

Nutrition Ecology – A Topic for Biology Lessons

Imke Köpke, Dr.rer.nat
Kirsten Schlüter, Dr.sc.nat.

ABSTRACT

In this article the concept of nutrition ecology (*Ernährungsökologie*) is introduced as a basis for combining health, ecological, and societal aspects when teaching nutrition. It supports the idea of sustainable development. There are several parallels between these two concepts that will be illustrated. A teaching unit is described that combines imparting knowledge about nutrients, food categories and production methods that can be the foundation of food selection for the diet. To assess students' attitudes a questionnaire was developed based on the concept of nutrition ecology. The main elements of this questionnaire and interpretation of the data emanating from it are discussed.

Umwelt und Gesundheit Online, 2008; 1, 38-43.

Introduction

Nutrition ecology (*Ernährungsökologie*) is a relatively new academic discipline that refers to the relationship and interdependence of nutrition, the needs of human beings, the environment, and society-at-large (von Koerber, Männle, & Leitzmann, 1999). Nutrition ecology, however, not only should be a topic at the university level but also should find its way into classrooms at other levels of education. It demonstrates that decisions concerning nutrition are not only based on health-related factors, but also on many other criteria which are often not immediately obvious. Students should be taught that diet-related decisions not only have health consequences, but also influence other areas of their lives. Among the concerns about which students should be aware include that buying special foods supports certain production methods that may have environmental impacts and certain crop-growing subsidies can have societal implications.

In this paper, the main aspects of nutrition ecology are presented and compared with the principles of sustainable development. Recommendations are made concerning how aspects of nutrition ecology can be integrated in the school and university settings.

Subsumption of Nutrition to the Curriculum

When a teacher gives lessons in nutrition they are usually under the broader area of *health education*. However, with the teaching of nutrition ecology, the teacher also can integrate aspects of education for a sustainable development (ESD). According to Rost (2002), ESD comprises three different orientations:

- a value orientation,
- a future orientation, and
- a competence orientation.

Value Orientation

This orientation refers to three different views or value areas by which a problem can be analyzed (de Haan & Harenberg, 1999). First, there is the *ecological perspective* – the view that human beings' actions should not destroy the environment, but rather, should be in harmony with nature; they should be environmentally sound.

A second value area is the *economical perspective*. From this point of view, even when one acts in an environmentally compatible way, one has to keep in mind the economic consequences. Environmental protection can be an expensive endeavour, and when restrictions concerning manufacturing are prohibitively high, companies may produce their products in other countries where there are fewer or no environmental regulations.

Finally, there is the *social perspective*, which refers to justice. Affluence and natural resources are not distributed evenly in the world. First World countries are obligated to assume responsibility for people of developing countries and offer developmental aid as needed. Justice also means that one should think of future generations so that they, too, can lead a life whose quality is at least as good as that of the present generation. Consequently, one should be careful in utilizing natural resources, and not leave behind a legacy of a damaged or compromised environment.

Comparison of the Value Orientation of ESD with Nutrition Ecology

Similar perspectives to those of ESD can be found in the *concept of nutrition ecology* developed by von Koerber, et al. (1999). Again, there is an *ecological perspective* that points out the need to be aware of how foods are produced. For example, are numerous pesticides used? To what extent are artificial fertilizers used? Are foods quick-frozen, a process that consumes a lot of energy – but that preserves the integrity of vitamins for a longer time?

Have foods been brought into the country from other countries or from great distances? In the best case scenario – referring to von Koerber, et al. (1999) – one should consume foods that are produced by organic farming, that come extensively from within the region, are minimally processed, and that have environmentally sound packaging. Minimal environmental impact occurs through consumption of vegetables and vegetable-derived products, as opposed to animal products, because a lot of the energy is stored in living creatures, and becomes lost from one trophic level to the next.

In both concepts – sustainable development and nutrition ecology – there is also a *social perspective* (Figure 1). With respect to nutrition ecology, this perspective refers to the nutritional culture that is influenced by the habits of an individual, and by societal effects. In addition, ethical aspects are included in this perspective. If purchasing food products imported from developing countries, one should be aware whether they are produced in a way that is acceptable to the well-being of society. Thus, this perspective directs people to pay attention that resources and affluence will be distributed in an egalitarian manner.

A comparison of sustainable development and nutrition ecology reveals that the *economical perspective* is missing in the latter (Figure 1). In a revised version of nutrition ecology (von Koerber, Männle, & Leitzmann, 2004), the economical perspective is introduced. In the previous version presented here (von Koerber et al., 1999) the economical perspective is included as part of the social perspective and refers to the interests of the growers, the hosts, and the merchants whose concerns involve the elements of yield, the harvest properties, shelf life, marketing aspects, production costs, and sales price.

