

New Approach to the Lipids in Secondary Schools

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Abstract This article focuses on the problem of teaching food chemistry and nutrition in secondary school curricula. In it we propose a new approach to the topic of lipids from the perspective of food chemistry and nutrition, and we have developed this topic into a new program for interactive whiteboards. The program should be understood as an overview, and its content was derived from the results of a range of analyses of secondary school chemistry and biology textbooks. These analyses have shown that the textbooks in question have substantial shortcomings in addressing the topics of food chemistry and nutrition. While the textbooks contain sufficient terminology related to the given topic, their attention to nutrition and illnesses associated with it is minimal. In addition to the textbooks analyzed, the proposed content of the lipids unit is derived from the results of numerous World Health Organization research projects, as well as from the recommendations of dietitians and doctors. The results of our survey conducted among third year secondary school students confirmed their insufficient knowledge about the issues of nutrition and illnesses associated with it, thus confirming the need to change the way in which it is taught. We have created entirely new content for the topic of lipids in the form of an educational text designed for secondary school (or potentially even primary school) teachers. It consists of three sections: 1) lipids as a component of food, 2) the digestion and metabolism of lipids, and 3) proper nutrition, diet, and illnesses associated with nutrition. Each section contains motivational-educational material created for interactive whiteboards. For each section there is also a corresponding PowerPoint presentation which can be given to students as further study material.

Keywords: secondary schools, lipids, interactive whiteboard, student survey, healthy nutrition, obesity

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1. Introduction

Extensive research conducted by the World Health Organization (WHO) in 53 European countries shows that a poor diet, overweight, and obesity are responsible for many diseases of affluence, including cardiovascular disease and cancer, the two most common causes of death in Europe [1]. According to the WHO, the biggest problems are overconsumption of fat, insufficient intake of fruits and vegetables, low physical activity, and the growing problem of obesity. Overweight and obesity are not exclusively European problems, but global ones. In 2014, more than 39 % (1.9 billion) of the adult world population was overweight, and 13% (over 600 million) was obese. Since 1980, worldwide obesity has more than doubled. It is both remarkable and alarming that the majority of the world population lives in countries where overweight and obesity kill more people than underweight. [2].

In 2014, overweight and obesity was most prevalent in the American region [3], with the most affected countries being the Bahamas, where more than 36% of the population was obese, followed by the USA, where 33.7% of the population was obese [4]. The second most affected region was Europe, with the highest percentage of obesity in the populations of Turkey and Andorra (29.5 %),

followed by England (28.1%), and the Czech Republic (26.8 %). In all regions the percentage of obese women was greater than that of men.

Overweight and obesity are not merely problems of the adult population, but also of children and adolescents. Childhood obesity is considered one of the most serious health problems of the 21st century. According to WHO research, 42 million children under the age of 5 suffered from overweight or obesity in 2013 [5]. These children are very likely to remain obese into adulthood, increasing their risk of developing illnesses such as diabetes and cardiovascular disease at a young age. Yet overweight and obesity, like their associated illnesses, are avoidable to a certain degree. This is why the prevention of childhood obesity should be a priority, and why the WHO recommends focusing on schools and improving the health and nutrition of school-aged children and adolescents.

Overweight and obesity have negative metabolic effects on blood pressure, cholesterol, triglycerides, and resistance to insulin. The risk of coronary heart disease, ischemic stroke, and type 2 diabetes increases proportionately with increased body mass index (BMI), the measurement of mass in relation to height. A high body mass index also increases the risk of breast, intestinal, prostate, kidney, uterine, and gall bladder cancers, and mortality rates increase as BMI increases. A healthy BMI ranges from

18.5 to 24.9; a BMI greater than 25 is considered overweight, and a BMI of 30 or more is considered obese.

Food and a healthy diet are popular topics which children and adults encounter on a nearly daily basis in pervasive advertising and discussion in various media outlets. The renowned Czech dietician Dr. Svačina [6] notes that in every bookstore, pharmacy, and on Czech websites, non-scientific information outnumbers scientific information, further complicating the situation. This is why the topic of food chemistry, nutrition, and related illnesses should be regularly included in school curricula.

