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# Do German Student Biology Teachers Intend to Eat Sustainably? Extending the Theory of Planned Behavior with Nature Relatedness and Environmental Concern

Alina Weber <sup>1,\*</sup>, Alexander Georg Büssing <sup>2</sup> , Raphael Jarzyna <sup>1</sup> and Florian Fiebelkorn <sup>1</sup>

<sup>1</sup> Didactics of Biology, Osnabrück University, 49076 Osnabrück, Germany; rjarzyna@uni-osnabrueck.de (R.J.); florian.fiebelkorn@uni-osnabrueck.de (F.F.)

<sup>2</sup> Working Group of Biology Education, Institute of Science Education, Leibniz University Hannover, 30167 Hannover, Germany; buessing@idn.uni-hannover.de

\* Correspondence: aliweber@uni-osnabrueck.de

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**Abstract:** Non-sustainable food choices are responsible for many global challenges, such as biodiversity loss and climate change. To achieve a transformation toward sustainable nutrition, it is crucial to implement education for sustainable development (ESD), with the key issue “nutrition”, in schools and teacher training. Biology teachers are crucial for promoting ESD competences. Thus, the main aim of the study is to investigate the social and environmental psychological factors that may affect the intention of student biology teachers to eat sustainably as an integral part of their action competence needed for teaching this topic effectively. We conducted a paper-pencil questionnaire ( $N = 270$ ,  $M_{age} = 22.9$ ;  $SD = 2.8$ ) based on the theory of planned behavior (TPB) and expanded the model by integrating environmental concern and nature relatedness. A path model is reported to show the relationships between the variables. The results show that the extended TPB model is suitable for predicting the intention to eat sustainably. Nature relatedness and altruistic concern positively predict attitudes and the intention to eat sustainably. This study suggests further research on the importance of (student) teachers’ nutritional behavior, as a possible determinant of the intention to teach this topic in their future school career.

**Keywords:** sustainable nutrition; pre-service biology teachers; attitudes; subjective norm; perceived behavioral control; environmental concern; nature connectedness; teacher training; education for sustainable development

## 1. Introduction

### 1.1. Nutrition and its Role in Sustainable Development

Many of the recent global environmental problems, such as biodiversity loss and climate change, are affected by unsustainable human behavior. This is mainly due to humankind’s unsustainable eating habits, with high meat consumption and a high amount of food waste [1,2]. Moreover, the world population is expected to reach 10.9 billion by 2100 [3]. This is accompanied by an increase in meat and dairy consumption, especially in the emerging and developing countries [4]. To meet the increased nutritional demands, an agricultural transition, as well as a restructuring of the food system and changes in individual eating habits toward more sustainability are needed [5,6].

According to von Koerber [7], the concept of sustainable nutrition is based on five dimensions: (1) health, (2) society, (3) economy, (4) environment, and (5) culture. In addition to these, von Koerber [7]

proposes practical orientations for actions to implement the concept of sustainability in the field of nutrition. The following seven principles can be understood as concrete instructions for everyday action to achieve sustainable nutrition: preference for (1) plant-based foods, (2) organic foods, (3) minimally processed foods, (4) regional and seasonal products, (5) fair trade food products, (6) resource-saving housekeeping, and (7) an enjoyable eating culture. So far, the goal of sustainable nutrition has not been sufficiently implemented in daily nutrition behavior [7].

### *1.2. Nutrition as an Appropriate Learning Field for Education for Sustainable Development*

Nutrition is thus a key issue in the progress of sustainable development [8]. Therefore, it is necessary to find determinants that underlie sustainable nutrition and practical approaches to solutions to generate a transformative sustainable change [9,10].

Sustainable nutrition is linked to many of the 17 Sustainable Development Goals (SDGs) [11]. Consequently, within Agenda 2030, the transition to sustainable nutrition is required for achieving the SDGs (e.g., SDG 2, “Zero hunger”; or SDG 12, “Responsible consumption and production”). Here, teacher training plays an important role in reaching the SDGs in the formal education sector and has been regarded as a priority field of the UNESCO Global Action Programme (GAP) on Education for Sustainable Development (ESD) [12,13]. The aim is to ensure, by 2030, that all teachers and learners have the required competencies through ESD to promote sustainable development (SDG 4, “Quality education”) [11], as this is an obligatory part of German school curricula for biology [14]. Education is a necessary tool that can contribute directly to sustainability and to solving global environmental problems, such as the transformation toward sustainable nutrition [15]. In 2012, “nutrition” was declared an appropriate learning field for ESD [16]. ESD aims to deliver transformational education that empowers learners “to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations” [11] (p. 7). In addition, it plays a crucial role, as it can contribute to the change needed and promote the acquisition of sustainability competencies and, thus, a change in eating habits toward greater sustainability [17].

In the context of ESD, the aim should not be to prescribe certain ways of thinking and behaving or to accept them without reflection. Rather, the aim should be to enable people to critically question their own values and attitudes in the context of sustainable development in the sense of reflected decision-making [11,18]. Thus, the acquisition of so-called holistic sustainability competencies, such as knowledge, attitudes, values, beliefs, and behavior, is not only relevant for learners but also for (student) teachers [10,11,19–21]. This highlights the importance of teacher education. Before addressing learners, it is crucial to find teacher educators who can act as mediators of the learning processes, as they are key agents in educating new teachers, who will later affect the shaping of future sustainability makers [15,22].

### *1.3. Teachers’ Professional Action Competencies for Teaching Sustainability Topics*

Given the need for teachers to develop such a large variety of cognitive and affective competencies in their students, teaching about sustainability is very demanding for teachers. Therefore, the conceptualizations of how effective teachers may be educated are rather complex. One possibility for defining the competencies of effective teachers is the model of professional action competence [23]. This model defines several cognitive and affective variables as being essential for effective teaching. First and foremost, teachers need sufficient professional knowledge from the different domains of content, pedagogical, and the subsequent pedagogical content knowledge [24]. In addition to this, Baumert and Kunter [23] also defined beliefs, values, and motivations as other competencies needed for effective teaching. These more affective variables may be especially necessary in regard to teaching about sustainability topics [25]. For example, a study on the topic of returning wolves as a biodiversity issue found how the protection motivation of wolves was connected to the enjoyment of teaching about the species [26]. Similarly, general values may also affect the enjoyment teachers experience when teaching in inclusive settings [27].