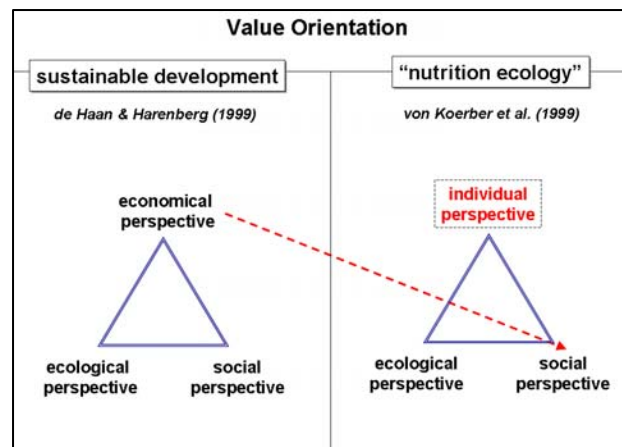
Another difference between the concept of sustainable development and nutrition ecology is that the latter contains the so called *individual perspective*. This perspective touches, among other things, aspects of health, pleasure, and suitability. The common element among these aspects is that they all are of direct importance to the individual.

Future Orientation

The philosophy of ESD ensures a high quality of life for everyone, not only in the present generation, but also for future generations. Therefore, it is critical that the earth's resources be handled carefully. If this idea is transferred to the concept of nutrition education, the human is of concern because it, too, should be viewed as a resource. If the body is not treated gently and in a healthy way during one's

youth, the likelihood of having diet-related diseases later in life becomes magnified.

Figure 1. Comparing Sustainable and Nutrition Ecology



Competence Orientation

The competence orientation is divided into two domains: the competence of evaluation and the competence of action. *Competence of evaluation* implies that we should know methods to evaluate a certain situation to judge whether this situation or action is in line with our moral concepts. The *competence of action* indicates that we should know ways for acting to overcome an unsatisfying situation.

Taken together, both competence constructs result in the *competence of creativity*, which means that we can participate in organizing society and societal life. We can develop new ideas to solve environmental problems and we know how to realize these ideas.

The Concept of Nutrition Ecology

As stated earlier there are three perspectives to determine the quality of food products: *individual*, *environmental*, and *societal*. To describe these perspectives in more detail, von Koerber et al. (1999) assigned different value categories to each.

The Individual Perspective

The *individual perspective* is characterized by four value categories. First there is the *health value* that refers to the content of essential nutrients (like vitamins, minerals, the eight essential amino acids, and polyunsaturated fatty acids), the content of health-promoting ingredients like dietary fibre and secondary plant ingredients. The health value further refers to the density of essential nutrients (which correspond to the ratio of essential nutrients to energy-rich nutrients), the amount of energy, the

presence and amount of contaminants of pathogenic germs, and finally, it refers to the ripeness and freshness of fruits and vegetables and to their digestibility. Discussing the health value in a society like ours (Germany), which is an affluent society, it will lead to nutritional consequences other than what might occur in a developing country. In our society one should avoid consuming a large proportion of “empty calories,” highly processed food products containing calories but little diet fibre and little essential nutrients.

The *suitability value* expresses that the food products are suitable for the purpose for which one wants to use them. Thus, the consumer will pay attention to the shelf life of a food, its price, and the time needed for buying, preparing and consuming it. “Fast food” is convenient because one does not need to prepare it.

The *pleasure value* refers to whether the food looks good, whether it tastes and smells good.

The *psychological value* concerns the joy involved in eating a special food – say, *eating a piece of chocolate makes me happy*. It also refers to conceptions and misconceptions about the effects of special foods – say, *I feel much more creative when I have eaten a piece of chocolate*. Another example for a psychological effect is that one eats special food products to reward himself or herself – say, *I have done my homework so I will reward myself with a piece of chocolate*. And finally, advertisements may manipulate my choice of special food products.

The Ecological Perspective

The *ecological perspective* is defined by *ecological values* like the waste of energy, raw materials, and water. The ecological value of a food product refers also to the costs to produce the food – say, *the food should not be highly processed*. Moreover, the ecological value refers to the efforts of waste disposal, and the pollutants being released during food production or waste disposal. According to von Koerber, et al. (1999), organic farming would be the most ecologically acceptable way of food production.