The content of school curricula in the Czech Republic comes from so-called Educational Framework Programs (EFP). However, these are very general, and schools (or more specifically, teachers) must use them to create their own School Educational Programs. Their actual form and content is comes primarily from textbooks. As part of the completed dissertation titled Food Chemistry and Nutrition in Secondary School Education, we conducted an extensive analysis of the most widely used chemistry and biology textbooks, testing both the qualitative and quantitative extent of the topic's inclusion. The analysis revealed that while the textbooks contain enough terms related to the topic in question, their attention to nutrition and diseases associated with it is insufficient.

Detailed analyses have been published in the following articles: The Topic of Lipids in Teaching at Secondary Schools in Relation to Food Chemistry and Nutrition [7] Food Chemistry and Nutrition in Biology Textbooks in Secondary Education [8]; Food Chemistry and Nutrition in Chemistry Textbooks of Secondary Education [9]; Food Chemistry and Nutrition in Educational Framework Programs for Grammar School and in Secondary School Textbooks [10].

Because lipids are a key factor in nutrition, we decided to redesign the topic of lipids in relation to food chemistry, nutrition, and associated illnesses for secondary school teaching. The proposal was based on analyses of the EFP for secondary schools, analyses of secondary school biology and chemistry textbooks, the demands of modern society, the recommendations of renowned dieticians and doctors, and especially the recommendations of the World Health Organization. The topic has been incorporated into an educational text for teachers, complete with teaching materials designed for use with interactive whiteboards, and also into PowerPoint presentations.

2. The Study and Findings

2.1. Questionnaire

In order to form an understanding of secondary school students' knowledge and their interest in the topic of food chemistry, nutrition, and illnesses associated with it, we devised a questionnaire consisting of 13 questions, some of which also included a series of subquestions. Eight of the questions tested the students' knowledge in the area of proper nutrition, diet, and illnesses associated with nutrition. The remaining questions tested how much information about nutrition the students had acquired in secondary school and in which subject(s), as well as their overall interest in the topic. The questionnaire was given to the students at the end of the third year of secondary

school, by which time we believed that they should already have acquired the relevant knowledge. The questionnaire was also meant to test our hypothesis that secondary school students lack sufficient knowledge in the area of proper nutrition, diet and associated illnesses, even though the topic interests them.

We tested 88 students at three different secondary schools, and the results confirmed our hypothesis. Secondary school students have little and largely flawed knowledge about nutrition and illnesses associated with it. In the following text we present the results of the questionnaire.

2.1.1. Question 1

According to the principles of proper nutrition, what is the recommended amount of fruits and vegetables in any form that we should consume daily? (One serving is the size of a clenched fist - for example apple or one sliced carrot)

According to the Nutritional Recommendations of the Czech Ministry of Health, the daily recommended intake of fruits and vegetables is at least 400g, preferably 600g, with a vegetable to fruit ratio of roughly 2:1. Only 9.1% of students chose the correct response of 400-600g; the remaining students either thought that the recommended amount was smaller or they did not know at all [see Figure 1].

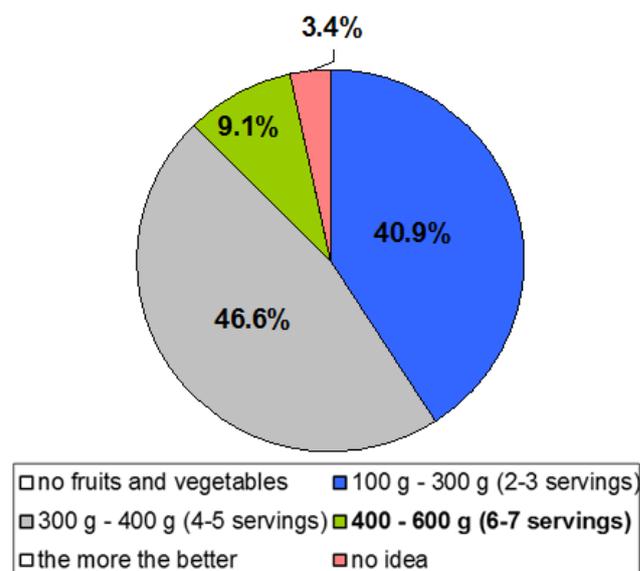


Figure 1. Student responses to the question: According to the principles of proper nutrition, what is the recommended amount of fruits and vegetables in any form that we should consume daily?