This professional action competence may also be needed to successfully teach nutrition as an ESD topic in schools [28]. Student teachers' sustainability competencies (knowledge, attitudes, values, beliefs, behavior) profoundly affect their future teaching practice, as their ways of thinking and understanding are necessary components of their teaching practice [29]. Their knowledge, attitudes, values, beliefs, and behavior can also have an effect on their teaching activities and teaching motivation [26,30–35]. In addition, student teachers' competencies are crucial for restructuring educational processes and educational institutions toward sustainability [36]. These sustainability competencies can be particularly promoted by the topic of sustainable nutrition [8,16]. However, previous studies have given them only scant consideration [37].

In particular, biology teachers should be able to meet the challenges of sustainable nutrition and their own role in this process [28]. Considering this, universities should address and convey a central comprehension of sustainability, so that students can consider this perspective in their future professional activities as teachers [17]. This is all the more true because teachers can act as role models—especially regarding sustainable behavior—and therefore give young people direction for their own attitudes and actions [38]. It is highly important that teachers understand the concept of sustainable development, give credence to the significance of ESD, and believe in the power of education to affect sustainability issues, as well as sharing the vision of a sustainable world. Adequate and efficient educational programs at schools and universities on the key topic of sustainable nutrition could offer great potential within the framework of ESD to induce behavioral changes in both students and teachers [8].

Even if the implementation of ESD and the topic of nutrition is still missing in German teacher education in many places [11,39,40], it is important to investigate the intention of student biology teachers to eat sustainably and its influencing factors. Investigating the (sustainable) nutritional behavior of student biology teachers is promising, as this may be a possible part of their professional action competence needed for the effective teaching of sustainable nutrition as an ESD topic in schools. Furthermore, the intention to eat sustainably may have an effect on the intention to teach this topic, the quality of teaching, and the students' learning progress. So far, this possible causal relationship is merely an assumption.

Whether student biology teachers in Germany have positive attitudes toward sustainable nutrition and intend to eat sustainably has only been shown in an initial study [41]. Before the influence of teaching behavior is examined, the present study first examines whether and to what extent student biology teachers intend to eat sustainably, and what factors may predict this intention.

#### *1.4. Aim of the Present Study*

For this study, selected aspects of teachers' professional action competence for the topic of sustainable nutrition [23] are operationalized via the theory of planned behavior (TPB) [42]. The TPB is considered suitable for identifying attitudes, subjective norm, and perceived behavioral control, which may have an influence on the intention to eat sustainably. The TPB has been successfully applied in the context of different sustainable and environmentally friendly behaviors [43,44]. Furthermore, its usefulness for studies with (student) teachers has been demonstrated [45,46].

As many individual background factors can influence a person's attitudes [47], and variables from environmental psychology seem to be promising for investigating attitudes toward sustainable nutrition [48–50], the present study aims to show to what extent the environmental psychological variables nature relatedness and environmental concern impact on the TPB variables in the context of sustainable nutrition. Therefore, an extended TPB model for predicting student biology teachers' intention to eat sustainably will be tested. It can be used to derive empirically based educational interventions for biology teacher training at universities.

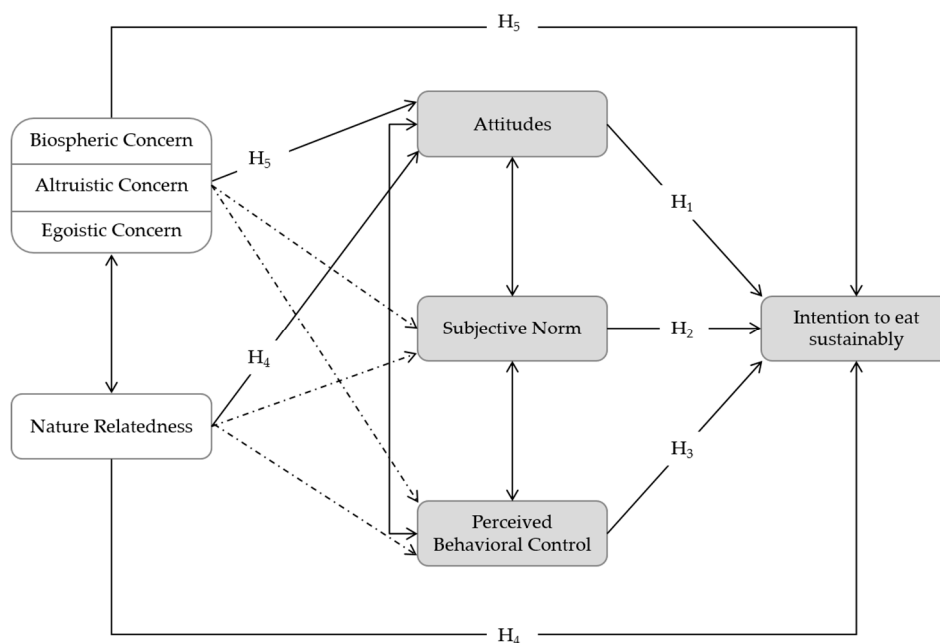
In more detail, the aim of the present study is two-fold: first, we want to examine whether and to what extent attitudes, subjective norm, and perceived behavioral control as TPB variables affect the intention to eat sustainably. Second, we will assess whether environmental concern and

nature relatedness—which have been added to the TPB model—have explanatory power for attitudes, subjective norm, perceived behavioral control, and the intention of student biology teachers to eat sustainably. The resulting TPB-based conceptual framework, including the hypothesized determinants of the intention to eat sustainably, is presented in Figure 1.

## 2. Theoretical Framework: An Extended TPB

In environmental and nutritional psychology, the TPB is one of the most frequently used models for explaining environmentally friendly and sustainable behavior [51,52]. The model has been used for explaining sustainable consumption, waste reduction, and energy or water saving [20,43,53–55].