The Societal Perspective

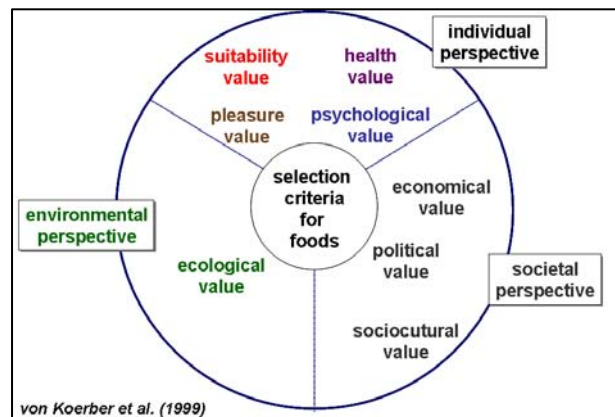
The *sociocultural value* of food products refers to the prestige of certain products (e.g., caviar and other delicacies). It refers also to cultural aspects, because there are special eating habits and traditions in each culture and even in each family. In addition, consuming specific foods might have effects on other people – such as parents, teachers, or other individuals who can be positive examples or role models for children and youth.

The *economical value* of a food product refers to its properties being important to growers, hosts and merchandisers. This value is less relevant to the teaching unit we developed because we want to concentrate on the values of greatest interest and importance to the consumers (i.e., the students).

Finally, there is the *political value*. In the revised concept (von Koerber et al. 2004) it has been replaced by the *ethical value* of food products. The ethical aspect becomes visible when one looks at products being imported from third-world countries. Foods and other commodities, such as bananas and coffee, often are produced by workers in plantations where they are paid low wages. This cheap labour force is a main reason why these food products are less costly when offered in supermarkets. When buying fair trade products, however, these foods were produced by small farmers and the consumers have to pay higher costs for which the farmers receive a return that supports their work and independence.

Another ethical problem is that a lot of animal-food is imported from third-world countries whose industries could instead, perhaps even better, be used to nourish the local population. A final aspect of the ethical value is appropriateness of the conditions of animal husbandry.

Figure 2. Relationship of Individual, Ecological, and Societal Perspectives to Food Selection Criteria



Recommendations for Wholefood-Nutrition

The term *wholefood-nutrition* (*Vollwert-Ernährung*) describes how the concept of nutrition ecology can be put into practice. The work of von Koerber et al. (1999) contains a classification system that divides or categorizes foods according to their level of “recommendation.” This category system builds up on a similar one developed by Kollath (1960). A main grouping criterion for foods in this classification system is the degree of processing.

Highly processed foods are less-recommended because they are low in essential nutrients, they consume a great deal of energy in the production process, and they often contain food additives such as dyes or artificial flavours.

Depending on the degree of processing the recommended food quantity one should eat varies. The first food category is highly recommended and the corresponding food products should comprise nearly the whole daily intake. This category can be divided into two subgroups. The first one contains non-processed or minimally-processed foods. The second subgroup, comprising the other half of our daily intake, is moderately processed (for example, has been heated). Food products of the next category are less recommended and should be eaten less often. Finally, products of the third category should be completely avoided because they are extensively processed.

To illustrate this system, some examples for two product groups, namely cereals and sweeteners, are provided. Highly recommended cereals are ones derived from whole-grain products. Less recommended are the non-wholemeal products, and the non-recommended ones are isolated roughage products that stimulate digestion.

The second example refers to sweeteners. Highly recommended sweeteners are fresh fruits. Non-sulphurated dried fruits and non-heat-treated honey also are recommended; however, they should be used in moderation, because of their high sugar (carbohydrate) content. Less recommended are non-refined sucrose and sugar beet syrup. Isolated sugars and sweets are not recommended.

How to Integrate Aspects of Nutrition Ecology into Class

A teaching unit is presented which was developed for and tested with 9th graders (Köpke 2006). It contains traditional aspects of nutrition education as well as new aspects referring to nutrition ecology. The goal of this unit – next to transferring knowledge – is to have students become aware of their decision criteria concerning food choices and to apply these decision criteria critically.

In the first lesson students have to complete a questionnaire. To determine students' nutritional motives they get a list with several decision criteria concerning food choice and they shall mark the criteria that are important to them. Results reveal that students can be grouped into two clusters. These two clusters differ significantly in students' agreement regarding the importance of various items. The first cluster is called "necessity oriented," because students emphasize the pleasure and habit aspects as well as the suitability aspects of the food products.