2.1.2. Question 2

According to the principles of proper nutrition, how many times a day should we eat?

According to the Nutritional Recommendations of the Czech Ministry of Health [in 8], we should eat 5-6 times a day. 45.5% of students selected this response and the remaining students thought that the number of meals per day should be lower. [see Figure 2].

2.1.3. Question 3

The energy value of 100g of milk chocolate is approximately 2300kJ (540 kcal). How much of the recommended daily intake is this?

The recommended daily intake depends on gender and age; 10,000 kJ for men and 9,200 kJ for women. For adolescents, the average energy consumption in correlation

with the individual's physical activity is slightly higher. The correct answer should be approximately one quarter of the daily energy consumption. Fewer than half (44.3%) of the students selected this response [see Figure 3].

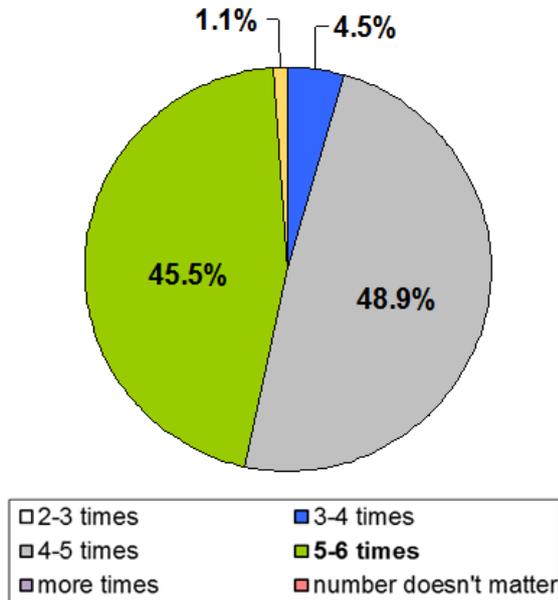


Figure 2. Student responses to the question: According to the principles of proper nutrition, how many times a day should we eat?

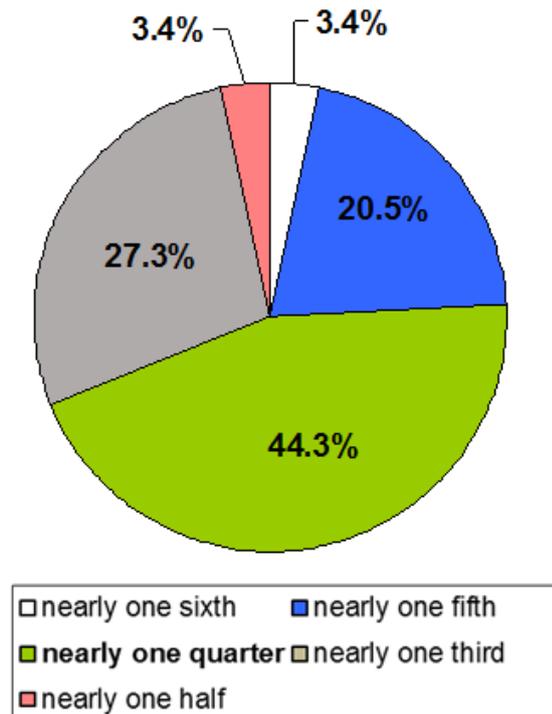


Figure 3. Student responses to the question: The energy value of 100g of milk chocolate is approximately 2300kJ (540 kcal). How much of the recommended daily intake is this?

