sustainability

MDPI

Article

Students' Conceptions of Sustainable Nutrition

Maximilian Dornhoff *, Annelie Hörnschemeyer and Florian Fiebelkorn

Didactics of Biology, Osnabrück University, 49076 Osnabrück, Germany;
ahoernscheme@uni-osnabrueck.de (A.H.); florian.fiebelkorn@uni-osnabrueck.de (F.F.)
* Correspondence: mdornhoff@uni-osnabrueck.de

Received: 30 May 2020; Accepted: 23 June 2020; Published: 28 June 2020

Abstract: In Education for Sustainable Development, the topic of sustainable nutrition offers an excellent learning topic as it combines the five dimensions of health, environment, economy, society, and culture, unlike most topics with a regional-global scope. The identification of existing students' conceptions of this topic is important for the development of effective teaching and learning arrangements. This study aimed to understand students' conceptions of sustainable nutrition and the relevance that students attribute to the five dimensions. For this purpose, we conducted semi-structured individual interviews with 10th-grade students at secondary schools in Germany (n = 46; female = 47.8%; M_{Age} = 15.59, SD = 0.78). We found that the health dimension prevailed in students' conceptions of sustainable nutrition; however, the more dimensions the students considered, the less importance was attached to the health dimension. The ecological dimension, in turn, became more prominent as the students' conceptions became more elaborate. Many students neglected the social, economic, and especially the cultural dimensions. Furthermore, alternative conceptions of the terminology of sustainable nutrition, which did not correspond to the scientific concept, were identified. Students had difficulties linking the ecological, social, economic, and cultural dimensions to sustainable nutrition due to a predominant egocentric perspective on nutrition, which primarily entails focusing on one's own body.

Keywords: sustainable diet; pupils; preconceptions; understanding; qualitative interview study; Education for Sustainable Development

1. Introduction

The current global food system is the largest greenhouse gas emitting sector in the world [1]. Furthermore, it is mainly responsible for biodiversity loss and the degradation of ecosystems [2,3] and is considered the largest sector-specific source of water pollution [4]. While 820 million people are currently suffering from hunger [5], the number of overweight people has almost tripled to over 1.9 billion since 1975 [6]. Similarly, the rising prevalence of diet-related diseases in industrialized countries is an expression of the inherent shortcomings of the current food and agricultural sector [7]. Without a transformation toward healthy diets from sustainable food systems, the international community will be unable to meet the Sustainable Development Goals (SDGs) set by the United Nations [8] and the Paris Climate Agreement [9,10].

Changes in individual nutritional behavior are an essential prerequisite for such a transformation; therefore, education that empowers learners in the context of nutrition "to take informed decisions and responsible actions for environmental integrity, economic viability, and a just society for present and future generations" is needed [11] (p. 7). In view of its importance for achieving the SDGs, our own diet and the processes related to our food system are perfectly suited to Education for Sustainable Development (ESD). As future consumers and decision makers, students can actively contribute to the sustainable development of the nutrition system, e.g., by shaping their individual nutritional habits in

a sustainable way and exerting a positive influence on their personal and social environment. In this context, schools fulfill an important educational task, as appropriate education "empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability, and a just society, for present and future generations, while respecting cultural diversity" [12] (p. 12).

Following a constructivist perspective, we understand students to be actively structuring their knowledge [13,14]. Based on their individual experiences, students already hold conceptions of teaching content before they are confronted with it in the classroom. We use the term "conceptions" to summarize cognitive constructs of different levels of complexity, such as associations, cognitions, and subjective theories [15]. Students construct new knowledge structures based on pre-existing conceptions [16]. They use already existing conceptions in order to explain new problems or phenomena (assimilation) and extend or adapt their conceptions when these are not adequate to explain new problems (accommodation) [14,16]. We base our research on this learning theory, because behaviorism only examines what is observable (interaction between environmental influences and behavior) and does not take into account the inner processes of information processing. Cognitivism, in turn, takes this inner process into account but fails to consider individual differences in the learning process and assumes that knowledge is passed on from one person to another and then exists as a representation of the environment in the individual [17,18]. This is contrasted with a constructivist view according to which learning represents an active, self-defined, and individual construction process that takes place in context-bound social situations and cannot be controlled from the outside but can be stimulated by a supportive learning environment with suitable learning options [14,19]. It forms the basis for research on students' conceptions in didactics of natural sciences.

A better understanding of students' conceptions helps teachers systematically address them in science teaching [20,21]; thus, the identification of students' existing conceptions is essential for the development of appropriate and effective teaching and learning arrangements on sustainable nutrition, and its consideration is critical for the students' learning success [20,21]. In our study, we were especially interested in students' naïve and alternative conceptions of sustainable nutrition. "Naïve conceptions" represent students' conceptions of sustainable nutrition before they receive information on this topic from us. "Alternative conceptions" represent students' conceptions that do not correspond to the scientific definition of a sustainable diet according to von Koerber et al. [22] (see also, Results, research question two (RQ2): What alternative conceptions do students hold about sustainable nutrition?).

To the best of the authors' knowledge, only a few studies on students' conceptions of sustainable nutrition have been published. Most of these studies relate to their general conceptions of nutrition or agriculture, but none were clearly based on a definition of sustainable nutrition; therefore, the primary aim of this study is to explore students' conceptions of sustainable nutrition in order to compare them with scientific conceptions and derive implications for teaching practice.

1.1. Definition of Sustainable Nutrition

There are various definitions of sustainable nutrition [4,10,22–24]. Internationally, reference is often made to the definition published by the Food and Agriculture Organization of the United Nations (FAO) [4] (p. 294), which defines sustainable diets as follows:

> "Sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources."

Our study is based on the concept of sustainable nutrition posited by von Koerber et al. [22], which is particularly prevalent in German-speaking countries and therefore suitable for use in German schools. This representation takes into account the five dimensions: (1) health, (2) environment, (3) economy,

(4) society, and (5) culture. In addition, it contains seven recommendations for action in everyday life, which includes how people can feed themselves as sustainably as possible by incorporating (1) plant-based foods, (2) organic foods, (3) regional and seasonal products, (4) minimally processed foods, (5) Fair Trade products, (6) resource-saving housekeeping, and (7) an enjoyable eating culture.

There are many similarities between the two definitions of sustainable diets posited by the FAO [4] and von Koerber et al. [22], especially with regard to the different dimensions of sustainable nutrition. The concept of sustainable nutrition by von Koerber et al. [22] was used as a basis for data collection and evaluation in this study. The advantage of this definition lies in its clearer structure resulting from unambiguously defined dimensions and the concrete recommendations for implementing sustainable nutrition in everyday life. Conversely, the definition described by the FAO [4] is less accessible to students due to its complex structure. In addition, it does not give clear instructions on how to sustainably feed oneself in everyday life. Because a detailed description of sustainable nutrition according to Koerber et al. [22] is beyond the scope of this article, we recommend using the original literature to review the concept [22,25].

1.2. Sustainable Nutrition as a Teaching Topic in Education for Sustainable Development

Through the 2030 Agenda, the United Nations formulated 17 SDGs for shaping a sustainable future, which will guide political action until 2030 [8]. In the field of education, the SDGs aim to "ensure that all learners acquire the knowledge and skills needed to promote sustainable development" (Target 4.7 of SDG 4–Quality Education) [8]. The transition to sustainable nutrition is considered key for achieving many SDGs (e.g., SDG 2 "Zero Hunger" or SDG 12 "Responsible consumption and production") [26]. Due to its high relevance for achieving the SDGs, sustainable nutrition is perfectly suited for an ESD [11], and because this topic combines ecological, economic, social, and health aspects to a greater degree than most other topics with a regional-global scope, it was declared by the German Commission for UNESCO as the 2012 topic of the year of the UN Decade of Education for Sustainable Development [27].

In Germany, each of the 16 federal states has its own school curricula, but they are very similar. We only refer to the school curricula of the three school types (Hauptschule, Realschule, and Gymnasium; see *Data Collection and Sampling*) in Lower Saxony, where the study was conducted. German school curricula are competence-oriented, which is why there are few recommendations for concrete teaching topics, and teachers have a high level of freedom to choose adequate content. ESD is an integral part of school curricula and can be taught through varying content, which can be chosen at the teachers' discretion. Nevertheless, there are a few recommendations in the sifted school curricula for teaching nutritional topics and ESD.

Despite the topic of nutrition being perfectly suited for ESD, in Germany, school curricula for natural sciences only recommend it in combination with health aspects in the context of one's diet [28], or it is missing completely [29,30]. Conversely, ESD is associated with issues of environmental conservation or sustainable energy [28–30]. A similar trend can be observed in the most commonly used biology textbooks [31–35]. Both textbooks and school curricula indicate that, despite its potential, as indicated by Burlingame et al. and von Koerber et al. [4,22], the topic of nutrition is not yet perceived as a suitable topic for ESD in the German teaching practice.

1.3. Students' Conceptions of (Sustainable) Nutrition and Agriculture—Current State of Research

In recent studies, both high school students [36] and adult consumers [37] perceived nutrition mainly from a self-centered perspective and hardly noticed the environmental impact of their own nutrition. Consequently, they either did not recognize the influence of their own dietary behavior on the global food system or considered it to be very small [36,37]. Hamann [38], who examined primary school children's conceptions of agriculture in Germany, concluded that they had only diffuse and superficial ideas about the environmental impact of agriculture and took little account of ecological and economic aspects. A meta-study of 190 studies derived similar results, concluding that young

people (aged 3–19 years) have very limited knowledge and understanding of agriculture and food production [39].

Regarding nutritional-physiological aspects, de Freitas Zompero et al. [40] found that Brazilian elementary and high school students lack coherent conceptions of nutrients and are unable to distinguish nutrients from food; however, a study on Australian high school students revealed they understand the importance of different macronutrients in the body but are unable to distinguish their functions [41]. Furthermore, Rasnake et al. [42] identified a tendency for young people to be dose insensitive (e.g., something harmful in large amounts should be avoided in small amounts) and categorical thinkers (e.g., foods are either good or bad). With respect to the relationship between body and nutrition, it has been shown that many young people are dissatisfied with their body, in the sense that they think they are overweight [43], and that female adolescents in particular adopt eating behaviors in which they forego certain foods or entire meals as a means of achieving their desired figure [44–46].

Concerning nutrition as a sustainability issue, Gralher [36] showed that high school students primarily focused on health aspects of nutrition and mostly ignored ecological, social, and economic aspects. The focus on health is also evident in the German population, where 89% of people believe that eating should be healthy [47], which some surveys found to be more important than taste [48]. In contrast, university students were found to have an ecological perception of sustainable nutrition [49,50]. The latter finding was also noted in numerous studies of other sustainability contexts in which the participants took account of ecological aspects but paid little attention to economic and social aspects [51–55]. Moreover, in general, high school students seem to have difficulties in taking into account more than two dimensions in sustainability contexts [56].

1.4. Aim of the Study and Research Questions

Based on the current state of research, the present study aimed to explore students' conceptions of sustainable nutrition. We were particularly interested in the extent to which their conceptions are consistent with the scientific conception of a sustainable diet according to von Koerber et al. [22]. In more detail, the following research questions were addressed:

RQ1: What relevance do the students attribute to the five dimensions of sustainable nutrition?
RQ2: What alternative conceptions do students hold about sustainable nutrition?