The *pleasure value* is described by two items: *the foods taste good* and *it should look good*. However, there is another, more psychological oriented item with a similar answering pattern: *the food has always been eaten by me*. This item is also integrated into the same value category, which now is called *pleasure and habit value*. The *suitability value* category is characterised by five items: *the food should be filling, it can be eaten by hands, it should be cheap, it should be easy to get, and it should be handy for transport*.

The second cluster is called "standard oriented," because students put more emphasis on the health, fitness and even ecological aspects than their colleagues of the other cluster. The *health value* is determined by six items: *The food should contain little sugar, little fat, a lot of vitamins, a lot of fibres, no meat, and the food should not be genetically modified*. The *psychological value* category comprises three items: *the food should support a good figure, it should support cognitive abilities and it should make students fit for sport*. Finally, there is the *value* category composed of two items, namely: *the foods should come from organic farming, and the foods should be as unprocessed as possible*.

After having completed the survey, students can analyse on a percentage level whether they marked more necessity-oriented items in comparison to standard-oriented items, or vice versa. In the first case, they tend to belong to the necessity oriented cluster; in the second case, they are more standard oriented. The survey data, however, should be analysed and discussed at the end of the teaching unit, because a second survey is planned at the end of the unit, and there might be the problem that students' answers will be influenced by social desirability.

To analyze students' *intentions*, they are asked what they would like to eat during recess if they could choose five foods from a product list of a hypothetical school kiosk. This kiosk contains traditional foods, foods of organic production, functional foods with an additional health value, calorie-reduced foods, and foods of fair trade. These food products also can be grouped in another way according to the classification system of von Koerber et al. (1999), namely in highly, less and non-recommended products according to their degree of processing. What we did was provide food products with different scores: highly recommended products with 2 points, less recommended with 1 point, and non-recommended products with 0 points. Summing up the scores one gets a maximum of 10 points. If these data are gathered anonymously in class, the teacher can present the distribution of the aggregated scores to the students. In the course of this it is interesting to analyse the distribution of girls and

boys. In the survey we conducted, 9th grade boys scored significantly less than 9th grade girls (Schlüter, Köpke, & Bayrhuber, 2005).

The second through the sixth lessons are used for information input. Students shall get to know the different sorts of nutrients and their importance for the human body. They also get to know the different food categories of the nutrition cycle: (1) cereal products and potatoes, (2) vegetable and pulses, (3) fruits, (4) drinks / water; (5) milk and dairy products, (6) meat, fish and eggs, (7) fats. Students become informed about the food categories by the jigsaw puzzle-method. For this exercise, the class is divided into groups. Each group delves into a special food category. So they will get written information about the nutrients and their effects which are typical for the foods of that particular food category. In this first phase of group work students are organized in expert groups. After they have become experts on their special food category, new groups will be formed. In these new groups seven students with different specialist knowledge meet together to exchange what they have learned.

By the size of the segments in the nutrition cycle, students can estimate how much one should eat of a special food category per day or week in relation to the other food categories. In addition students receive information about ecological-related aspects, like various packaging of foods, about organic production, about faire trade and about regionalization of products.

Concerning packaging, there exist more or less environmentally sound packaging materials: so one could choose between plastic or paper packing, between bottles with refundable deposits made of glass or plastics, and tins or coated cardboard boxes. Students become familiar with different cultivation methods like integrated production in which chemicals for plant protection as well as chemical fertilizer are used as little as possible. They are also introduced in the cultivation method of organic farming. However, information about conventional production was excluded because it is hardly used in Germany nowadays. In addition, the various labels for organic products are introduced.

Students also become informed about faire trade, so they will know that there exist products which are more expensive – and that this additional money consumers pay is returned to farmers of developing countries and emerging markets to grow these products and to stay independent from plantation and large corporate-owned groups.

Finally, students learn about labels for regional products. These products have the advantage that they do not need to be transported from a long distance.

In the seventh lesson students play a game (Köpke & Schlüter 2007). They receive a letter of a hypothetical school in their neighborhood. This school wants to establish a school kiosk where foodstuffs are sold. They want to start with five product groups, namely granola, apples, banana, yoghurt and fruit juice. For each product group there exist different versions of the product. On a so-called product card the product is presented and marked by special labels: it has been produced by integrated or organic farming, it originates from the region or it comes from abroad, it is a fairly merchandised food or not, it is more or less expensive according to its cultivation method and packaging. Thus, students must choose five product cards, one from each category, and afterwards, they have to defend their choice. For this game, students role-play, acting as parents, as owners of the school kiosk, or as themselves as students. Referring to their role, students probably will choose different products for the kiosk of the neighbouring school and it will become obvious that there exist different criteria for food choices and that the importance of these criteria are rated differently according to the societal group one belongs to.