In the TPB, behavioral intention captures the motivational factors that influence a person's decision to perform (or not) a particular behavior and is a measure of how much effort the person wants to put into it. Behavioral intention is the most important predictor and the primary antecedent for the behavior [53,56]. It is determined by three variables (Figure 1): (1) attitudes, (2) subjective norm, and (3) perceived behavioral control [42,57]. These variables differ in terms of different target behavior and different groups of people [56]. Yet, it has been shown that attitudes, subjective norm, and perceived behavioral control correlate positively with the intention of student biology teachers to eat sustainably [41].



**Figure 1.** The relationships presented are examined in the present study. The theory of planned behavior (TPB) variables are in grey; the extended variables are in white. Dashed lines show the assumed exploratory relationships examined in the present study. Solid lines show the assumed relationships based on the literature.

In addition to these specialized factors from the original TPB, the present study investigates how far other sustainability-related variables may be relevant to the intention to eat sustainably. Such a connection of more general factors to more specialized ones can be hypothesized from the theory of cognitive hierarchy. The theory states that deeper personality variables such as values are the foundation of higher-order attitudes and behaviors [58]. Consequently, the variables are understood as part of a cognitive hierarchy, moving from general values to more specific attitudes toward sustainable nutrition and norms, and up to the intention to eat sustainably [58,59].

## 2.1. Original Variables of the TPB

### 2.1.1. Attitudes toward Sustainable Nutrition

Attitudes indicate to what degree a person has a favorable or unfavorable evaluation of the behavior of interest [42]. If respondents believe that eating sustainably has mainly positive effects on the environment, their attitudes toward sustainable nutrition are likely to be positive, and vice versa [20]. Furthermore, attitudes might have an effect on teaching motivation, teaching behavior [26,30–35], and on the integration of ESD contexts—such as sustainable nutrition—into biology teaching [26].

In previous studies on healthy and sustainable dietary behavior, attitudes proved to be the most relevant TPB variable for health-promoting dietary behavior [60], the intention to eat insect-based products [61], and the intention to consume sustainable dairy products [44]. Therefore, we assume that positive attitudes toward sustainable nutrition should also have a high influence on the intention to eat sustainably in our student biology teacher sample.

**Hypothesis 1 (H1).** *Attitudes toward sustainable nutrition are a positive predictor of the intention of student biology teachers to eat sustainably.*

### 2.1.2. Subjective Norm

Subjective norm refers to the individually perceived social pressure to perform a certain behavior (or not). The opinions and expectations of the social environment affect the development of a person's behavioral intention and help to determine whether the person will actually carry out a certain behavior [42,57]. Subjective norm seems to be less important in the context of sustainable nutrition [41]. Based on the literature, it can be assumed that subjective norm has a positive influence on student biology teachers' intention to eat sustainably, albeit to a smaller extent than attitudes or perceived behavioral control.

**Hypothesis 2 (H2).** *Subjective norm is a positive predictor of the intention of student biology teachers to eat sustainably.*

### 2.1.3. Perceived Behavioral Control

Perceived behavioral control refers to the perception of one's own ability and the anticipated degree of difficulty in performing the behavior of interest [42,57]. It has particularly high relevance in behavioral prediction when the person has little control over how to behave, regardless of how positive their attitudes are. For example, if respondents find it difficult to eat sustainably due to a lack of time or financial resources, perceived behavioral control will be low and affect the intention negatively [43,62]. Therefore, it can be assumed for the present study that a high level of perceived behavioral control makes a major contribution to the respondent's intention to eat sustainably.

**Hypothesis 3 (H3).** *Perceived behavioral control is a positive predictor of the intention of student teachers to eat sustainably.*

## 2.2. Extending the TPB: Nature Relatedness and Environmental Concern

Despite the multifaceted application of the TPB, there are concerns about the incompleteness of the model [10]. To increase the predictive power of the intention to eat sustainably, the inclusion of further predictors is recommended [42,63–65]. Variables from environmental psychology in particular seem to be promising for researching the formation of attitudes and motives in the context of sustainable nutrition [41]. So far, only a few studies based on the TPB have taken these determinants into account [56].

Nature relatedness is a predictor of various pro-environmental and sustainable behaviors, such as the purchase behavior of environmentally friendly products [66,67], as well as the intention to eat

sustainably [39]. In addition, environmental concern has an influence on the willingness to buy organic food [48,50,68]. The extent to which environmental concern [69] and nature relatedness [70] influence the intention of student biology teachers to eat sustainably has been investigated insufficiently and in very few studies [41].

Therefore, the present study focusses on the role of nature relatedness [70] and the three types of environmental concern (altruistic, egoistic, biospheric) [69], to gain deeper insight into the variables affecting the intention to eat sustainably.

### 2.2.1. Nature Relatedness

Nature relatedness is defined as a permanently existing personality trait that can, however, change depending on environmental conditions [71,72]. It encompasses the individual differences in human attachment to the natural environment, and expresses the extent to which people identify with it [70,73,74]. Being related to nature can predict environmentally friendly attitudes and behavior [49,70,74,75]. The more people feel connected to nature, the more they become aware of the consequences of their own activities for the environment [76]. Therefore, strong nature relatedness goes hand in hand with a greater sense of responsibility toward nature and ecologically more sustainable behavior [73,77]. Nature relatedness is crucial for reaching the SDGs, because it involves our fundamental relationship with the natural world [78].

With reference to the present study and based on the literature, it is assumed that nature relatedness leads to more positive attitudes toward sustainable nutrition, and thus increases the intention of student biology teachers to eat sustainably.

**Hypothesis 4 (H4).** *Nature relatedness is a positive predictor of the TPB variables (attitudes toward sustainable nutrition, subjective norm, perceived behavioral control, intention to eat sustainably).*

### 2.2.2. Environmental Concern

Environmental concern is defined as individual awareness or insight that the state of the environment is threatened by human behavior, such as pollution and the excessive use of resources [79]. Thus, it aims at the perception and personal evaluation of environmental problems, and how they can be solved or addressed [80–82].