2. Materials and Methods

2.1. Data Collection and Sampling

To answer our research questions, we conducted semi-structured individual interviews with 46 10th-grade students from August 2017 to March 2018. The school system in Germany covers primary (grades 1–4) and secondary (grades 5–13) education. The lower secondary education (grades 5–10) follows a tripartite structure in which three different school types are included. The *Hauptschule* offers students a "basic general education," the *Realschule* offers a "more extensive general education," and the *Gymnasium* offers an "intensified general education" [57] (p. 121–122). The Hauptschule is completed after nine school years and can be extended by one year to achieve a better degree. The Realschule is completed after ten years, and the Gymnasium, after 13 years. In order to capture the diverse ideas of students from all three school types, we considered all three in our sample selection ($n_{Gymnasium}$ = 16, *female* = 8, M_{age} = 15.1, SD = 0.44; $n_{Realschule}$ = 15, *female* = 7, M_{age} = 15.6, SD = 0.63; $n_{Hauptschule}$ = 15, *female* = 6, M_{age} = 16.1, SD = 0.83; for detailed information on the respective subsamples and on individual participants, see Supplementary Material, Table S1). We decided to choose the 10th-grade because we assumed, based on a screening of the respective curricula, that students of all school types should already have received at least some ESD-relevant content in science education [28–30]. Since we conducted a qualitative study with a relatively small sample, it was at no time our intention to compare the students from the three school types.

For each school type, our sample comprised students from three or four different schools in northwest Germany in and around the city of Osnabrück. The acquisition of participants at the respective schools was conducted with the help of a supervising teacher, who was informed in advance by the first author regarding the contents and process of the study. The teacher gave a short introduction to the study and, if possible, selected two male and two female students from the volunteers. Apart from the gender ratio, they had no selection criteria. Accordingly, they selected the students who were the first to volunteer for participation. Since our goal was to explore naïve conceptions, the students were only informed that the study was about their conceptions of nutrition and not explicitly about sustainable nutrition. Due to deviations from the interview guide used during two of the interviews, the authors decided to exclude those two from the sample. Since the students who volunteered first were selected, it can be assumed that some of the participants had a particularly high interest in the topic of nutrition. This assumption is supported by the fact that six participants stated that they follow a vegetarian diet (13%; see Supplementary Material, Table S1), which is considerably higher than the proportion in the German population (4.3%; 18–79 years) [58].

Anonymity was guaranteed and participation was voluntary. Approval for the study was obtained in August 2017 from the responsible State Board of Education in Lower Saxony, Germany—Niedersächsische Landesschulbehörde (NLSchB), which is the body responsible for providing approvals for studies conducted in schools. The headmasters of the participating schools were informed beforehand about the study and provided written consent. In addition, the parents of the students were informed about the study by an information letter in which the voluntary participation and anonymity of the participants were explained. The possibility to contact us was given by the attached contact data. Both the parents and students gave their informed written consent for participation in the study. During the interviews, all participants could decline to participate and withdraw from the study at any time.

2.2. The Interview Procedure

Within the respective schools, individual interviews were conducted in a quiet room by one of three interviewers who were familiar with the subject matter and had received prior instructions in the interview procedure and interview management. All interviewers conducted two or three test interviews with students in the age group to become familiar with the interview procedure and content of the interview guide. The test interviews were not included in the final sample.

The interviews were conducted in German, and the statements were translated into English for the purpose of this paper. The duration of the interviews was between 40 and 113 min (M = 64.11 min; SD = 15.36 min). The large differences in interview duration were caused by the varying response behaviors of the students. Some students needed more time to formulate their thoughts, while others presented their thoughts in detail. The length of the interview does not have any bearing on the quality of the statements made.

Interviews were conducted with the help of a semi-structured interview guide that had previously been tested and adapted through pre-tests (the complete interview guide can be obtained from the first author upon request). The interview guide served as an orientation for the interviewers and was used to develop discussions while allowing participants to express their thoughts in a flexible way. Due to the limited space in this paper, we present the phases of the interview in a shortened form, considering all steps of the interview relevant to the research questions (see Table 1).

The interview guide was divided into four thematic phases: naïve conceptions of sustainable nutrition (Phase 1), the conceptions of the dimensions of (Phase 2) and recommendations for (Phase 3) sustainable nutrition, and the assumed connections between the dimensions and recommendations (Phase 4; see Table 1). For research question one (RQ1), only Phase 1 was considered. For research question two (RQ2), all interview phases were considered. The various interventions in the different phases aimed to create opportunities for talking and revealing alternative conceptions of sustainable

nutrition. The statements that revealed alternative conceptions were determined in the course of the phases presented.

In the free association task used in Phase 1, we asked participants to note ten terms that they associated with a sustainable diet. They then explained why they wrote down these terms. Our analysis was based on the students' explanations regarding the terms and not on the terms themselves. The banana with the brand logo used in Phase 2 (see Table 1) represents the most famous brand for bananas in Germany. By the brand logo, we emphasized that it is neither a Fair Trade nor an organic product, whereby we wanted to encourage the students to talk about the different dimensions of sustainable nutrition.

Table 1. Excerpt from the interview guide with the questions that were used in the analysis. The original interviews were conducted in German.

Content and Questions	Materials Used in the Interview
Phase 1–Naïve conceptions of sustainable nutrition	
Students were given a list with the heading 'ten terms on sustainable nutrition' for entering ten terms (see right column). 1. What do you associate with sustainable nutrition? Please write down ten words on this sheet of paper that are coming to your mind. After the task, the students explained to the interviewer what they meant by each term, which was noted on the list. 2. Please try to describe in your own words what you understand by sustainable nutrition 3. Imagine giving a friend recommendations on how to eat more sustainably. Do you have any ideas what you could tell him/her?	**10 terms on sustainable nutrition** 1. Organic 2. Vegan 3. Genetic manipulation 4. Farm 5. Factory farming 6. Self-sufficiency 7. Vegetable garden 8. Home-baked 9. Whole grain spelt 10. Grain field (Data taken from GM9–Felix)
Phase 2–Dimensions of sustainable nutrition	
The students were given a schematic illustration of sustainable nutrition (see right column). 1. Can you explain to me what you understand by these five terms? In case they had any comprehension problems, the students were given a short explanation of the dimensions. 2. How would you relate these dimensions to sustainable nutrition? 3. Would you like to change something in the figure? The students were presented a banana with a clearly visible trademark sticker of a multinational company (Chiquita Brands International; see right column). 1. Do you have any ideas on how to relate this banana with the different dimensions of sustainable nutrition?	 Schematic illustration to illustrate the five dimensions of sustainable nutrition (modified from von Koerber et al. [22].  Banana used to relate the dimensions of sustainable nutrition to a concrete food item.

Table 1. *Cont.*

Content and Questions	Materials Used in the Interview
Phase 3–Recommendations for sustainable nutrition	
Students were presented with a list of the seven recommendations for implementing sustainable nutrition in everyday life (see right column). 1. Please explain what you think is meant by these recommendations. If the students misunderstood some recommendations, we gave them a short explanation.	**1. Preference of plant-based foods** **2. Organic foods** **3. Regional and seasonal products** **4. Preference of minimally processed foods** **5. Fair Trade products** **6. Resource-saving housekeeping** **7. Enjoyable eating culture** Seven recommendations for sustainable nutrition (modified from von Koerber et al. [22].
Phase 4–Relationships between the dimensions and recommendations	
1. Could you try to link the recommendations with the terms in this figure? (see the excerpt of the table in the right column) The table listed the five dimensions in the top row and the seven recommendations in the left column.	 Excerpt of the table used in the interview to support the students connecting the recommendations with the dimensions of sustainable nutrition.

2.3. Data Processing and Analysis

The interviews were digitally recorded with an Olympus WS-550M Voice Recorder and transcribed according to the transcription rules set by Dresing and Pehl [59]. We analyzed the interviews using the Qualitative Data Analysis (QDA) software MAXQDA 2018 [60] based on the ideas of qualitative content analysis [61]. In order to answer the two research questions, we modified and adapted the analysis process. To answer RQ1, we classified the students' statements into five deductive categories; "health," "ecological," "economic," "social," and "cultural," according to the five dimensions of sustainable nutrition [22] (Figure 1). As these were deductive categories, they were defined before the interview material was analyzed. The definitions were documented in a coding guideline, which described in detail what kind of statements should be assigned to the respective categories. For better comprehensibility, anchor examples from the interview material were added at the beginning of the coding process for the respective categories. Based on the number of statements assigned to the different dimensions, we were able to determine how many students considered how many and which dimensions and to what extent in Phase 1 of the interview.

To capture the alternative conceptions in the context of RQ2, we retained the structure of our initial code system and extended it by inductive subcategories based on the participants' statements. Furthermore, we added one inductive category including subcategories (terminology of sustainable nutrition; Figure 1). Because the category system was inductive, we developed the coding guide during the analysis and continuously adapted it to newly coded statements. The final coding guide corresponds to Table 2 in the results for RQ2. In contrast to RQ1, in this research question, we considered the entire interview and only coded statements that did not correspond to the essential foundations of the scientific definition of a sustainable diet according to von Koerber et al. [22].

Some of the students' statements were coded into several categories if they applied to more than one category. This was the case for both research questions. For the coding procedure, two raters were used who were familiar with the topic. Each rated half of the interviews using the same coding guide and met several times to discuss the coding. To validate our analysis of RQ1, we conducted an

inter-rater reliability test and used Brennan and Prediger's Kappa in MAXQDA to assess the level of agreement between the two raters [62,63]. Taking into account the expected number of coded segments in the interviews, the diversity of cases, and our available resources (people available who were willing and able to do a second round of coding), we chose to randomly select 15% of all statements for the calculation of Brennan and Prediger's Kappa [62]. The two raters each coded 15% of the interviews they had not coded before. The resulting Brennan and Prediger's Kappa revealed an "almost perfect" [64] (p. 165) agreement ($\kappa = 0.89$). Because the frequency distributions of the statements were not relevant for RQ2, and the categories were mainly inductive, the validity of our analysis on this research question was ensured by consensual validation. For this purpose, a consensus on the interpretations was reached among the researchers involved in the project as well as by argumentative validation with one layperson who was not involved in the project [65]. We conducted Chi-square tests with SPSS (IBM, version 26) to check for a random distribution of the statements to the different categories (health, ecological, social, economic, cultural) and for a random distribution of the categories to the subsamples (considering one, two, three, four, or five dimensions).

