representative study of German youths and young adults suggests that ESD is widely treated as an add-on topic ("teaching about sustainability") rather than an integrative perspective ("ESD as a teaching approach") [77] pp. 121–123. While this may help to improve students' familiarity with the term sustainability, it may be limited in its ability to significantly improve students' perceived

relevance of sustainability [78]. In this vein, future work may seek to include a more qualitative predictor to better account for the quality of previous formal and informal ESD experience;

3. **Lack of sophisticated sustainability conceptions in media-induced learning:** Recent findings show that while German newspapers have increasingly used sustainability terminology, they still refer to it mostly in an everyday language meaning of something being long-lasting or very intense [79]. The exposure to mass media may have contributed to an overall high familiarity with the term on the one hand but could have also given rise unspecific and unsophisticated understandings of it that may impede the perception of the concept as being relevant on the other hand.

5.2. Limitations

There are certain limitations of this study that need to be considered. In both regression analyses, we were able to show relationships only for two or three independent variables. This might suggest that PPRs are not related with other variables. It is more plausible, however, that the lack of connections, especially for sex, was a methodological inconsistency or an artefact of the unbalanced sample ratio between men and women. Furthermore, items with ceiling effects such as 'protecting ecosystems for future generations' or 'conservation of natural resources' (as aspects of sustainability conceptions) and different group sample sizes could be responsible for the lack of connections of the independent variables.

We make no claims that the survey sample is representative for the cohorts. The study was conducted with limited knowledge about sociocultural background, years of education or further information on students' individual characteristics and how these might influence students' responses. Finally, despite the large number of the survey respondents, the scope of the study was limited to a comparatively uniform group - first year students in one university in one European country in a 2-year time frame. In view of these limitations, an essential contribution of our study is to have developed and tested an empirically based approach that can be used to empirically clarify the connections between different established influential factors and PPRs. The model developed is necessarily limited in its external validity and generalizability. A promising direction for further research in this field could be to apply the approach tested here to other national, historical, cultural and institutional settings and to examine the differences and similarities that emerge.

5.3. Implications for Future HESD Research and Theory-Building

We see theoretical implications for further theory-building on PPR of sustainability as a construct in the conceptualization of learning outcomes and as a covariate especially in the detected lack of powerful predictors. As the predictors included in this study do not have a lot of incremental power and seem to be rather unspecific, further research is needed to probe the contribution of other variables. These could be, for example, individual values or practical relevance in a course or the way in which a teaching approach is designed. Furthermore, more research is needed on specific constructs or aspects that investigate what perceived relevance could mean more specifically in the context of major subjects (e.g., educating future change agents as a teacher, designing less resource-consuming products as an engineer) or different universities. Overall, our research shows that there is a need for greater consistency in the application of concepts and terms in research on student conceptions and perceptions of sustainability. Our review of existing works revealed that the terms *perception* or *view* are more often used in the context of how students perceive the implementation of sustainability in their professional contexts or how they perceive ESD, whereas the term *conception* refers to the mental representation of (aspects of) a concept. Future research should ensure greater consistency in the usage of these terms and the definitions underpinning them in order to allow for more comparable results and a consolidation of research. A further limitation for the generalization of results and models on conceptions and PPRs lies in the study designs, which are based on concepts developed in Western cultural settings and restricted to data collected in a case study context. While this study did not aim

to produce generalizable results, it seems worthwhile to build on our findings to explore how similar research in different contexts would yield differences and similarities that could then inform further theory building.

5.4. Practical Implications for Teaching Approaches in HESD

Which recommendations can be derived from these findings for the development of teaching approaches in HESD as to increase PPRs and sophistication of students' sustainability conceptions? We see three possible implications: first, given the variations in sustainability conceptions that students bring to the classroom, the instrument can inform the design of learning settings, which should provide adequate room for a critical and non-affirmative engagement with divergent sustainability conceptions. In light of the important role that prior experiences seem to play for the formation of these conceptions, learning settings should provide sufficient opportunities for students to reflect on previous informal and formal experience in their learning process [80]. Two practical implications can be drawn from this result. Universities need to offer support—especially for first year students with less informal experiences—in developing PPRs of sustainability. One possible way to leverage students' perceptions of sustainability as being professionally relevant could be to more explicitly communicate the advantages of integrating sustainability issues into curricula to and with students.

Additionally, university teachers dealing with sustainability issues should be aware of the importance of prior informal learning experiences of their first semester students and provide opportunities for transfer of this informal knowledge especially in the first semesters. Second, curriculum designers in HESD may work to strengthen the sociocultural aspects of sustainability, as these seem to be the most important factors when it comes PPRs of sustainability. For example, explicit efforts could be made to complement the presentation of environmental and/or economic-technical issues with a discussion of sociocultural conditions or implications of sustainability. Third, HESD teaching approaches should more explicitly enable students to actively engage with different understandings of sustainability. Teaching approaches including for instance mindfulness practices [81] may enable students to reflect on different understandings and provide opportunities for conceptual change.

6. Conclusions

With the SDGs, sustainability is today a key idea and concept in politics, the private and corporate sector, as well as civil society worldwide. Universities play a key role in engaging students with different concepts of sustainability so that they can develop their own understanding and use it as a framework to decide and act in different contexts. The findings of this study reveal significant differences between first year students' sustainability conceptions and the relevance that they ascribe to sustainability for their current studies and future professional contexts. These findings highlight a twofold challenge that HESD is facing to increase its effectiveness: first, to more adequately address the wide range of undergraduates' sustainability conceptions; and second, to make their academic engagement with sustainability more relevant for their current and future professional work. Our research suggests that possible curricular innovations could highlight sociocultural aspects of sustainability in order to enhance the perceived relevance of sustainability in professional contexts. This study provided a first exploration of the link between different individual characteristics, sustainability conceptions, and the relevance that students ascribe to sustainability for their professional lives that future studies in HESD research can build up on.

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