In the eight and ninth lessons students get to know the *method of explicit judgment* (Ahlf-Christian et al. 2003). With this method they develop their own judging scheme to assess the quality of different food products. Once again, students declare which decision criteria are important to them, and then they attach weight to the chosen criteria. *If students think the taste of food to be very important, they may decide that this criterion should represent 50% of the weight of all criteria. So 0.5 will be the multiplication factor for the taste. Another criterion, like the vitamin content, might be less important to the students. Therefore, 0.1 might be the multiplication factor for this criterion.*

After determining the multiplication factors, students chose a food they want to assess, *for instance fresh-squeezed orange juice. The taste is superb. It can be marked with 1, 2 or 3 points, where 3 points is the best mark. Then, students will multiply the assigned 3 points by 0.5. So the weighted score is 1.5 for the taste. Orange juice contains also a lot of vitamins. So 3 points are given for this criterion. The multiplication factor is 0.1. So the weighted score is just 0.3.*

Finally the weighted scores for all criteria expected to be important are summed. If different foods have been assessed, that product with the maximum sum score will be the best one. By using the method of explicit judgement students learn to reflect their own decision criteria and to negotiate with colleagues about the importance of the different

criteria. By this process of developing a general assessment scheme, and applying it, students might change their attitude concerning the importance of different motives for food choice, and ultimately, they might change their purchase intentions. If one wants to analyse such effects, a post-test has to be done in the tenth lesson by using the same survey used in the first lesson.

Köpke (2006) did such a post-test. Concerning the nutritional motives she could detect that students changed from the necessity-oriented cluster to the standard-oriented one more frequently than vice versa. Also, changes were noted on the level of the purchase-intentions; however, a special direction towards more highly recommended foods could not be detected.

References

Ahlf-Christiani, C. et al. (2003) *Förderung der Urteilskompetenz im Fachunterricht der Sekundarstufe I und II*. Berlin: BLK-Programm "21", Koordinierungsstelle, Freie Universität Berlin.

de Haan, G. & Harenberg, D. (1999) *Bildung für eine nachhaltige Entwicklung*. Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung (BLK); no. 72, Bonn: BLK.

Kollath, W. (1960) *Die Ordnung unserer Nahrung*. Stuttgart: Hippokrates.

Köpke, I. (2006) *Bewertung von Lebensmitteln im Biologieunterricht – eine empirische Untersuchung zum Ernährungshandeln von Schülerinnen und Schülern der Klasse 9*. Thesis. University Kiel.

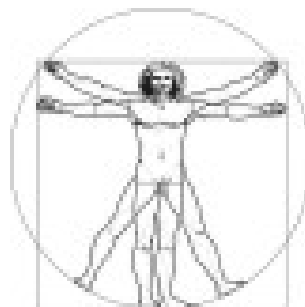
Köpke, I. & Schlüter, K. (2007) Der Warenkorb. Wertereflexion im Ernährungsunterricht. *Praxis der Naturwissenschaften* 56(1), 22-25.

Rost, J. (2002) Umweltbildung – Bildung für nachhaltige Entwicklung. Was macht den Unterschied? *Zeitschrift für internationale Bildungsforschung und Entwicklungspädagogik*, 25(1), 7-12.

Schlüter, K., Köpke, I., & Bayrhuber, H. (2005) Analysis of value awareness and purchase intentions in the field of nutrition. In: Ergazaki, M., Lewis, L., Zogza, V. (ed.) *Trends in biology education. Research in the new biology era. Proceedings of the 5th ERIDOB Conference*. Patras: University press, pp. 383-396.

von Koerber, K., Männle, T., & Leitzmann, C. (1999). *Vollwert-Ernährung*, 9th edition Heidelberg: Haug

von Koerber, K., Männle, T., & Leitzmann, C. (2004). *Vollwert-Ernährung*, 10th edition Heidelberg: Haug



ABOUT THE AUTHORS

Imke Köpke (koepke@bitsalat.de) graduated in biology didactics at the Leibniz-Institute for Science Education, University of Kiel, and now teaches at a German high school. Kirsten Schlüter (schlueter@biologie.uni-siegen.de) is professor of biology didactics in the Department of Chemistry and Biology, University of Siegen, Siegen, Germany. An earlier version of this paper was presented by Dr. Schlüter in December 2007 at the inaugural meeting of the International Consortium for Interdisciplinary Education about Health and the Environment, Cologne, Germany. Copyright 2008 by *Umwelt und Gesundheit Online* and the Gesellschaft für Umwelt, Gesundheit und Kommunikation.