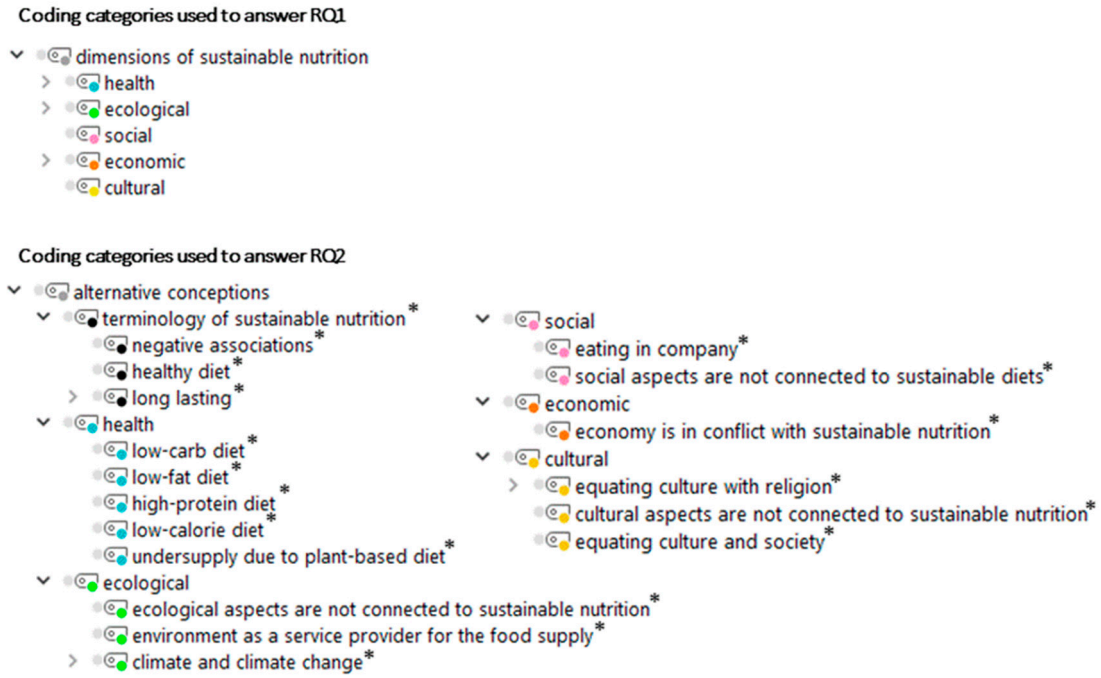

Figure 1. Overview of the coding categories used to analyze the interview material. Categories were further differentiated based on statements by the participants. * Inductive codes.

3. Results

3.1. RQ1: What Relevance Do the Students Attribute to the Different Dimensions of Sustainable Nutrition?

Based on the association task in interview Phase 1 (see Table 1), we assigned 159 statements to the health dimension, 77 to the ecological dimension, 37 to the social dimension, 23 to the economic dimension, and 7 to the cultural dimension (see Figure 2). A complete list of students' associations with sustainable nutrition can be found in the Supplementary Material (Tables S2–S6). With the help of a Chi-square test, we checked the probability that the distribution of the statements to the different categories could have occurred randomly [62]. We rejected the null hypothesis of a random distribution ($\chi^2 = 249.56$, $p < 0.001$; see Supplementary Material, Figure S1). The health dimension of sustainable nutrition, followed by the ecological dimension, had the highest relevance in the students' conceptions. The social and economic dimensions had relatively low relevance, while the cultural dimension was hardly considered.

Furthermore, we divided the sample into five different subsamples depending on how many dimensions the students considered in their conception of sustainable nutrition (see Figure 2). The health dimension dominated in almost all subsamples except the one that considered five dimensions. Especially in the subsample that considered only one dimension, the health dimension was the most frequently mentioned. Next, the ecological dimension was the second most mentioned and was present in all subsamples. Furthermore, the relevance of the ecological dimension increased with the number of dimensions considered. The social and economic dimensions were rare but present in all subsamples that considered two dimensions or more, whereas the cultural dimension was only mentioned by students who considered all five dimensions. For detailed information on how the conceptions of the subsamples are composed on an individual level, see Figure 3. In addition, using a Chi-square test, we checked the probability that the distribution of the different categories on the subsamples (considering one, two, three, four, or five dimensions) could have occurred randomly. We rejected the null hypothesis of a random distribution ($\chi^2 = 101.29$, $p < 0.001$; see Supplementary Material, Figure S2).

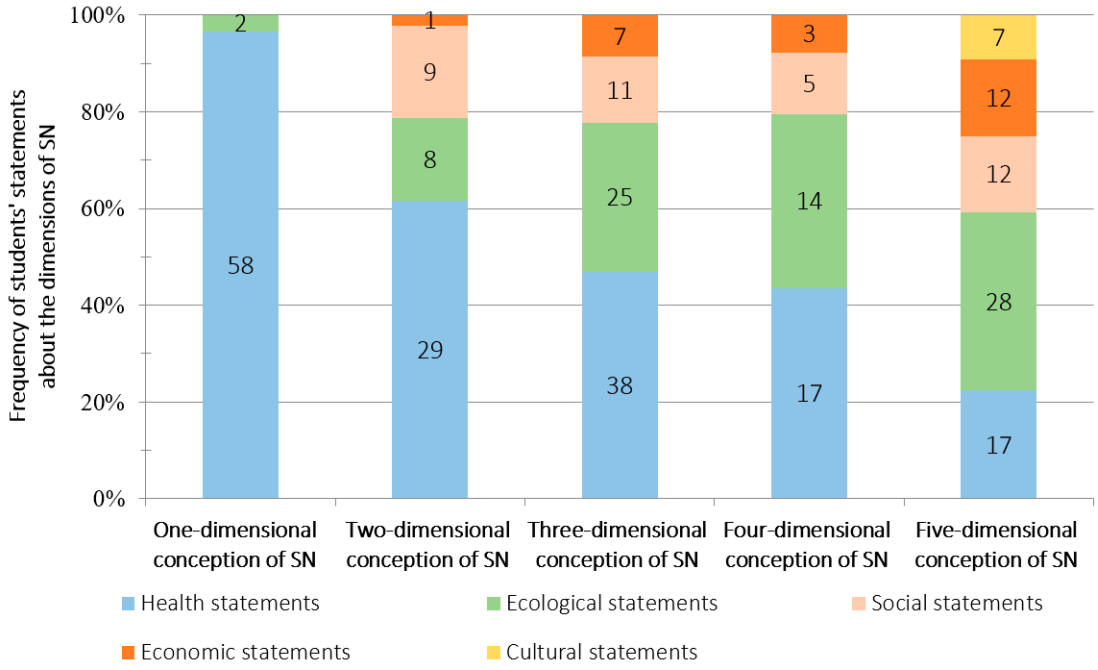

Figure 2. Frequency of (y-axis) and number of students' statements (in the bars) about sustainable nutrition, ranked according to whether they included one, two, three, four, or five dimensions in their conceptions. In total, the analysis included 303 coded statements from 46 students ($n_{\text{one dimensional conception}} = 21$; $n_{\text{two dimensional conception}} = 9$; $n_{\text{three dimensional conception}} = 9$; $n_{\text{four dimensional conception}} = 3$; $n_{\text{five dimensional conception}} = 4$). SN, sustainable nutrition.

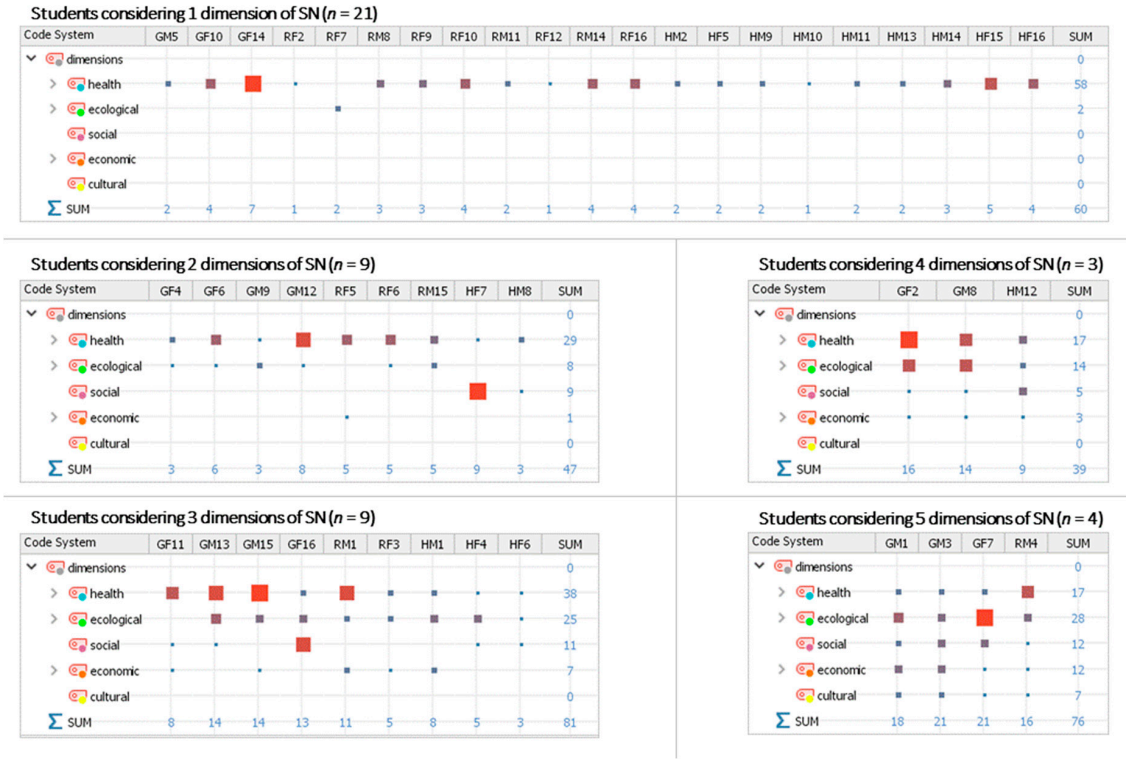

Figure 3. Students' conceptions of sustainable nutrition on an individual level, ranked according to whether they included one, two, three, four, or five dimensions in their conceptions. The size of the squares indicates the number of statements within a category; the larger the square, the higher the number of statements. SN, sustainable nutrition; G, Gymnasium; R, Realschule; H, Hauptschule; F, female; M, male.

3.2. *RQ2: What Alternative Conceptions Do Students Hold about Sustainable Nutrition?*

We structured students' alternative conceptions regarding the terminology of sustainable nutrition (Table 2) and the five dimensions of sustainable nutrition (Table 3).

Table 2. Students' alternative conceptions regarding the terminology of sustainable nutrition.

Conceptions	Definitions	Examples	Students Holding this Conception
Negative associations	Sustainable nutrition is understood as something negative.	GM12–Tim: "Sustainable" just sounds negative. So, in terms of nutrition, it might mean that it is simply not the ideal food.	GM12, RM8, RF9, RM11, RF12, RF16, HF5, HF6, HM10, HM11, HM13, HM14, HF16 (*13 students*)
Healthy diet	Sustainable nutrition is understood exclusively as a healthy diet.	RF2–Saskia: I imagine sustainable nutrition to mean eating things for a healthy body.	GF4, GM5, GM12, GF14, GM15, RM1, RF2, RF6, RF10, HF5, HM11, HF15, HF16 (*13 students*)
Lasting into the future	Sustainable nutrition is understood exclusively in the sense of long-lasting: long-lasting satiation, health or shelf life of foods.	RM8–Malte: Things you get full off longer or which are very nutritious, which have a lot of carbohydrates. RM14–Thomas: If you eat sustainably over a longer period of time, then you may also have a longer life expectancy and a good spirit. HM2–Jona: For me, milk would be sustainable because you can keep the milk in the refrigerator for two or three days.	GM1, GM5, GM8, GF11, GM12, GM13, GF14, GM15, RF7, RM8, RF10, RM14, HM2, HF4, HM8, HM14, HF15, HF16 (*19 students*)

G, Gymnasium; R, Realschule; H, Hauptschule; F, female; M, male.