2.1.4. Question 4

Fill in the names of the following terms to match their characteristics: breakfast, lunch, dinner, snack.

In this task the students were asked to complete seven sentences using the terms breakfast, lunch, dinner, and snack. The most problematic questions involved the energy values of individual meals. Only one third of the students knew that the energy value of a snack makes up

about 15% of total daily energy intake. 15% of the students incorrectly selected dinner or breakfast as the most energy rich meal of the day. The most energy rich meal of the day should be *lunch*.

2.1.5. Question 5

A Czech macrobiotic dish will **not** contain:

Macrobiotic practitioners select foods that come from the region in which they live while excluding all types of meat except for fish. 61.4% of surveyed students selected the correct answer, that a Czech macrobiotic practitioner does not eat oranges or bananas. Fewer than a quarter of the students selected the second correct answer, lean beef. However more than a third of the students mistakenly thought that macrobiotic practitioners do not eat fish [see Figure 5].

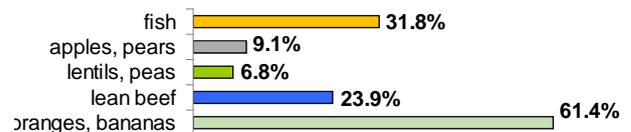


Figure 4. A Czech macrobiotic dish will not contain – percentage of student responses

2.1.6. Question 6

Select the illness whose treatment or prevention is highly dependent on diet

We based our work on professional research published by a top Czech dietician and doctor [6], who classifies diseases into three categories by degree of dietary influence on their treatment and prevention. Illnesses which fall into the category where diet has the greatest influence are overweight and obesity; arteriosclerosis and cardiovascular illness; high blood pressure and carcinoma of the large intestine, rectum, kidneys, etc. Diet has a less significant influence on illnesses of the joints and movement, although the impact of diet on them is overestimated thanks to advertising for various joint supplements. Diet has a negligible influence on neurological illnesses.

The overwhelming majority of students surveyed (98.9%) were aware of the close connection between the food they consume and overweight or obesity, but they largely underestimated the influence of their diet on other illnesses. 80.7 % of students surveyed recognized the correlation between nutrition and high blood pressure, 65.9% recognized the correlation between arteriosclerosis and cardiovascular illness, and just 56.7% knew that nutrition has a substantial influence on the formation of various carcinomas, especially of the rectum and large intestine [see Figure 5].

2.1.7. Question 7

Have you ever heard of the term “metabolic syndrome”? If so, please explain it briefly.

Metabolic syndrome is a group of illnesses (or risk factors) which often occur together and which can lead to the development of arteriosclerosis and associated complications commonly linked with obesity and type 2 diabetes Figure 6. shows that 13.6 % of respondents say yes, I know what is metabolic syndrome. However, only 9.1% of all inquired students properly explain this term.

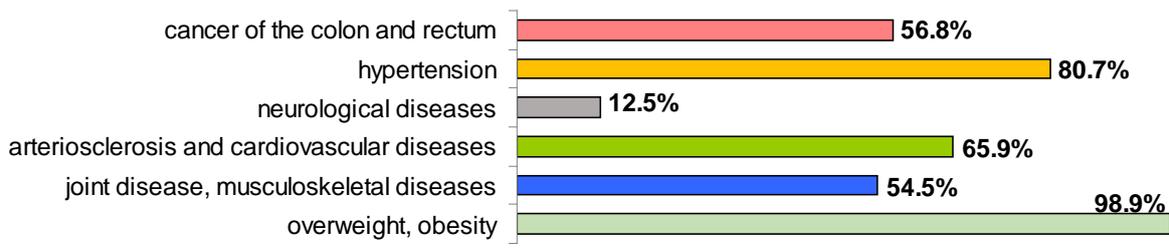


Figure 5. The influence of diet on selected illnesses – selected student responses expressed in percentages