As part of their value basis of environmental concern theory, Stern and Dietz [83] showed that environmental concern can be based on a person's egoistic, social-altruistic, and biospheric value orientations. Following from this, Schultz [69] demonstrated a three-dimensional structure of the construct:

- (1) Egoistic concern describes that persons attribute a higher meaning to themselves rather than to other people and living things. Their interest in environmental problems and their consequences is based on the concern for their own well-being. People who are egoistically concerned will consider the costs and benefits of eating sustainably for them personally (e.g., for their own health). When the perceived benefits for oneself are higher than the perceived costs, people will intend to eat sustainably, and vice versa [56,64].
- (2) By contrast, altruistic concern is characterized by concern for other people who may be affected by environmental changes. People who are altruistically concerned will base their decision to eat sustainably (or not) on the perceived costs and benefits for all people [64].
- (3) Biospheric concern includes care for the biosphere and all living beings existing in it [69,83]. People with high biospheric concerns will base their decision to act pro-environmentally on the perceived costs and benefits for the ecosystem and biosphere [56].

In our study, we will assess all three dimensions of environmental concern to better understand whether and how each type of concern affects attitudes toward sustainable nutrition, subjective norm, perceived behavioral control, and the intention to eat sustainably (Figure 1). Based on the results

of previous studies, we assume that altruistic and biospheric concerns are positive predictors, and egoistic concern is a negative predictor of attitudes toward sustainable nutrition and the intention to eat sustainably.

**Hypothesis 5 (H5).** *Altruistic and biospheric concern are positive predictors and egoistic concern is a negative predictor of the TPB variables (attitudes toward sustainable nutrition, subjective norm, perceived behavioral control, intention to eat sustainably).*

### 3. Materials and Methods

#### 3.1. Research Design

For the present study, we conducted a cross-sectional study with a paper-pencil questionnaire distributed at four universities in north-west Germany in 2018 (Bielefeld [ $n = 28$ ], Münster [ $n = 81$ ], Osnabrück [ $n = 125$ ], Hannover [ $n = 36$ ]). The initial sample consisted of 281 student biology teachers. Prior to the analyses, we excluded 11 questionnaires that had not been fully answered by the respondents (not more than 50% of items answered). Therefore, the final sample consisted of 270 student biology teachers (69% female, 64% BA students). In total, we asked six universities to participate in the study. Two universities did not answer or were conducting their own questionnaire studies at the time, and therefore did not have the capacity for external studies. All respondents were enrolled in teacher programs to become biology teachers. More than 90% of the students were studying to be biology teachers in secondary school (general school, secondary school, high school, comprehensive school), and 10% of the participants were studying to be teachers in vocational school. As we did not intend to examine differences specific to either subjects or school type, we have summarized the sample as “student biology teachers”.

The participants were aged 18–33 years ( $M_{\text{age}} = 22.9$ ;  $SD = 2.8$ ). We ensured the anonymity of all participants. In addition, the participants could cancel the survey or skip single questions at any time. The average duration for questionnaire completion was between 15 and 30 min. At the universities of Osnabrück and Münster, the third author conducted all questionnaire surveys. All other questionnaires, together with a standardized information sheet on how the survey was to be conducted, were sent to the respective persons in charge of the universities’ institutes of biology education.

#### 3.2. Measuring Instruments

The original items in the questionnaire were formulated in German. The corresponding items were translated into English for the purpose of this publication. At least three items were used for each construct (Table 1). The original scales were translated into German using a double-translation approach, by back-translating them from German to English and checking for coherence. In general, the survey was part of a larger research project, and therefore covered more scales than presented here. Table 1 shows the descriptive statistics (mean, SD, Cronbach’s alpha). All items and the results of the confirmatory factor analyses (CFA) are shown in Supplementary Material S1. The original questionnaire with all items can be obtained on request from the first author.

##### 3.2.1. TPB Variables

The items of the TPB constructs were adapted and operationalized according to the recommendations by Graf [57] for the context of sustainable nutrition. Most of these TPB constructs had been tested in a prior German version of the questionnaire [41]. Only the scale used for measuring attitudes toward sustainable nutrition has been modified, and has not been tested in the present form.

Intention to eat sustainably was measured using a scale based on the seven principles of sustainable nutrition according to von Koerber [7]. We used a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) from a previous study, and modified it based on the previous results [41]. In total, the scale consists of seven items (e.g., “Next month, I intend to buy preferably vegetable foods”). After CFA, the item

“Next month, I intend to buy only as much food as I really need” was eliminated due to factor loading of  $<0.40$  [84]. The item “Next month, I intend to buy preferably minimally processed food” was also eliminated due to low factor loading. Nevertheless, the factor loading was slightly above 0.40 (0.419). Based on the results of the previous study, the elimination of this item was suggested [41]. Therefore, we excluded it, based on the theoretical justification from the previous study. This led to a higher Cronbach’s alpha value. Cronbach’s alpha for the modified scale with five items was  $\alpha = 0.78$ , which is close to the  $\alpha = 0.79$  in the previous study [41].

Attitudes toward sustainable nutrition were measured using a semantic differential on a 7-point scale with six bipolar adjective pairs ( $-3 =$  negative pole,  $+3 =$  positive pole, e.g., “To eat sustainably is very bad—very good for me”), based on Graf [57]. After CFA, the item “eating sustainably is very stressful—very easy for me” was eliminated, due to a factor loading of  $<0.40$  [84]. Excluding the item increased the internal consistency from  $\alpha = 0.81$  to  $\alpha = 0.85$ .

We used a 7-point Likert scale for measuring subjective norm (1 = very likely; 7 = very unlikely, e.g., “My family thinks that I should eat sustainably”). After CFA, one of the four items (“My lecturers think that I should eat sustainably”) was excluded, due to factor loading of  $<0.40$  [84]. Eliminating the item led to a higher Cronbach’s alpha for the modified subjective norm scale (from  $\alpha = 0.82$  to  $\alpha = 0.88$ ), which is consistent with the result of the previous study ( $\alpha = 0.87$  [41]).