Table 3. Students' alternative conceptions regarding the five dimensions of sustainable nutrition.

Conceptions	Definitions	Examples	Students Holding this Conception
Health dimension			
Low-carb diet	Sustainable nutrition is understood as a low-carb diet or implies the avoidance of products high in carbohydrates.	HM10—Burhan: In terms of carbohydrates, I would say that sustainable nutrition implies that you should try to buy as few carbohydrates as possible.	GF14, RF6, RM8, RF9, HM8, HM9, HM10, HF16 (*8 students*)
Low-fat diet	Sustainable nutrition is understood as a low-fat diet or implies the avoidance of fatty products.	HM9—Lutian: Sustainable nutrition might mean a diet "low in fat," not adding a lot of fat where it doesn't have to be.	GM1, GF4, GF6, GM12, GF14, RM1, RF6, RM8, RF9, RF10, RM11, RF16, HF5, HF6, HM8, HM9, HM10, HM11, HM14, HF15, HF16 (*21 students*)
High-protein diet	Sustainable nutrition is understood as a high-protein diet or implies preferring products high in protein.	RF9—Elif: When I think of sustainable nutrition, I think of a diet "high in protein," when a diet is based on many proteins.	GF14, RF6, RF9, RM11, HF6, HF8, HM14, HF16 (*8 students*)
Low-calorie diet	Sustainable nutrition is understood as a low-calorie diet or implies the avoidance of products high in calories.	HF5—Ela: For a sustainable diet, I would recommend buying fruits, vegetables, and potatoes, because they have relatively few calories [. . .].	RF6, HF5, HM10, HF16 (*4 students*)
Undersupply due to a plant-based diet	An undersupply (especially of macronutrients) through a plant-based diet is feared since animal foods are considered to have a monopoly on certain nutrients.	GF10—Julia: Regarding the preference for plant-based foods, I wouldn't say that it would lead to sustainable nutrition. Well, it's clear to me that animals die for producing meat. But in some way, I need milk. Milk is also an important part of our diet. So, you need the calcium that is in it [. . .] but I personally would not be a vegan, they do not use any animal food.	GF10, RF6, RF7, HM8, HM10, HF16 (*6 students*)

Table 3. *Cont.*

Conceptions	Definitions	Examples	Students Holding this Conception
Ecological dimension			
Ecological aspects are not connected to sustainable nutrition	No connection can be made between the environment and sustainable nutrition.	RF6—Caroline: I would leave out the environmental dimension, because for me, personally, it has very little to do with nutrition.	GM5, RF6, RF7, RF12, HF5, HM10, HM13 (*7 students*)
Environment as a service provider for the food supply	The relationship between sustainable nutrition and the environment is only understood in the sense that food comes from the environment.	HM10—Burhan: I can't imagine the connection between sustainable nutrition and the environment. Well, actually, I do, because vegetables are actually the environment. Well, it comes from the earth, the vegetables. And that's why I think that the environment plays a very important role in sustainable nutrition.	GF4, GM5, GF6, RF5, RF7, RM11, HF4, HF5, HM10, HM12, HF15 (*11 students*)
Climate and climate change	Statements about climate or climate change that show that the phenomenon of climate change has not been properly understood. Technically incorrect statements about the consequences of CO_2 emissions.	GM3—Lukas: CO_2 emissions are generally problematic for the environment. All this goes back into the cycle and then it becomes more and more difficult to cultivate food sustainably, if the whole soil is then contaminated, or the air, or the rain. Then the actual system will be damaged.	GM3, GM9, GF11, GM13, GM15, RF3, RM4, RF5, RF6, RF7, RM14, RM15, HM1, HF4, HF6, HF7, HM9, HM10, HM11, HM12, HM13, HM14, HF15, HF16 (*24 students*)
Social dimension			
Social aspects are not connected to sustainable nutrition	No connection can be made between society and sustainable nutrition.	GF16—Laura: In terms of the dimension society, I don't know exactly how this is related to sustainable nutrition.	GF2, GM5, GM12, GF14, GM15, GF16, RM11, HF5, HM9, HM10, HM14, HF15 (*12 students*)
Economic dimension			
Economy is in conflict with sustainable nutrition	The economic dimension is not considered compatible with the other dimensions of sustainable nutrition.	GM8—Noah: And the economy is for me rather the driving force against sustainable nutrition, because the economy in general has the urge to make a lot of money with little effort and regardless of the consequences and therefore I think that the economy really doesn't match well with sustainable nutrition.	GF4, GM5, GM8, RM1, RM4, RF6, RF7, RM15, HF6 (*9 students*)
Cultural dimension			
Equating culture with religion	Culture is being reduced to religion.	RF12—Leonie: When I link culture to sustainable nutrition, I would think about religion, for example that Muslims are not allowed to eat pork.	RF6, RF12, HF6, HF7, HM9, HM10, HM13 (*7 students*)
Cultural aspects are not connected to sustainable nutrition	No connection can be made between culture and sustainable nutrition.	RF5—Emilia: Regarding culture [...] I couldn't understand at all what this has to do with nutrition.	GM5, GF6, GF7, GM9, GM12, GF14, GM15, RF5, RF10, HM9, HM11, HM14, HF15 (*13 students*)
Equating culture with society	The cultural and social dimension cannot be separated.	GF4—Anna: In relation to culture or society 'preference for plant-based foods' refers to the fact that some people prefer to eat plant foods, for example, eating vegan or vegetarian.	GM1, GM3, GF4, GM5, GF6, GF7, GM8, GF11, GM12, GF14, GF16, RM1, RF3, RM4, RF7, RM8, RF9, RM14, HM1, HF4, HF6, HM8, HM14, HF15 (*24 students*)

G, Gymnasium; R, Realschule; H, Hauptschule; F, female; M, male.

4. Discussion

4.1. RQ1: What Relevance Do the Students Attribute to the Different Dimensions of Sustainable Nutrition?

The fact that many students—20 out of 46—solely considered the health dimension in their naïve conceptions can be explained by the great relevance attributed to the health aspect, which has already been demonstrated in other studies on students' and laypeople's conceptions of and attitudes toward nutrition issues [36,47,48]. The reason for this could be that, in German schools, a nutritional-physiological teaching approach is primarily used in biology lessons to help students become familiar with the topic of nutrition [28–35]. This could have led to an automated association of nutrition topics in the school context with the health aspect.

Our results suggest that the health dimension is particularly present in students' naïve conceptions. In the context of nutrition in adolescence, the health aspect, or rather the figure ideal, is of particular importance [44]. The enormous social pressure to optimize their bodies that young people are exposed to, which is often associated with eating behavior [44], may explain the focus of our sample on the health dimension. Moreover, the health dimension, in contrast to the other dimensions, has an immediate relation to the student's own body and thus affects their everyday life to a great extent. It seems easier for students to approach the topic of sustainable nutrition from an egocentric perspective rather than to adopt the perspective of other people (altruistic perspective) or the environment (biospheric perspective). We suggest that the link between nutrition and health aspects is the most intuitive one and therefore the easiest to create. This assumption is supported by the fact that the relevance of the health dimension decreases with an increasing number of the dimensions of sustainable nutrition considered by our participants. This means that the less elaborate the naïve conception of sustainable nutrition is in terms of the total number of dimensions considered, the more prominent the health dimension is.

Nevertheless, references to the ecological dimension frequently made by students should not be neglected. Although students' focus on ecological aspects has already been identified in other studies on sustainability topics [52,55], it was previously observed that it has no relevance in students' conceptions of nutrition in general [36]. Now, the results are completely different when the naïve conceptions of sustainable nutrition are investigated. The results of RQ1 showed that a total of 21 students considered both the health and ecological dimensions (see Figure 3, Students considering 2, 3, 4, or 5 dimensions).

The often co-occurring consideration of both dimensions can be explained by the specific question of "sustainable" nutrition, which did not take place in previous studies on nutrition (e.g., [36], as it combines the focus on ecological aspects in sustainability topics with the focus on health aspects in nutrition topics. However, the preference for the two dimensions cannot be attributed exclusively to the combination of the two topics. Health and the environment are generally two important topics for young people in Germany. For example, the 17th Shell Youth Study showed that 80% of over 2500 young people (aged 12–25 years) surveyed considered it important to live health-conscious lives and 66% to act with respect for the environment [66].

The ecological dimension was the second most coded, but unlike the health dimension, it became more prominent when two or more dimensions were considered. Studies conducted on student teachers in home economics classes showed that this sample group focused on the ecological dimension [50]. Since we assume that prospective home economics teachers have more elaborate conceptions of sustainable nutrition than many students, it confirms our assumption that consideration of the ecological dimension increases with increasing expertise.

The economic and social dimensions were rare in students' naïve conceptions but present in all subsamples that considered two dimensions or more, whereas the cultural dimension was only mentioned by students who considered all five dimensions (Figure 2). Although less pronounced, the presence of those dimensions (social, economic, cultural) in the students' conceptions is striking, as it is not commonplace in their conceptions of sustainability issues [56].

4.2. RQ2: What Alternative Conceptions Do Students Hold about Sustainable Nutrition?

4.2.1. Terminology of Sustainable Nutrition

We noticed that some students had problems with the terminology of sustainable nutrition. This is particularly evident in statements such as those of GM12—Tim (Table 2). In addition, particularly students with no prior experience with the term understood it as something negative; they associated it with a bad, unhealthy, or wrong diet. Their conceptions are therefore contrary to the scientific conceptions.

This contrasts with the results of a large-scale online survey of university students on the topics of "sustainable development" and "sustainability," in which no negative associations and only a positive understanding of the terms were found [67]; however, the study was conducted in an English-speaking country, and ours, in a German-speaking country. In our study, the negative evaluation of the term "sustainable nutrition" can be traced back to the German adjective "nachhaltig/sustainable," to which the students intuitively had negative associations. We assume as a possible cause of the negative connotation the similarity to other German words like "nachteilig/disadvantageous" or "nachlässig/careless," which are phonetically similar but semantically different [68,69]. In German, the prefix "nach" often gives words a negative meaning; therefore, the reason underlying the negative interpretation of sustainable nutrition could be an unconscious overgeneralization of this phenomenon.

In addition to the negative understanding of the term "sustainable nutrition", there were also positive understandings of it in the context of a healthy diet (Table 2; *Healthy diet*). This is likely due to the great relevance attributed to the health aspect and the predominant practice of teaching nutrition topics under the health aspect (explained in the discussion on RQ1). Although this alternative conception of a healthy diet does not entirely contradict the scientific conception of sustainable nutrition, it does not cover it completely and only illuminates a part of it.