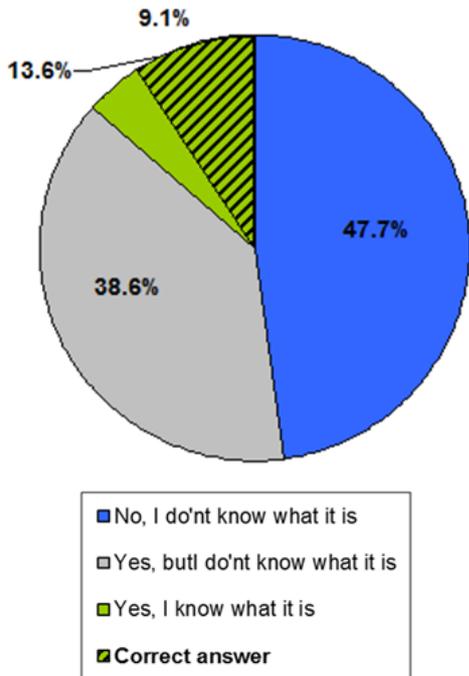


Figure 6. Student responses to the question: Have you ever heard the term “metabolic syndrome”?

2.1.8. Question 8

What is BMI and what purpose does it serve?

BMI (Body Mass Index) is a value calculated by the ratio of a person’s body mass to their height squared. It serves as an indicator for measuring underweight, normal weight, overweight, and obesity. The majority of students surveyed (76.1%) had some idea of what BMI is, but fewer than half (48.9%) of them knew its meaning or how it is used [see Figure 7].

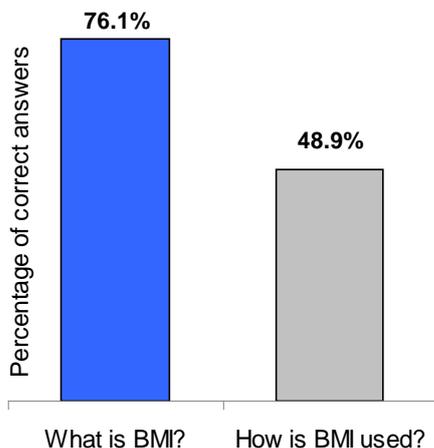


Figure 7. The number of correct responses to the question: What is BMI and what purpose does it serve?

2.1.9. Question 9

In the section of the questionnaire which gauged student interest in the subject, most students said that they found the topic interesting and useful. Students rated their interest in the subjects covered in the previous questions on a scale of 1-5 [see Figure 8].

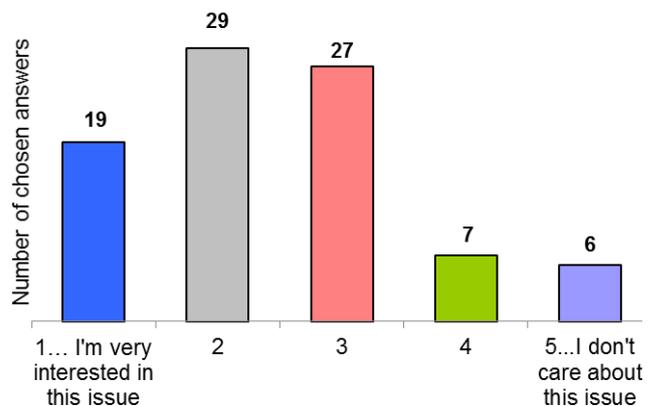


Figure 8. The degree of student interest in the subject of nutrition and illnesses related to it

2.2. Discussion of the Questionnaire’s Results

The results of the questionnaire confirmed our hypothesis that secondary school students do not have sufficient knowledge about proper nutrition, diet, and illnesses associated with nutrition, even though they are interested in the topic and most said that they had been taught about nutrition and illnesses associated with it in school. How much they were taught is expressed in Graph 9. Even though we are aware that the questionnaire we used to test the students’ knowledge consisted of only 8 questions, they were designed to address key information about the given topic, as well as a range of issues relating to proper nutrition such as creating a menu, types of diets including alternative trends, and illnesses associated with. This is why we consider the collected data to be both valid and, at the same time, alarming.