We used a 7-point Likert scale for assessing perceived behavioral control (1 = very likely; 7 = very unlikely; e.g., “For me, achieving a sustainable diet is very difficult—very easy”). The scale consists of four items. Based on the CFA, the item “The decision to eat sustainably underlies my complete control” was excluded from further analyses. This item showed low factor loading, but with a value of 0.44, which was still above 0.40. However, it had also been excluded in the previous study [41]. In addition, its elimination led to higher internal consistency, with Cronbach’s alpha increasing from  $\alpha = 0.76$  to  $\alpha = 0.79$ , which is nearly consistent with the value ( $\alpha = 0.78$ ) in Weber and Fiebelkorn [41].

### 3.2.2. Environmental Psychological Variables

The construct of nature relatedness was assessed using the NR-6 scale [77], a short six-item version of the nature relatedness scale [70]. The short version is increasingly used in sustainability research [77]. Based on a 5-point Likert scale, respondents rated their relatedness to nature from 1 = strongly disagree, to 5 = strongly agree (e.g., “I always think about how my actions affect the environment”). CFA showed that all items loaded on one factor. Therefore, all items were retained for further analyses. The internal consistency of this scale lay with Cronbach’s alpha of  $\alpha = 0.83$ , within the range of 0.83–0.86 for scale testing [77].

Environmental concern was measured using the three-dimensional scale by Schultz et al. [64]. We used this 5-point Likert scale (1 = not important, 5 = important) to measure individual perception of environmental problems based on egoistic (e.g., “I am concerned about environmental problems because of the consequences for me”), altruistic (e.g., “[...] for all people”), and biospheric (e.g., “[...] for plants”) motives. In total, the scale consists of 12 items—four items per subdimension. Based on the CFA, all items were retained for further statistical analysis. The internal consistency of this scale was  $\alpha = 0.87$  for all 12 items,  $\alpha = 0.77$  for the egoistic dimension,  $\alpha = 0.79$  for the altruistic dimension, and  $\alpha = 0.96$  for the biospheric dimension.

### 3.3. Data Analysis

All calculations were performed using SPSS (IBM, Version 26) or RStudio version 1.1.463 with the lavaan package [85]. In the first step of the statistical analyses of our data, we performed CFA using RStudio. We used CFA to generally test whether there was sufficient agreement (model fit) between our empirical data and the a priori conceptualized, theoretical model (Figure 1).

The first unmodified estimation of the data led to an unacceptable fit of the CFA model, with the comparative fit index (CFI) not meeting the selected criteria (robust root mean square error of approximation (RMSEA) = 0.054, robust CFI = 0.896, standardized root mean square residual



(SRMR) = 0.069). Further inspection indicated factor loadings of <0.40 for some items (Supplementary Material S1). In the second step, we decided to modify the measurement model based on theoretical and empirical justifications [86]. The items INT5 and PBC4 showed low factor loadings, but were still >0.40. Previous results [41] suggested excluding these two items. Therefore, we decided to eliminate them based on theoretical justification to obtain a better fit of the measurement model.

These modifications led to a satisfactory model fit, with RMSEA = 0.050, CFI = 0.928, and SRMR = 0.066, which indicated sufficient discriminant validity of the scales. An acceptable model fit is indicated by RMSEA  $\leq$  0.06, CFI between 0.90 and 0.95, and SRMR  $\leq$  0.08 [86,87].

After conducting the CFA, we calculated Cronbach's alpha as an additional indicator of the internal consistency of all scales (Table 1; [84]). All factors showed acceptable internal consistency with values above 0.70 [84]. After examining their reliability, we constructed the scales based on the mean of the described items using aggregated means. We calculated the descriptive statistics (e.g., mean and SD) and bivariate correlations of all variables (Table 1). We then calculated a path model to answer the subsequent research questions and hypotheses.

#### 4. Results

Concerning the connections between the variables, all of the variables correlated positively with attitudes toward sustainable nutrition, subjective norm, perceived behavioral control, and the intention to eat sustainably (Table 1). In general, the strongest relations were found between the environmental concern dimensions ( $r = 0.34$ – $0.54$ ,  $p < 0.001$ ) and between the TPB variables, which all showed positive correlations with medium to large effect sizes ( $r = 0.32$ – $0.55$ ,  $p < 0.001$ ). In particular, attitudes correlated positively to the intention to eat sustainably with a large effect size ( $r = 0.55$ ,  $p < 0.001$ ).

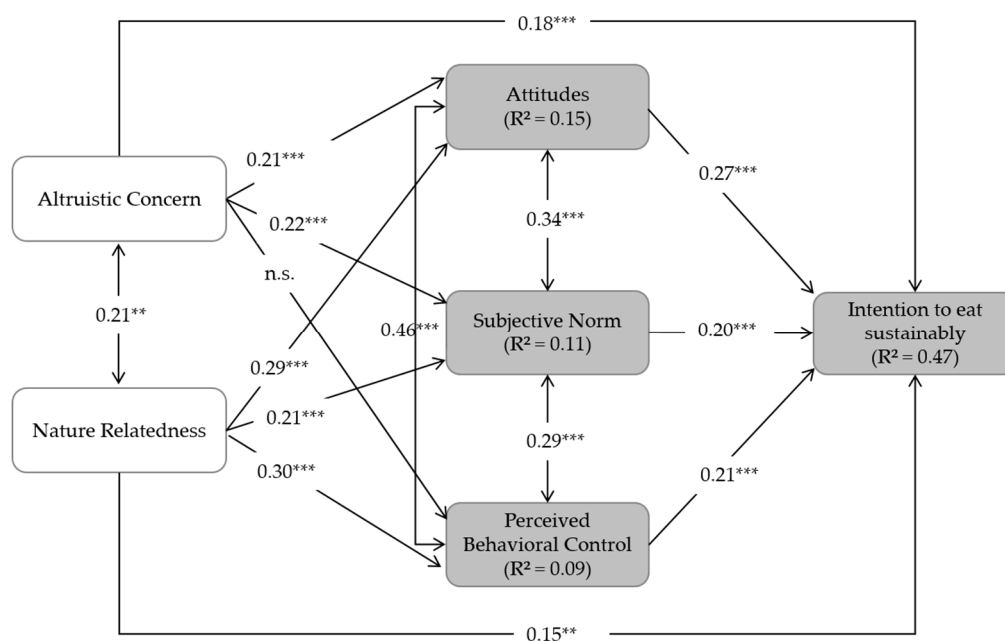
**Table 1.** Intercorrelations and descriptive statistics of all variables.