Even more frequently, the students expressed the view that sustainable nutrition means *lasting into the future* (Table 2). This alternative conception suggests that there are parallels with the definition for sustainable development of the World Commission on Environment and Development (WCED) [70]: development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." However, it is evident that the students' understanding of "anhaltend/long lasting" does not include future generations, which were considered by only 12 students (GF7, GM8, GF11, GM12, GM13, GM15, GF16, RM1, RM4, RM15, HM1, HF6) but often focuses on their own life span. Their conceptions regarding *lasting into the future* can be divided into long-lasting satiation, health, or the shelf life of foods (Table 2; *Lasting into the future*). The conception *lasting into the future* can also be traced back to the German adjective "nachhaltig/sustainable". The students seemed to interpret the prefix "nach/after" in the sense of continuation or extension [71].

Taken together, the large number of participants with alternative conceptions indicates that problems of understanding the term "sustainable nutrition" do not occur sporadically among students but are widespread; however, further quantitative studies are needed to verify the findings on the basis of larger samples.

4.2.2. Health Dimension

Regarding the health dimension, we found that students had strong beliefs about the recommended intake of macronutrients that contradict nutritional recommendations. The students frequently pointed out that only small amounts of carbohydrates and fats, but large amounts of protein, should be consumed (Table 3; *Low-carb diet*; *Low-fat diet*; *High-protein diet*); however, leading nutrition societies recommend covering approximately 50% of total energy intake with carbohydrates, 30% with fat, and only a small part with proteins (for normal body weight, 9% to 11%) [72]. We see the students' alternative conceptions of carbohydrate intake replicated in the actual nutritional behavior of the German population that fell below the recommended carbohydrate intake [73].

Our results regarding students' alternative conceptions of dietary fat intake are consistent with Rasnake, Laube, Lewis, and Linscheid [42], who identified a tendency for young people to be dose insensitive (e.g., something harmful in large amounts should be avoided in small amounts) and categorical thinkers (e.g., foods are either good or bad). Moreover, Heseker et al. [74] examined 238 textbooks of various subjects that included nutritional topics for general education schools in Germany and found that those textbooks gave lower fat intake recommendations than recommended by official nutrition societies [75]. Furthermore, the study found that textbooks do not mention the aspect of fat quality, especially in relation to vegetable fats. Considering that the fat intake of the German population is generally higher than recommended [75] and that the students' recommendations to consume only small amounts of fatty products comply with the dietary guidelines of various countries [76,77], the students' assessment is partly correct.

With regard to protein intake, it is evident that students' recommendations to consume large amounts of protein conflict with official recommendations of nutrition societies, which refer to a protein intake of 0.8 g/kg body weight (for normal body weight, 9% to 11% of total energy intake) [72]. However, it has been shown that even textbooks for general education schools erroneously give excessive protein intake recommendations [74]. Because textbooks are still the preferred teaching medium for teachers [78], we assume that their use in class may contribute to a fear of undersupply regarding protein intake.

We suspect that students' conceptions concerning macronutrients (carbohydrates, fats, and proteins) and the emphasis on low-calorie diets (Table 3; *Low-calorie diet*) can be attributed to the most popular weight loss diets (low-carb and low-fat diets) [79], which are designed for weight reduction rather than a balanced, long-term healthy diet. The reasons for this are traced to the slimness ideal supported by society and the media [80] alongside the associated social pressure that affects both sexes [44]. According to the data for Germany in the Health Behavior in School-aged Children (HBSC) Survey of the WHO, 53% of girls and 36% of boys at the age of 15 think they are too fat [43].

The importance of the desired body ideal in adolescents for the formation of conceptions of sustainable nutrition should therefore not be underestimated, as it is dietary behavior in particular that is one way to achieve a body ideal [45,46]. The results show that dietary recommendations for weight reduction are perceived by students as a healthy diet; therefore, the task of nutrition education must be to provide information about the actual conditions of the supply of energy-providing nutrients.

The alternative conception *undersupply due to a plant-based diet* (Table 3) is particularly relevant, as it affects all other dimensions of sustainable nutrition in a special way (e.g., greenhouse gas emissions due to livestock breeding (ecological), food shortage due to land usage for livestock breeding (social), higher input costs for the production of animal food products than for plant food products (economic), and high meat consumption has become normal over the last 60 years (cultural)) [22]. For some students, a plant-based diet is contrary to a healthy diet. We conclude from the students' statements that this evaluation is based on the assumption that animal food products are the only source of some macro- and micronutrients. Heseker et al. [74] found that 238 textbooks of various subjects, including nutritional topics, often overstated the negative consequences of a vegan diet and unjustifiably identified the consumption of animal products such as milk as the only way to prevent deficiency symptoms. Such misrepresentations in textbooks could be responsible for the students' alternative conceptions in this respect.

The students' fear of undersupply due to a plant-based diet seems unjustified as food societies in many countries are in favor of appropriately planned vegetarian diets, including vegan diets for all stages of the life cycle, even while recognizing the need to supplement certain nutrients [81,82].

Conversely, the German Nutrition Society does not recommend a vegan diet for certain groups of people (e.g., pregnant women, lactating women, infants, children, or adolescents), but assumes "that a plant-based diet (with or without low levels of meat) is associated [with] a reduced risk of nutrition-related diseases in comparison with the currently conventional German diet" [83] (p. 93).

4.2.3. Ecological Dimension

We found some students to have problems recognizing the environmental impact of food consumption and production. In some cases, students were entirely unable to deduce a connection between food and the environment, arguing that the ecological dimension should be omitted from the concept of sustainable nutrition because it "has very little to do with nutrition" (RF6–Caroline; Table 3; *Ecological aspects are not connected to sustainable nutrition*).

Apart from this complete negation of the ecological aspects of sustainable nutrition, other students only succeeded in establishing a unidirectional connection between the environment and sustainable nutrition by recognizing ecosystem services, such as the provision of food [84], but not taking into account the environmental impacts of dietary behavior or the intensive agriculture associated with it [1,10] (Table 3; *Environment as a service provider for the food supply*).

Moreover, several indications could be identified that point to a lack of understanding of the importance of greenhouse gases for climate change. This lack of understanding led to little or no recognition of the links between nutrition and ecological aspects, particularly climate change. For example, we observed that although the transportation of food was associated at a superficial level with environmental consequences such as "pollutants in the air" (RF3–Lara), no connection could be established directly with CO_2 emissions, the greenhouse effect, or climate change (RF3, HF4, HM11). In addition, some students identified CO_2 emissions as problematic but could not explain why or erroneously linked emissions to phenomena other than climate change, such as soil acidification and acid rain (GM3, GM15, RF6, RF7).

Our results complement the results of previous research on students' conceptions of climate change [85]. Previous studies found that climate change was attributed to more or less incorrect mechanisms, some of which did not involve greenhouse gases at all (for a summary of previously identified students' conceptions of the greenhouse effect, see [85]).

4.2.4. Social Dimension

A total of 12 students expressed that they could not connect the social dimension with sustainable nutrition (Table 3, *Social aspects are not connected to sustainable nutrition*). It is striking that all students who had this problem did not succeed in adopting the perspective of employees in the food sector, especially in developing countries, but only argued from an egocentric perspective as consumers. GM12–Tim, for example, spoke about the power of the consumer, noting that "society is already responsible for what is happening, for example, prices and so on," but did not manage to direct this perspective toward workers in the value chain of food products. It is thus evident that some students have shortcomings in their ability to take on the perspective of workers in the value chain of food products; however, the ability to change perspectives was defined as one key competency for sustainable development [86].

4.2.5. Economic Dimension

Regarding the economic dimension of sustainable nutrition, we found that some students perceived the economy as a kind of "driving force against sustainable nutrition" (GM8—Noah; Table 3; *Economy is in conflict with sustainable nutrition*). Such an alternative conception negates the possibility of achieving "sustainable development in its three dimensions—economic, social, and environmental—in a balanced and integrated manner" [8] (p. 3), as sought by the United Nations.

This alternative conception not only occurs from a macroeconomic perspective ("the economy"; GM8—Noah), but also at the level of the individual microeconomic situation of students and their families ("organic products are just more expensive and when they are more expensive, then you just buy them less often"; RM1—Tobias). Similar results were obtained by Krüger and Strüver [87], who found by conducting qualitative interviews with adult consumers that a part of the sample

believed that the economy is opposed to healthy and sustainable food practices and that sustainable consumption is a privilege of the affluent population.

Such a conception carries the risk of feeling powerless in the face of the unsustainable practices of the food system and undermines the students' perceived effectiveness in their role as food consumers. Similarly, Gralher [36] found that students often did not know any ways of influencing the sustainable development of the food system; however, the seven recommendations of von Koerber et al. [22] show that there are many options that can be implemented at low costs that are even cheaper than the unsustainable alternative (e.g., preference for plant-based foods or resource-saving housekeeping).

4.2.6. Cultural Dimension

Although we considered different definitions of culture in our evaluation, we primarily followed the Cambridge Dictionary's social science definition of culture, which describes it as follows: The way of life of a particular people, especially as shown in their ordinary behavior and habits, their attitudes toward each other, and their moral and religious beliefs [88]. A total of seven students were unable to see the connection between the cultural dimension and sustainable nutrition (Table 3; *Cultural aspects are not connected to sustainable diets*). All seven students showed a very narrow understanding of culture, which probably explains this barrier. For example, some students reduced culture to "paintings of former times" (RF10—Hannah) or to "what once was, what remains of that time" (HM11—Daniel), and thus to the past preserved by traditional constructs. Also, a reduction in cultural festivals such as "Oktoberfest" or "Carnival" (HM14—Nicolas) led to difficulties in combining cultural aspects with sustainable nutrition. Even if it was recognized that the term culture also refers to current trends, these could not always be transferred to the field of nutrition but were exclusively related to the fashion sector (RF5—Emilia: "Trends are actually more about clothing than about nutrition"). A possible explanation for this could be that, in the short life span of adolescents (M_{Age} = 15.59, SD = 0.78), the slow changes in the food sector are difficult to experience. In contrast, changes in the fashion sector happen very quickly and are easier for adolescents to identify. Nevertheless, it is surprising that, despite the presence of a huge variety of ethnic restaurants from different countries in Germany, culture was not associated with nutrition by some students. Such a concept carries the risk that culturally determined eating habits that are contrary to sustainable nutrition (e.g., high meat consumption or its association with masculinity) will not be questioned.

Furthermore, a total of seven students considered the cultural dimension to be exclusively reduced to religion (Table 3; *Equating culture with religion*) and frequently referred their statements to the Islamic religion. With approximately 4.5 million Muslims in Germany, Islam is the third largest religion in Germany. It is therefore not surprising that, for some students, the rules of halal, especially the abstention from pork, are representative of religion-specific nutritional habits. Nevertheless, according to the Federal Statistical Office of Germany [89], 58% of the German population belongs to Christian religions. We therefore assume that Christian eating habits and the prevalent renunciation of food restrictions are considered normal and have therefore not been addressed by the students.