There are many possible reasons why the students’ knowledge was insufficient, despite the fact that the subject is taught in secondary schools. The information which the students are given is not selected properly, meaning that some important information is left out and other included information may be superfluous. This could be because Czech teachers are not told what content they are meant to cover when teaching this topic or even given any publications specifically designed for teaching it in secondary schools, which they could use as a source of information. The content of the unit on food chemistry, including proper nutrition and illnesses associated with it,

depends largely on the teacher and his or her experience and knowledge of the topic. Another reason why their knowledge may be insufficient could be low student interest due to teacher methodology, or lack of interaction in lessons. This is why we created an educational text for teachers which includes interactive study materials for students. We present these materials later in the text.

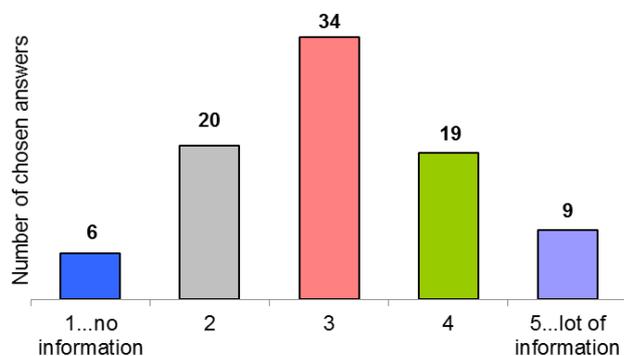


Figure 9. The graph shows the amount of information which students received about the subject of proper nutrition, diet, and illnesses associated with nutrition

2.3. Educational Text for Teachers

Our analysis of textbooks showed that teachers do not have a complete source of information about the subject of food chemistry, proper nutrition, and illnesses associated with it, making it difficult for them to provide students with this information practically and coherently. This is why we created the educational text for teachers consisting of three basic sections:

- Lipids as a component of food
- Digestion and metabolism of lipids
- Proper nutrition, diet and diseases associated with nutrition

The first section, *lipids as a component of food*, is dedicated primarily to the chemical composition of lipids contained in foods. It links individual types of lipids to nutrition and thus combines chemical knowledge with practice. There is a substantial section devoted to fatty acids as the basic building blocks of simple lipids or homolipids. We traditionally divide fatty acids into saturated and unsaturated categories. In relation to food chemistry, attention is devoted to cis-unsaturated fatty acids— ω -3 and ω -6, as well as to transunsaturated fatty acids. We present the importance of these acids for humans and their health, and their beneficial and harmful effects, as well as examples of foods in which different fatty acids are found. For simple lipids, the emphasis is on triglycerides – hard fats and liquid oils, and their chemical, physical, and nutritional properties. In the category of heterolipids, we focused on phospholipids. An important example is lecithin (known in food science as E 322), which is contained namely in egg yolks. An important example of derived lipids is cholesterol, which is covered in the second section of the educational text. At the end of the first section we included a chapter on the modification of fats and their influence on the quality of foods, where we incorporated information about the refining, hydrogenation, and transesterification of lipids.

The second section is devoted to the *digestion and metabolism of lipids*. It is linked to the chemical and

biological aspects of these processes. While digestion is usually a part of secondary school biology curricula, metabolism usually falls in the domain of chemistry. Students often do not see how these processes are linked, which is why the educational text explains that the metabolism of lipids also includes their digestion in the first stage of lipid catabolism, connected to the absorption and transport of lipids. We then focus on the beta oxidation of fatty acids and finally on the citric acid cycle, Krebs cycle, and electron transport chains. The sequence of these catabolic paths leads to the formation of ATP as an organism's energy "currency." In connection with the transport of lipids we devote attention to cholesterol and its transport with other lipids in particles called lipoproteins. We address the often poorly interpreted essence of "good" and "bad" cholesterol, which is related to the cholesterol transport mechanism in lipoproteins and the fact that cholesterol is only one of them. This chapter includes our own schematic of the β -oxidation of fatty acids, lipolysis, and the synthesis of ketone bodies as an alternative method of gaining energy under certain circumstances.