Variable	1	2	3	4	5	6	7	8
1. Intention	1	0.55 ***	0.48 ***	0.40 ***	0.36 ***	0.35 ***	0.29 ***	0.25 ***
2. Attitudes		1	0.42 ***	0.43 ***	0.32 ***	0.30 ***	0.28 ***	0.23 ***
3. Subjective norm			1	0.32 ***	0.22 ***	0.26 ***	0.19 **	0.16 **
4. PBC				1	0.27 ***	0.14 *	0.18 **	0.13 *
5. Nature relatedness					1	0.22 ***	0.42 ***	0.25 ***
6. Altruistic concern						1	0.54 ***	0.44 ***
7. Biospheric concern							1	0.34 ***
8. Egoistic concern								1
Number of items	5 (7)	5 (6)	3 (4)	3 (4)	6 (6)	4 (4)	4 (4)	4 (4)
Mean	3.48	5.68	3.78	4.70	3.11	4.41	4.45	4.10
SD	0.76	1.08	1.55	1.18	0.75	0.56	0.69	0.64
Cronbach's $\alpha$	0.78	0.85	0.88	0.79	0.83	0.79	0.96	0.77

Note: \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ ; PBC = perceived behavioral control. Brackets show the number of the original scales' items before elimination due to the confirmatory factor analysis.

Concerning the added environmental psychological variables, nature relatedness and altruistic concern showed positive correlations with a medium effect size with attitudes (nature relatedness:  $r = 0.32$ ,  $p < 0.001$ ; altruistic concern:  $r = 0.30$ ,  $p < 0.001$ ) and intention to eat sustainably (nature relatedness:  $r = 0.36$ ,  $p < 0.001$ ; altruistic concern:  $r = 0.35$ ,  $p < 0.001$ ). Egoistic and biospheric concerns showed correlations with only a small effect size with the TPB variables ( $r = 0.13$ – $0.29$ ,  $p < 0.05$  to  $< 0.001$ ).

After the descriptive analyses, we constructed a path model based on the theory of cognitive hierarchy and the theoretical background (Figure 1). Figure 2 shows the standardized path coefficients of the final model.



**Figure 2.** Results of the path analysis based on Figure 1 for predicting the intention to eat sustainably. Model fit indices: robust root mean square error of approximation (RMSEA) = 0.027; standardized root mean square residual (SRMR) = 0.041; robust comparative fit index (CFI) = 0.997. The directional arrows show the predictive power. The double arrows show correlations between the variables. R<sup>2</sup> = Explained variance. \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Biospheric and egoistic concern showed no predictive power for any of the other variables. For reasons of clarity, they are not presented in this figure.

The fit indices indicated a good model fit (robust RMSEA = 0.027, SRMR = 0.041, robust CFI = 0.997) [88]. The overall model explained about 47% of the variance of the intention to eat sustainably ( $R^2 = 0.47$ ), 15% of the variance of attitudes toward sustainable nutrition ( $R^2 = 0.15$ ), 11% of the variance of subjective norm ( $R^2 = 0.11$ ), and 9% of the variance of perceived behavioral control ( $R^2 = 0.09$ ). Attitudes toward sustainable nutrition ( $\beta = 0.27$ ,  $p < 0.001$ ), subjective norm ( $\beta = 0.20$ ,  $p < 0.001$ ), and perceived behavioral control ( $\beta = 0.21$ ,  $p < 0.001$ ) were positive predictors of the intention to eat sustainably. Attitudes had the strongest effect on the intention to eat sustainably.

Nature relatedness significantly predicted attitudes toward sustainable nutrition ( $\beta = 0.29$ ,  $p < 0.001$ ), subjective norm ( $\beta = 0.21$ ,  $p < 0.01$ ), and perceived behavioral control ( $\beta = 0.30$ ,  $p < 0.001$ ), and to an even smaller degree, the intention to eat sustainably ( $\beta = 0.15$ ,  $p < 0.01$ ). In the path model, three dimensions of environmental concern were tested. The path analysis identified only altruistic concern as a predictor. The path model showed that—in comparison to nature relatedness—altruistic concern was another, but weaker, direct predictor of attitudes toward sustainable nutrition ( $\beta = 0.21$ ,  $p < 0.001$ ), subjective norm ( $\beta = 0.22$ ,  $p < 0.001$ ) and the intention to eat sustainably ( $\beta = 0.18$ ,  $p < 0.001$ ). It showed no significant predictive power for perceived behavioral control ( $p > 0.05$ ).

## 5. Discussion

### 5.1. The Original TPB-variables as Predictors of the Intention to Eat Sustainably

Attitudes toward sustainable nutrition, subjective norm, and perceived behavioral control showed significant positive predictive power for the intention of student biology teachers to eat sustainably.

Consistent with our first hypothesis ( $H_1$ ), of the three determinants of the original TPB model, attitudes were the strongest predictor of the intention of student biology teachers to eat sustainably. This is in line with previous studies that highlight attitudes as being the most important predictor in

the field of nutrition (intention to eat healthy products [45], intention to consume sustainable dairy products [46], intention to eat insect-based products [47]).

Subject-specific attitudes are considered an integral part of the teacher identity [26,89]. If student teachers have positive attitudes toward a particular teaching context, they find it easier to acquire new knowledge on the subject [90]. In addition, positive attitudes may promote or prevent (student) biology teacher integration of special ESD contexts—and in the case of the present study, in particular, the issue of sustainable nutrition—into biology classrooms. In the official school curricula for biology, teachers in Germany are not prescribed which examples they should use to teach ESD relevant topics [91], e.g., they can teach ESD by using the examples of mobility, environmental protection, or nutrition. Consequently, teachers could or should choose a suitable topic for assessing ESD in biology lessons, and therefore contribute to their students' development of sustainability competencies, and particularly, to decision-making competence. If (student) biology teachers have positive attitudes toward sustainable nutrition, they may be more likely to teach this topic in schools. In future studies, it would be useful to compare attitudes toward different ESD contexts, such as biodiversity conservation, mobility, and sustainable nutrition.