Furthermore, it was difficult for the students to separate the social and cultural dimension (Table 3, *Equating culture and society*). The students also criticized the distinct dimensions of sustainable nutrition posited by von Koerber et al. [22] and suggested they should be considered together. Von Koerber et al. only poorly justified the extension of the dimensions of sustainable nutrition by the cultural dimension by factoring "the respective cultural background [that] influences food habits" [22] (p. 35) and do not present it in a clear-cut way in relation to the social dimension. In older literature regarding the concept, cultural aspects were summarized within the social dimension [25]. The definition of culture is inextricably linked to social groups of people, which is why the cultural and social dimensions overlap greatly in content. We suspect that students were therefore unable to conceptually separate the dimensions from one another.

5. Conclusions and Educational Implications for Teaching

Before explaining the comprehensive conclusions and educational implications of this research for teaching, it is important to not ignore possible limitations regarding the results. First of all, due to the selection of participants by the teachers, we cannot exclude the possibility that some of the participants had a particularly high interest in the topic of nutrition, even though the students were only told that the interview was about nutrition (not sustainable nutrition). Furthermore, we recognize that education based policies have limited impact on the modification of nutritional habits. For example, despite well-developed educational concepts, they have not been able to prevent the increase in obesity worldwide [6]. Other factors, such as the socioeconomic status of parents, have a major influence on the nutritional behavior of young people [90]. However, in samples with nearly the same socioeconomic status, nutritional interventions in schools showed an effect on the nutritional behavior of students [91].

Considering these limitations, the following conclusions and educational implications can be drawn from the results described in this article. In the context of RQ1, we identified a self-centered perspective of many students on the topic of sustainable nutrition, with a frequent focus on the health dimension. For this reason, we suggest that it should be clarified, especially for students without much previous experience on the topic or at the beginning of a teaching unit, that sustainable nutrition and nutrition in general are not exclusively health-related topics. By promoting systems thinking, the connections between sustainable nutrition and the ecological, social, and economic dimensions should be highlighted. Although we advocate strongly for the promotion of a multidimensional perspective, we emphasize that the health and ecological dimensions should not be neglected, given their importance for sustainable nutrition, even though these were already present in the students' conceptions. The health dimension in particular can be used as a starting point to make sustainable nutrition more easily accessible for students without much previous experience.

5.1. Terminology of Sustainable Nutrition

Since the negative interpretations of the terminology (Table 2; *Negative associations*) are contrary to the positive meaning of sustainable nutrition in the sense of sustainable development, interventions must be taken in the classroom in the direction of scientifically accurate conceptions of sustainable nutrition. For example, cognitive conflicts could be used to trigger conceptual change [16,92]. For this purpose, impulses such as the use of the term "sustainable" in a known context (e.g., sustainable energy) would be useful. In class, media reports, advertisements, or product descriptions could be used as materials. This includes products advertised as sustainable, which seem to have a potential for cognitive conflicts due to the inherent contradictions to the students' conceptions.

In contrast to the *negative associations* mentioned above, the origin of the other alternative conceptions (Table 2; *Healthy diet, Lasting into the future*) already contains correct elements of the scientific conception that could be useful for the learning process. To achieve a modification toward scientific conceptions, the promotion of a wider understanding of the term is critical; perspectives restricted to the context of food or one's own body must be broadened. Since the term "sustainable" is subject to inflationary use in everyday life and the media in a wide variety of situations, teaching practice should promote the development of a differentiated understanding of the term.

5.2. Health Dimension

Due to the numerous alternative conceptions regarding the recommended intake of macronutrients contradicting official nutritional recommendations, we advocate for resources outlining the recommendations of nutrition societies, such as the Nutrition Circle of the German Nutrition Society [76], which shows dietary guidelines, or the Eat Well guide for the United Kingdom [93], because they demonstrate in everyday practice that each individual nutrient performs vital functions in the organism. Knowledge about actual macronutrient requirements can eliminate uncertainties regarding dietary behavior in everyday life. Because we identified fear of an *undersupply due to a plant-based diet* (Table 3),

we propose the use of alternative dietary recommendations for vegetarians and vegans, such as vegetarian food pyramids, to alleviate this fear and enable students to adopt a healthy plant-based diet. Resources describing the positions of nutrition societies on vegetarian and vegan diets could also help to dispel those fears; however, attention should be drawn to the necessity of supplementing certain nutrients as well as regular medical observations.

5.3. Ecological Dimension

As we found some students to have difficulties recognizing the environmental impact of food consumption (Table 3; *Ecological aspects are not connected to sustainable nutrition*) and to understand the *environment as a service provider for the food supply* (Table 3), sustainable nutrition education should aim to illustrate the environmental impact of the food system and individual nutritional behavior. To prevent students' resignation, however, positive examples for the implementation of sustainable nutrition from an ecological perspective should also be provided. The recommendations of von Koerber et al. [22] are excellently suited for this purpose. To encourage the students' perceived effectiveness, the reduction of one's ecological footprint through a sustainable diet (e.g., preference for plant-based foods) compared to a meat-based diet could be illustrated. Ideas for comparing different meat alternatives in biology and geography classes according to selected sustainability criteria can be found in Fiebelkorn and Kuckuck [94].

Although other students considered the connection between sustainable nutrition and the ecological dimension, we found that students considered certain behaviors, especially the emission of CO_2, to be harmful to the environment but did not link them to the greenhouse effect; therefore, the relationship between CO_2 emissions and the greenhouse effect should be known by all students in order to correctly evaluate the positive effects of sustainable nutrition. Niebert and Gropengießer [85] provide a detailed overview of different methods to illustrate the relationship between CO_2 emissions and the greenhouse effect.

5.4. Social Dimension

Regarding the social dimension, we found that it bears little relevance in students' conceptions of sustainable nutrition. Moreover, we identified a frequently occurring egocentric perspective and shortcomings in students' abilities to adopt the perspective of other people in situations that are dissimilar to their own (e.g., workers in the value chain of food products); thus, teaching should aim to encourage students to change perspectives. This can be done both through direct contact with actors in agribusiness (e.g., farmers or food traders) and by using media that portray the food situations in other countries. In this way, a global perspective can be developed and a better understanding of people in countries with food poverty may be promoted. Furthermore, to better understand the interests and needs of different groups, group discussions with defined roles can be useful. The use of reports presenting problematic working conditions or child labor in the food industry could also be an effective means of stimulating a change in perspective. Here too, however, great care should be taken not to emotionally overwhelm the students and to avoid resignation. Instead, options for action for consumers to improve working conditions (e.g., regional and seasonal products and Fair Trade products) [22] should be highlighted; however, it is important to emphasize the freedom of the consumer and to also address students' perceived barriers that may make it difficult for them to consume socially sustainable products (e.g., low income of parents or limited control over food purchases in the family).

5.5. Economic Dimension

Education for sustainable nutrition should aim to teach students that the central idea of sustainable development is the promotion of the different dimensions "in a balanced and integrated manner" [8] (p. 3). Because the economic dimension had little relevance in the students' conceptions (results on RQ1; Figure 2), the importance of this dimension and its compatibility with sustainable nutrition

should also be emphasized in biology classrooms. Examples could include the large number of jobs in the food sector as well as the creation of new jobs in new food areas, such as vegan and vegetarian products, or the support of regional agricultural businesses.

We found that some students perceived the economic dimension at the macro and micro levels as an antagonist of sustainable nutrition (Table 3; *Economy is in conflict with sustainable nutrition*); therefore, it is important to give students examples of economic actors in the food sector who, for example, manage their companies in a sustainable way, e.g., by marketing organic food, saving on packaging, and standing for fair working conditions, all within profitable business models. In this way, students can recognize that there is not necessarily a contradiction between economically strong companies and sustainable food. Students' perceived effectiveness can be fostered by discussing in class what opportunities consumers have to support sustainable companies (e.g., every purchase decision supports a particular company).

Because, at the microeconomic level, students often cited the higher costs of sustainable nutrition as a barrier to consuming sustainable products, we recommend providing concrete examples of sustainable nutrition that can be implemented at low costs (e.g., preference for plant-based foods, resource-saving housekeeping, regional and seasonal products; preference for minimally processed foods) [22].

5.6. Cultural Dimension

Because some students could not make a connection between culture and sustainable food, which could lead to adopting culturally determined unsustainable eating habits without questioning, we suggest a critical examination of students' own eating habits and their cultural determinants as well as helping them to become more familiar with the eating habits of other cultures (e.g., consumption of insects—entomophagy) [95]. In addition, an evaluation of different nutritional styles according to sustainability criteria [94] could strengthen cultural sensitivity and ultimately lead to increased acceptance of "foreign" eating habits. To reduce any fears of new foods, or so-called "food neophobia," it may also help to look at the origin and history of popular foods or dishes such as bananas, pizza, or döner kebab. In Germany, for example, the Federal Ministry of Food and Agriculture offers materials for time travel through nutrition, which can be used for teaching arrangements [96]. Students will quickly notice that many culturally accepted foods were considered novel until some time ago, and that supposedly novel foods (e.g., insects in Germany) already have a history in their own country [95].

Furthermore, it was difficult for the students to separate the social and cultural dimensions. Despite the predominant consideration of the three sustainability dimensions (ecological, economic, social) in the past, the cultural dimension is currently also taken into account in the context of ESD [11]. In our opinion, this dimension is of particular importance in many areas, but especially in the field of nutrition, and should also be considered in teaching practice. Nevertheless, our results show that a separate consideration of the cultural and social dimensions leads to numerous confusions for students and is difficult to understand. For this reason, and because the two dimensions overlap greatly in content, we agree with the students' suggestion to combine the two dimensions and support the consideration of cultural aspects under the social dimension.

5.7. General Conclusions

In conclusion, it can be said that the nutrition issue is particularly well suited to ESD, as it combines health, ecological, social, and economic aspects to a greater extent than most other topics with a regional-global scope. Teachings on this topic should aim to ensure that students understand nutrition as a system based on the four dimensions (cultural aspects should be considered under the social dimension) of sustainable nutrition. Interventions should be implemented to encourage students to give up their egocentric views and improve their ability to change perspectives. In addition, clear options for action and their effect on the food system should be communicated to increase the students' perceived effectiveness in the sustainable development of the food system.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/13/5242/s1; Figure S1: Chi-square test on the distribution of the statements regarding the different dimensions of sustainable nutrition, Figure S2: Chi-square test on the distribution of the different dimensions on the subsamples, Figure S3: Chi-square test on the distribution of the students on the number of considered dimensions, Table S1: Sociodemographic data, additional information of the participants and the interview duration, Table S2: Associations with the term sustainable nutrition that corresponded to the health dimension, Table S3: Associations with the term sustainable nutrition that corresponded to the ecological dimension, Table S4. Associations with the term sustainable nutrition that corresponded to the social dimension, Table S5. Associations with the term sustainable nutrition that corresponded to the economic dimension, Table S6. Associations with the term sustainable nutrition that corresponded to the cultural dimension.