The third section focuses more on biology and proper nutrition, diets, and illnesses associated with nutrition. It includes information about creating a healthy menu using the food pyramid and general nutritional recommendations. We learn about the most common diets and their role in the prevention and treatment of certain illnesses. We inform students about alternative nutritional trends, namely vegetarianism and its benefits and risks. In the chapter on illnesses we cover metabolic syndrome and its basic components – obesity and overweight; hyperglycemia, insulin resistance, and diabetes; dyslipidemia, atherosclerosis, cardiovascular disease, and hypertension.

2.4. Digital Learning Materials

For each of the three main sections of the educational text for teachers, we created corresponding study materials for students to use with an interactive whiteboard.

The interactive whiteboard (IWB) is a modern educational technology which allows for effective instruction full of various learning activities [11]. The IWBs promising benefits for learning and instruction have led to its increased popularity and attractiveness as expressed by a number of researchers [12,13]. The benefits of using IWBs have been recognized by both students and teachers [14]. The potential benefits of IWBs for teaching are: flexibility and versatility; multimedia presentation; efficiency; supporting planning and the development of resources; modelling ICT skills and interactivity; and participation in lessons [12]. Using IWBs also increases the motivation of students and improves their attention. On the other hand, using IWBs also brings some problems and issues into a real-life educational setting. One of the most frequent issues raised by both teachers and students is the need for adequate training in order to use IWBs to their full potential [12]. Other difficulties commonly cited by teachers relate to the preparation of lessons incorporating IWBs. If we want to create original materials, then it will take time commensurate with the quality of the result. If we use ready-made products (such as objects created by other teachers), we save more time because we only need to adjust them to the lesson's needs [11].

Based on a little research I conducted among students in two Prague secondary schools and personal consultations with their teachers, I found that the use of interactive whiteboards is mostly limited to that of a projection screen. The majority of students surveyed stated that the first time they had used an interactive whiteboard in a truly interactive way was when they were testing my materials. The teachers' main explanation for this was that they lacked the time to create interactive materials. Several students also stated that they covered less material using

the interactive whiteboard than they did during the same amount of time spent in traditional instruction. However, the majority of students evaluated the use of the interactive whiteboard very positively.

The teaching materials for interactive whiteboards were created using the SMART Notebook program. We present examples of interactive pages designed for student classwork in the following pictures, with captions which describe their actions [see Figure 10, Figure 11].