To foster attitudes toward sustainable nutrition in teacher education, it is important to increase student teacher awareness regarding, for example, the food production process or the conditions of mistreatment or injustice against employees and animals [92]. Only if learners are aware of the value chains of food products, they can use the dimensions according to von Koerber [7] to understand the complexity of each process of the food value chain.

Learners should also be aware of sustainable nutrition being relevant and helpful for the environment, their own health, society, and the economy [93]. It may be promising to first tie up with existing courses in human biology, ecology, and bioethics, and to produce references to sustainable nutrition. The dimensions of sustainable nutrition, according to von Koerber [7], could be covered in these courses. The health dimension and environmental dimension could be addressed in human biology lectures and in ecology courses, respectively. In bioethics courses, student teachers' decision-making could be fostered by addressing topics on sustainable nutrition, such as eating insects, in vitro meat, or animal welfare [18,94].

Perceived behavioral control is another important predictor of the intention to eat sustainably ( $H_2$ ). The extent to which student biology teachers believe that they have control over how to eat sustainably, as well as perceived opportunities for action, spurs them to integrate sustainable eating habits into their everyday lives. This suggests that educational implications in teacher education should also strengthen perceived behavior control. Courses should address issues to support and facilitate sustainable eating habits as well as perceptions about, for example, the lack of necessary resources and possibilities for action in the students' everyday lives.

Educational implications for teacher training should foster the beliefs that people have the necessary resources and possibilities to eat sustainably. First, the positive aspects, e.g., the large number of sustainable products in supermarkets, high availability, and many possibilities for eating out sustainably, should be addressed. Only when people perceive possibilities for eating sustainably, the higher perceived control can lead to a higher intention to eat sustainably [95].

Subjective norm was a significant positive predictor of the intention to eat sustainably ( $H_3$ ), but to a smaller extent in comparison to attitudes and perceived behavioral control overall, which is consistent with previous studies in the field of nutrition (intention to eat sustainably [41], intention to eat sustainable dairy products [44], intention to eat insect-based products [61]). Based on the CFA results, the item concerning lecturers was eliminated. This shows that only the opinion and expectations of more closely related people are relevant to the respondent's decision to eat sustainably or not. Here, that student biology teachers are more self-determined than younger learners in schools should be taken into account. As the subjective norm still has an effect on the intention to eat sustainably, educational implications should also take its relevance into account.

The path model showed that attitudes, subjective norm, and perceived behavioral control explained 41.7% of the variance of the intention to eat sustainably. Previously, we showed an explained variance of 34% [41]. However, it must be noted that in the previous study, we used partly different scales and did not measure environmental concern with the three-dimensional scale. A meta-analysis of studies on healthy eating behavior using similar variables showed an average of explained variance of 21% [60]. In comparison, we estimated that the proportion of explained variance of the TPB variables for the intention to eat sustainably was high in the present study.

### 5.2. Nature Relatedness and Environmental Concern: Explaining the Intention and/or TPB Predictors?

Nature relatedness was a significant positive predictor of attitudes toward sustainable nutrition, subjective norm, perceived behavioral control, and the intention to eat sustainably. Thus, H<sub>4</sub> is fully supported. We assume that student biology teachers, who feel more related to nature, may be more willing to eat sustainably, as they might perceive sustainable nutrition as a means of protecting the environment. Those who view nature as a part of themselves are less likely to harm it [96]. Therefore, they may be more aware of the positive effects of sustainable nutrition on the environment, and thus have more positive attitudes toward it, and a higher intention to eat sustainably to protect the environment. This should be investigated in further studies. According to the explanatory power of nature relatedness for attitudes and the intention to eat sustainably, promoting nature relatedness could result in positive attitudes toward sustainable nutrition and a higher intention to eat sustainably. Stronger nature relatedness could in turn be accompanied by an assumption of responsibility for the environment, more ecologically sustainable behavior, and awareness of the consequences of one's activities on the environment [97]. Consequently, nature relatedness is an important antecedent to understanding sustainable nutrition behavior [98,99]. In the present study, we examined student biology teachers. In comparison to students from other disciplines (e.g., law or engineering), it is likely that student biology teachers have the highest nature relatedness. Therefore, it would be worthwhile to identify whether nature relatedness depends on the subject of study.

In the present study, of the three dimensions of environmental concern, only altruistic concern was identified as a positive predictor of attitudes, subjective norm, and the intention to eat sustainably, but not perceived behavioral control. Thus, we conclude that attitudes and subjective norm have a mediating role (Figure 2) between altruistic concern and the intention to eat sustainably.

The relationship between altruistic concern and subjective norm can be explained by the definition of altruistic concern, i.e., being concerned about the welfare of other people [69]. Thus, altruistically concerned people may attach more value to the opinions and expectations of other related people (subjective norm).

Contrary to H<sub>5</sub>, biospheric concern was not a positive predictor, nor was egoistic concern a negative predictor for the TPB variables. Even in the correlation analysis, both concerns showed only small effect sizes on the TPB variables. Biospheric-concerned people focus on the welfare of the biosphere and all living things, and egoistic-concerned people focus on their own welfare. In contrast, altruistic-concerned people focus on the welfare of other people who may be affected and disadvantaged through e.g., unsustainable (eating) behavior. Our results show that the respondents are only concerned about other people (altruistic concern) when intending (or not) to eat sustainably. Theoretically, all three dimensions of environmental concern provide a basis for sustainable (nutrition) behavior. However, the only impact of altruistic concern on attitudes, subjective norm, and the intention to eat sustainably may be explained by the respondents' potential concern for present and future generations as "other people", and therefore their intention to eat sustainably for reasons based on the social dimension of sustainable nutrition [7]. In addition, the respondents may be concerned about the food insecurity of more than 820 million people around the world [100], which, among other things, the unsustainable eating habits of many others are responsible for, and therefore intend to eat sustainably themselves.