Author Contributions: A.H., F.F., and M.D. made substantial contributions to the conceptualization of the research; M.D. and F.F. supervised the data acquisition; A.H. conducted interviews; M.D. carried out the analyses with the support of A.H.; M.D. drafted the original manuscript and prepared figures; F.F. revised the work critically for important intellectual content; F.F. provided the resources for conducting the study. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: We would like to thank the interviewers for conducting the interviews and our research assistant for the support in data analysis. We would also like to thank the schools for their cooperation, and the interviewed students who made this research possible.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IPCC (Intergovernmental Panel on Climate Change). *Ipcc Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*; Arneth, A., Barbosa, H., Benton, T., Calvin, K., Davin, E., Denton, F., Diemen, R., Driouech, F., Elbehri, A., Evans, J., et al., Eds.; IPCC: Geneva, Switzerland, 2019.
2. Campbell, B.M.; Beare, D.J.; Bennett, E.M.; Hall-Spencer, J.M.; Ingram, J.S.I.; Jaramillo, F.; Ortiz, R.; Ramankutty, N.; Sayer, J.A.; Shindell, D. Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecol. Soc.* **2017**, *22*, art8. [CrossRef]
3. IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; Díaz, S., Settele, J., Brondízio, E.S., Ngo, H.T., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K.A., Butchart, S.H.M., et al., Eds.; IPBES: Bonn, Germany, 2019; ISBN 978-3-947851-13-3.
4. FAO. *Sustainable Diets and Biodiversity: Directions and Solutions for Policy, Research and Action*; Burlingame, B., Dernini, S., Division, N., Eds.; FAO: Rome, Italy, 2012; ISBN 978-92-5-107288-2 (PDF).
5. FAO; IFAD; UNICEF; WFP; WHO. *The State of Food Security and Nutrition in the World 2019. Safeguarding Against Economic Slowdowns and Downturns*; FAO: Rome, Italy, 2019; ISBN 978-92-5-131570-5.
6. WHO. Obesity and Overweight. Available online: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (accessed on 8 April 2020).
7. Clark, M.; Hill, J.; Tilman, D. The diet, health, and environment trilemma. *Annu. Rev. Environ. Resour.* **2018**, *43*, 109–134. [CrossRef]
8. United Nations. *Resolution Adopted by the General Assembly on 25 September 2015. Transforming Our World: The 2030 Agenda for Sustainable Development*; A/RES/70/1, 25.9 2015; United Nations General Assembly: New York, NY, USA, 2015.
9. Rockström, J.; Edenhofer, O.; Gaertner, J.; Declerck, F. Planet-proofing the global food system. *Nat. Food* **2020**, *1*, 3–5. [CrossRef]
10. Willett, W.; Rockström, J.; Loken, B.; Springmann, M.; Lang, T.; Vermeulen, S.; Garnett, T.; Tilman, D.; DeClerck, F.; Wood, A.; et al. Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet* **2019**, *393*, 447–492. [CrossRef]
11. Rieckmann, M. *Education for Sustainable Development Goals: Learning Objectives*; UNESCO: Paris, France, 2017; ISBN 978-92-3-100209-0.
12. UNESCO. *UNESCO Roadmap Education for Sustainable Development*; UNESCO: Paris, France, 2014.
13. Piaget, J. *The Construction of Reality in the Child*; Klett: Stuttgart, Germany, 1974; ISBN 978-3129263105.

14. Piaget, J. *My Theory of Mental Development*; Fatke, R., Ed.; Fischer: Frankfurt am Main, Germany, 1983; ISBN 3-463-00835-1.
15. Kattmann, U.; Duit, R.; Gropengießer, H.; Komorek, M. The model of didactic reconstruction—A framework for scientific research and development. *Zeitschrift für Didakt. der Naturwissenschaften* **1997**, *3*, 3–18.
16. Posner, G.; Strike, K.; Hewson, P.; Gertzog, W. Accommodation of a scientific conception: Toward a theory of conceptual change. *Sci. Educ.* **1982**, *66*, 211–227. [CrossRef]
17. Tobinski, D.; Fritz, A. 4. Lerntheorien und pädagogisches Handeln. In *Pädagogische Psychologie*; Fritz, A., Hussy, W., Tobinski, D., Eds.; UTB: Munich, Germany, 2014; pp. 222–247, ISBN 978-3-8252-4241-1.
18. Reinmann, G.; Mandl, H. Unterrichten und Lernumgebungen gestalten. In *Pädagogische Psychologie*; Krapp, A., Weidenmann, B., Eds.; Beltz: Weinheim, Germany, 2006; pp. 613–658, ISBN 9783621275644.
19. Riemeier, T. Moderater Konstruktivismus. In *Theorien in der biologiedidaktischen Forschung*; Krüger, D., Vogt, H., Eds.; Springer: Berlin, Germany, 2007; pp. 69–79, ISBN 978-3-540-68165-6.
20. Kattmann, U. *Understand Students Better: Everyday Conceptions in Biology Lessons*; Aulis: Hallbergmoos, Germany, 2015; ISBN 978-3-7614-2941-9.
21. Duit, R.; Treagust, D.F. Conceptual change: A powerful framework for improving science teaching and learning. *Int. J. Sci. Educ.* **2003**, *25*, 671–688. [CrossRef]
22. von Koerber, K.; Bader, N.; Leitzmann, C. Wholesome nutrition: An example for a sustainable diet. *Proc. Nutr. Soc.* **2017**, *76*, 34–41. [CrossRef]
23. Gussow, J.D.; Clancy, K.L. Dietary guidelines for sustainability. *J. Nutr. Educ.* **1986**, *18*, 1–5. [CrossRef]
24. Gussow, J.D. Dietary guidelines for sustainability: Twelve years later. *J. Nutr. Educ.* **1999**, *31*, 194–200. [CrossRef]
25. von Koerber, K.; Männle, T.; Leitzmann, C. *Wholesome Nutrition: Conception of a Contemporary and Sustainable Diet*, 11th ed.; Haug: Stuttgart, Germany, 2012; ISBN 978-3830471042.
26. FAO. Food and Agriculture: Key to Achieving 2030 Agenda for Sustainable Development. Available online: http://www.fao.org/3/a-i5499e.pdf (accessed on 9 April 2020).
27. DUK (German Comission for UNESCO). *Teaching and Learning Materials on the Topic of the Year: Nutrition. Un Decade of Education for Sustainable Development*; DUK: Bonn, Germany, 2012; ISBN 978-3-940785-36-7.
28. Lower Saxony Ministry of Education. *Core Curriculum for the Gymnasium—Grades 5–10. Natural Sciences*; Lower Saxony Ministry of Education: Hannover, Germany, 2015.
29. Lower Saxony Ministry of Education. *Core Curriculum for the Hauptschule—Grades 5–10. Natural sciences*; Lower Saxony Ministry of Education: Hannover, Germany, 2015.
30. Lower Saxony Ministry of Education. *Core Curriculum for the Realschule—Grades 5–10. Natural sciences*; Lower Saxony Ministry of Education: Hannover, Germany, 2015.
31. Baack, K.; Steinert, C. *Natura 7/8—Biology for Gymnasien*; Klett: Stuttgart, Germany, 2015; ISBN 978-3-12-049311-2.
32. Beyer, I.; Remé, R.; Steinert, C. *Natura 9/10—Biology for Gymnasien*; Klett: Stuttgart, Germany, 2016; ISBN 978-3-12-049321-1.
33. Bergau, M.; Hoffmann, L.; Ixmeier, R.; Kalusche, D.; Ley, S.; Nelke, S.; Röhrich, R.; Schäfer, B.; Willmer-Klimp, C. *Prisma Biology 7/8 -Differentiating Teachers Edition*, 2nd ed.; Klett: Stuttgart, Germany, 2018; ISBN 978-3-12-068475-6.
34. Bergau, M.; Hoffmann, L.; Ixmeier, R.; Kalusche, D.; Ley, S.; Nelk, S.; Schäfe, B.; Walcher, M.; Willmer-Klimp, C. *Prisma Biologie 9/10—Differenzierende Ausgabe*, 1st ed.; Klett: Stuttgart, Germany, 2015; ISBN 978-3-12-068348-3.
35. Adamitzki, S.; Groth, H.; Hoppe, P.; Hoppe, T.; Jakobsen, J.; Kroll, D.; Leiding, U.; Mittler, D.; Moschner-Rahe, K.; Sudeik, T.; et al. *Blickpunkt Biologie 1*; Westermann: Braunschweig, Germany, 2020; ISBN 978-3141880250.
36. Gralher, M. *Understanding Sustainable Nutrition: A Contribution to the Didactic Reconstruction of Education for Sustainable Development*; Schneider Hohengehren: Baltmannsweiler, Germany, 2015; ISBN 978-3-8340-1467-2.
37. Macdiarmid, J.I.; Douglas, F.; Campbell, J. Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite* **2016**, *96*, 487–493. [CrossRef] [PubMed]
38. Hamann, S. Students' Presentations on Agriculture in the Context of Education for Sustainable Development. Ph.D. Thesis, University of Education, Ludwigsburg, Germany, 13 July 2014.

39. Dillon, J.; Rickinson, M.; Sanders, D.; Teamey, K. On food, farming and land management: Towards a research agenda to reconnect urban and rural lives. *Int. J. Sci. Educ.* **2005**, *27*, 1359–1374. [CrossRef]
40. de Zompero, A.F.; Figueiredo, H.R.S.; dos Santos, C.T.H.; Vieira, K.M. Conceptions of Brazilian elementary and high school students about food nutrients. *Creat. Educ.* **2019**, *10*, 862–873. [CrossRef]
41. Mann, M.; Treagust, D.F. Students' conceptions about energy and the human body. *Sci. Educ. Int.* **2010**, *21*, 144–159.
42. Rasnake, L.K.; Laube, E.; Lewis, M.; Linscheid, T.R. Children's nutritional judgments: Relation to eating attitudes and body image. *Health Commun.* **2005**, *18*, 275–289. [CrossRef]
43. Currie, C.; Zanotti, C.; Morgan, A.; Currie, D.; de Looze, M.; Roberts, C.; Samdal, O.; Smith, O.R.F.; Barnekow, V. (Eds.) *Social Determinants of Health And Well-Being Among Young People: Health Behaviour in School-Aged Children (Hbsc) Study: International Report from the 2009/2010 Survey*; Health Policy for Children and Adolescents; WHO Regional Office for Europe: Copenhagen, Denmark, 2012; ISBN 978 92 890 1423 6.
44. Bartsch, S. Eating culture of the youth: The importance of food for young people in the context of family and peer group. In *Reihe Forschung und Praxis der Gesundheitsförderung*; BZgA: Cologne, Germany, 2008; Volume 30, ISBN 9783937707372.
45. Fredrickson, J.; Kremer, P.; Swinburn, B.; de Silva, A.; McCabe, M. Weight perception in overweight adolescents: Associations with body change intentions, diet and physical activity. *J. Health Psychol.* **2015**, *20*, 774–784. [CrossRef]
46. Aragon, A.A.; Schoenfeld, B.J.; Wildman, R.; Kleiner, S.; VanDusseldorp, T.; Taylor, L.; Earnest, C.P.; Arciero, P.J.; Wilborn, C.; Kalman, D.S.; et al. International society of sports nutrition position stand: Diets and body composition. *J. Int. Soc. Sports Nutr.* **2017**, *14*, 16. [CrossRef]
47. *Deutschland, wie es isst: Der BMEL-Ernährungsreport 2017*; BMEL (Federal Ministry of Food and Agriculture): Berlin, Germany, 2017.
48. *Iss Was, Deutschland. TK-Studie zur Ernährung 2017*; Techniker Krankenkasse: Hamburg, Germany, 2017.
49. Subjective theories of students on sustainable nutrition. Exploratory study. *Haushalt Bild. Forsch.* **2015**, *4*, 78–92. [CrossRef]
50. Hertrampf, A.; Bender, U. What do prospective teachers know about sustainable nutrition? *Ernaehrungs Umschau* **2016**, *63*, 206–212. [CrossRef]
51. Berglund, T.; Gericke, N. Separated and integrated perspectives on environmental, economic, and social dimensions—An investigation of student views on sustainable development. *Environ. Educ. Res.* **2016**, *22*, 1115–1138. [CrossRef]
52. Lockley, J.; Jarrath, M. The nature of sustainability as viewed by european students. *J. Educ. Sustain. Dev.* **2013**, *7*, 113–124. [CrossRef]
53. Richter, T.; Schumacher, K.P. Who really cares about higher education for sustainable development? *J. Soc. Sci.* **2011**, *7*, 24–32. [CrossRef]
54. Fiebelkorn, F.; Menzel, S. Student teachers' understanding of the terminology, distribution, and loss of biodiversity: Perspectives from a biodiversity hotspot and an industrialized country. *Res. Sci. Educ.* **2013**, *43*, 1593–1615. [CrossRef]
55. Menzel, S.; Bögeholz, S. Vorstellungen und Argumentationsstrukturen von Schüler(inne)n der elften Jahrgangsstufe zur Biodiversität, deren Gefährdung und Erhaltung. *Zeitschrift für Didakt. der Naturwissenschaften* **2006**, *12*, 199–217.
56. Gausmann, E.; Eggert, S.; Hasselhorn, M.; Watermann, R.; Bögeholz, S. Wie verarbeiten Schüler/innen Sachinformationen in Problem- und Entscheidungssituationen nachhaltiger Entwicklung? *Zeitschrift für Pädagogik* **2010**, *56*, 204–215.
57. KMK. *The Education System in the Federal Republic of Germany 2016/2017*; Eckhard, T., Ed.; KMK (Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany): Bonn, Germany, 2019.
58. Mensink, G.B.M.; Barbosa, C.L.; Anna-Kristin, B. Verbreitung der vegetarischen Ernährungsweise in Deutschland. *J. Health Monit.* **2016**, *1*, 2–15. [CrossRef]
59. Dresing, T.; Pehl, T. *Practice Book Interview, Transcription & Analysis: Instructions and Rule Systems for Qualitative Researchers*, 6th ed.; Self-Published: Marburg, Germany, 2015; ISBN 978-3-8185-0489-2.
60. *MAXQDA, Version 2018*; VERBI GmbH: Berlin, Germany, 2018.

61. Mayring, P. *Qualitative Content Analysis: Theoretical Foundation, Basic Procedures and Software Solution*; SSOAR: Klagenfurt, Austria, 2014.
62. Kuckartz, U.; Rädiker, S. *Analyzing Qualitative Data with MAXQDA: Text, Audio, and Video*; Springer International Publishing: Cham, Switzerland, 2019; ISBN 978-3-030-15671-8.
63. Brennan, R.L.; Prediger, D.J. Coefficient Kappa: Some uses, misuses, and alternatives. *Educ. Psychol. Meas.* **1981**, *41*, 687–699. [CrossRef]
64. Landis, J.R.; Koch, G.G. The measurement of observer agreement for categorical data. *Biometrics* **1977**, *33*, 159. [CrossRef]
65. Bortz, J.; Döring, N. *Research Methods and Evaluation for Human and Social Scientists*, 4th ed.; Springer: Heidelberg, Germany, 2006; ISBN 978-3-540-33305-0.
66. Gensicke, T. The values of youth (2002–2015). In *Jugend 2015. Eine pragmatische Generation im Aufbruch. 17. Shell Jugendstudie*; Fischer: Frankfurt am Main, Germany, 2015; pp. 237–272.
67. Kagawa, F. Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. *Int. J. Sustain. High. Educ.* **2007**, *8*, 317–338. [CrossRef]
68. Nachteilig [Disadvantageous]. Available online: https://www.duden.de/node/153642/revision/153678 (accessed on 24 April 2020).
69. Nachlässig [Careless]. Available online: https://www.duden.de/node/153535/revision/153571 (accessed on 24 April 2020).
70. WCED (World Commission on Environment and Development). *Our Common Future: Report of the World Commission on Environment and Development*; Oxford University Press: Oxford, UK, 1987.
71. Nach [After]. Available online: https://www.duden.de/node/153411/revision/153447 (accessed on 24 April 2020).
72. DGE (German Nutrition Society); ÖGE (Austrian Nutrition Society); SGE (Swiss Nutrition Society). *D-A-CH-Referenzwerte für die Nährstoffzufuhr*, 3rd ed.; SGE: Bonn, Germany, 2017; ISBN 978-3865281487.
73. Hauner, H.; Bechthold, A.; Boeing, H.; Brönstrup, A.; Buyken, A.; Leschik-Bonnet, E.; Linseisen, J.; Schulze, M.; Strohm, D.; Wolfram, G. Evidence-Based guideline of the German Nutrition Society: Carbohydrate intake and prevention of nutrition-related diseases. *Ann. Nutr. Metab.* **2012**, *60*, 1–58. [CrossRef]
74. Heseker, H.; Dankers, R.; Hirsch, J. *Schlussbericht für das Bundesministerium für Ernährung und Landwirtschaft (BMEL): Ernährungsbezogene Bildungsarbeit in Kitas und Schulen (ErnBildung)*; BMEL: Paderborn, Germany, 2018.
75. Günther, W.; Bechthold, A.; Boeing, H.; Dinter, J.; Ellinger, S.; Hauner, H.; Kroke, A.; Leschik-Bonnet, E.; Linseisen, J.; Lorkowksi, S.; et al. *Evidenzbasierte Leitlinie—Fettzufuhr und Prävention Ausgewählter Ernährungsmitbedingter Krankheiten*, 2nd ed.; DGE: Bonn, Germany, 2015.
76. DGE German Nutrition Society DGE-Ernährungskreis. DGE Nutrition Circle. Available online: https://www.dge.de/ernaehrungspraxis/vollwertige-ernaehrung/ernaehrungskreis/ (accessed on 28 June 2020).
77. HHS (U.S. Department of Health and Human Services); USDA (U.S. Department of Agriculture). *2015–2020 Dietary Guidelines for Americans*, 8th ed.; USDA: Washington, DC, USA, 2015.
78. Fuchs, E.; Niehaus, I.; Stoletzki, A. *Schulbuch in der Forschung. Analysen und Empfehlungen für die Bildungspraxis*; V&R Unipress: Göttingen, Germany, 2014; ISBN 978-3-8470-0385-4.
79. Freedman, M.R.; King, J.; Kennedy, E. Popular diets: A scientific review. *Obes. Res.* **2001**, *9*, 1S–40S. [CrossRef] [PubMed]
80. Gonçalves, V.O.; Martínez, J.P. Imagen corporal y percepción de la influencia de los medios de comunicación: Diferencias de género en una muestra de adolescentes. *Rev. Inter Ação* **2014**, *39*, 461–478. [CrossRef]
81. Melina, V.; Craig, W.; Levin, S. Position of the Academy of Nutrition and Dietetics: Vegetarian diets. *J. Acad. Nutr. Diet.* **2016**, *116*, 1970–1980. [CrossRef] [PubMed]
82. Phillips, F. Vegetarian nutrition. *Nutr. Bull.* **2005**, *30*, 132–167. [CrossRef]
83. Richter, M.; Boeing, H.; Grünewald-Funk, D.; Heseker, H.; Kroke, A.; Leschik-Bonnet, E.; Oberritter, H.; Strohm, D.; Watzl, B. Vegan diet—position of the German Nutrition Society. *Ernaehrungs Umschau Int.* **2016**, *4*, 92–102. [CrossRef]
84. Millenium Ecosystem Assessment. *Ecosystems and Human Well-Being: Biodiversity Synthesis*; World Resources Institute: Washington, DC, USA, 2005; ISBN 9781597267113.
85. Niebert, K.; Gropengießer, H. Understanding the greenhouse effect by embodiment—Analysing and using students' and scientists' conceptual resources. *Int. J. Sci. Educ.* **2014**, *36*, 277–303. [CrossRef]

86. Rieckmann, M. Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures* **2012**, *44*, 127–135. [CrossRef]
87. Krüger, T.; Strüver, A. Narratives of "good food": Consumer identities and the appropriation of sustainability discourses. *Z. Wirtschgeogr.* **2018**, *62*, 217–232. [CrossRef]
88. Culture. Available online: https://dictionary.cambridge.org/de/worterbuch/englisch/culture (accessed on 10 May 2020).
89. Population Religious Affiliation in 1000. Available online: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/Tabellen/bevoelkerung-religion.html (accessed on 30 April 2020).
90. Zarnowiecki, D.; Ball, K.; Parletta, N.; Dollman, J. Describing socioeconomic gradients in children's diets - does the socioeconomic indicator used matter? *Int. J. Behav. Nutr. Phys. Act.* **2014**, *11*, 1–12. [CrossRef]
91. Ochoa-Avilés, A.; Verstraeten, R.; Huybregts, L.; Andrade, S.; Van Camp, J.; Donoso, S.; Ramírez, P.L.; Lachat, C.; Maes, L.; Kolsteren, P. A school-based intervention improved dietary intake outcomes and reduced waist circumference in adolescents: A cluster randomized controlled trial. *Nutr. J.* **2017**, *16*, 79. [CrossRef]
92. Strike, K.A.; Posner, G.J. A revisionist theory of conceptual change. In *Philosophy of Science, Cognitive Psychology, and Educational Theory and Practice*; Duschl, R.A., Hamilton, R.J., Eds.; State University of New York Press: Albany, NY, USA, 1992; pp. 147–176.
93. Public Health England; Welsh Government; Food Standards Scotland. Food Standards Agency in Northern Ireland Eatwell Guide. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/510363/UPDATED_Eatwell_guide_2016_FINAL_MAR23.pdf (accessed on 4 May 2020).
94. Fiebelkorn, F.; Kuckuck, M. Insekten oder In-vitro-Fleisch—Was ist nachhaltiger ? Eine Beurteilung mithilfe der Methode des "Expliziten Bewertens". *Prax. Geogr.* **2019**, *6*, 14–21.
95. Fiebelkorn, F. Insekten als Nahrungsmittel der Zukunft. *Biol. unserer Zeit* **2017**, *47*, 104–110. [CrossRef]
96. BMEL (Federal Ministry of Nutrition and Agriculture). *Zeitreise durch die Ernährung—Essen im Wandel*; BMEL: Bonn, Germany, 2018.