Teacher education should emphasize in particular their students' development of nature relatedness and environmental concern [92,101]. Students' relationships to nature are important

for creating a sustainable future [98,99,102,103]. Previous studies show that environmental education is an effective instrument for fostering attitudes toward environmentally friendly behaviors [104–106]. Fieldwork with direct contact with nature, spending time in nature, and learning experiences in the natural environment seem to be necessary for stimulating nature relatedness, altruistic concern, and attitudes and behavior concerning sustainability [67,78,107]. That is, repeated experiences in nature, especially pleasant ones, may foster nature relatedness and, subsequently, a desire to protect nature and to behave sustainably [70,74,108].

Outdoor learning, especially field trips to the agricultural sector with focus on students' decision-making competences, seem to be an appropriate alternative or addition to the traditional botanical or zoological field trips, where the focus is on systematic species knowledge [109]. It provides students with the opportunity to observe nature and the environment, and to test the ideas and concepts they have learned in teacher education, and that could prospectively be used in school [110].

Despite this, environmentally minded teachers might integrate environmental perspectives into their teaching as complementary curricula [111]. This could be adapted to the context of sustainability and sustainable nutrition—environmentally and/or sustainably minded teachers might integrate sustainable perspectives into their teaching in school.

However, we have to consider the low percentage of explained variance for attitude, subjective norm, and perceived behavioral control by nature relatedness and altruistic concern, which leads us to suspect that there are other (latent) variables we did not consider, which are also important in the explanation of the determinants of the intention to eat sustainably. Qualitative research methods could provide further insights and understanding of those (latent) variables.

### 5.3. Limitations of the Study

For interpreting the results, that the intention to eat sustainably is based on a prospective self-report and that social desirability might have influenced the responding behavior should be taken into account. Thus, an alignment with social norms and expectations regarding sustainable behaviors could have generated positive bias [112]. However, the respondents were informed that the participation was voluntary and anonymous. This is a common action to counteract socially desirable respondent behavior in questionnaires. Here, the aspect of social desirability could at least be relativized. Another limitation could be the sample, in view of the relatively high proportion of female students (69%) in relatively early semesters. This could be relativized by the nationwide distribution of female students who study to be biology teachers. Female students accounted for about 68% of the student population in the winter semester of 2018/19 [113]. However, our primary goal was not to investigate the influence of sex or progress in biology teacher training on the variables. Rather, the study was intended to provide initial insights into whether student biology teachers' nature relatedness and environmental concern are relevant to the intention to eat sustainably (or not).

Therefore, our sample consists of well-educated student biology teachers with a high environmental concern. Our results are only meaningful for the given context of German student biology teachers, and are thus limited to this cultural context. Future research should include a more heterogeneous sample and focus on the student teachers' second or third subjects studied. There may be differences between people studying social-sciences, natural sciences, or languages alongside biology.

When interpreting our results, it should be taken into account that the results cannot be generalized to teachers who are already practicing, as there could be differences in attitudes and beliefs toward sustainable nutrition between teachers and student teachers.

Whether the intention to eat sustainably results in a sustainable eating behavior cannot be answered based on the present study. Concerning the intention–behavior gap, intention is less strong than measuring the real (un-)sustainable eating behavior [114]. However, different studies have shown that intention often predicts behavior [115]. Thus, studying intention and its underlying determinants in the context of sustainable nutrition can provide useful insights in research, and for further research on sustainable nutrition.

## 6. Conclusions

We examined the relationships between attitudes toward sustainable nutrition, subjective norm, perceived behavioral control, nature relatedness, environmental concern, and the intention to eat sustainably. The study reveals that positive attitudes, high subjective norm, and high perceived behavioral control are explanatory factors for the intention to eat sustainably.

Furthermore, we identified nature relatedness and altruistic concern as direct significant predictors of attitudes toward sustainable nutrition, subjective norm, and the intention to eat sustainably. Nevertheless, it is difficult to draw general conclusions about the relative contribution of these predictors in explaining the sustainable nutrition behavior of student biology teachers, as studies on this topic have often used different target behaviors and target groups.

However, our results demonstrate the suitability of the extended TPB model for explaining the intention to eat sustainably. Educational interventions to foster sustainable nutritional behavior in students should therefore focus on a holistic approach and consider more than the traditional TPB variables.

Based on our results, future research should focus on the following question: does the intention of (student) teachers to eat sustainably lead to a higher intention to teach this topic? Recent research has already examined the effect of one's own nutrition behavior—as a possible part of sustainability competence—on self-efficacy and the intention to teach the topic of sustainable nutrition in school. In addition to the variables examined, the model of professional competence [23] suggests that many other factors, such as intrinsic motivation to teach the subject [26], expertise [31], or subject-specific enthusiasm [36,116], may affect the teaching intention of the topic of sustainable nutrition. They should also be taken into account in future research. A connection of such topic-specific variables with teaching motivation has been shown for other domains, such as teaching about returning wolves as a sustainability issue [26] or teaching in inclusive education [27].

Even if this topic is complex, young people in schools and universities should be empowered to understand the key concepts of sustainable nutrition, to broaden their view for recognizing that sustainable nutrition is a multi-dimensional concept, and to evaluate possibilities for action [43]. Teaching and practicing sustainability competencies should be established as an integral part of teacher education curricula, as it would provide student teachers with the necessary knowledge, attitudes, values, and behavior they could, in turn, incorporate into their own teaching [22,28]. Thus, the topic of sustainable nutrition should (increasingly) be made more visible and present in teacher education in university and in school by including it in university programs, as it can serve as a suitable context for promoting sustainability competencies (knowledge, attitudes, values and behaviors) in the context of ESD [8].

**Supplementary Materials:** The following are available online at <http://www.mdpi.com/2071-1050/12/12/4909/s1>, Table S1: CFA results based on the initial and modified calculations.

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