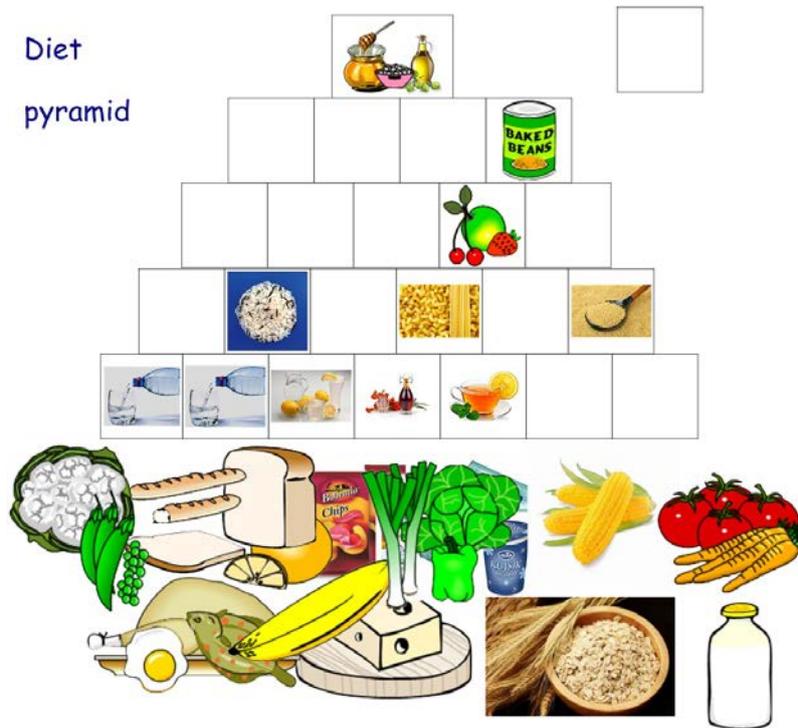


Figure 10. An example of an interactive page in the chapter titled “Proper Nutrition – Food Pyramid”

Students select pictures of individual foods and move them into the correct levels of the food pyramid while discussing and learning about the structure and contents of individual levels

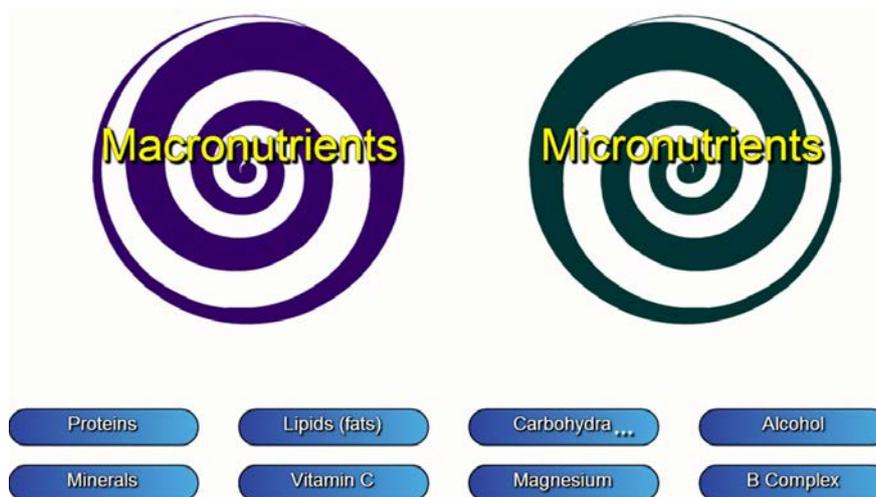


Figure 11. “An example of an interactive page in the chapter titled “Proper Nutrition – the Composition of Foods”

Students divide foods into macronutrients and micronutrients based on their energy content. They then draw a term from one of the vortexes. If a student places the term in the wrong vortex, the vortex returns it; if the student places the term in the correct vortex, the vortex swallows it.

The PowerPoint presentations were created based on the recommendations of the teachers whose classes we tested the materials in. They contain the same information presented in the interactive materials and can be given to the students as study material instead of a textbook. In

contrast with the educational text for teachers, they are not as detailed and so it is up to each teacher to decide whether to edit them or use them in their original form. They can also be used for teaching in cases where interactive whiteboards are not available or where the

teacher prefers this method of instruction. If the interactive materials are not used, the PowerPoint presentations can take their place with some further student involvement. The construction of the food pyramid with the pictures of foods was successful, with students cutting out pictures from readily available advertising fliers. Students can also bring packaging from various foods to school and discuss their ingredients or whether they belong in a healthy diet.

3. Conclusions

Our analysis of the issues of food chemistry, proper nutrition, and nutrition related illnesses in Educational Framework Programs and secondary school textbooks was inspired by the recommendations of top Czech nutrition specialists and doctors, the results of extensive research by the World Health Organization, and last but not least, the fact that students encounter this issue on a nearly daily basis in their everyday lives. We found that even though information about this topic is very relevant and needed, it is given only very minimal treatment in secondary school textbooks. On the basis of this we have proposed and developed a new unit on lipids for secondary school education. We linked the commonly taught fundamentals of chemistry and biology with the topic of food chemistry, nutrition, and illnesses related to it. We believe that our materials will be an asset for secondary school teaching, and that they will provide teachers and their students with important and interesting information, potentially even becoming the basis or inspiration for the creation of new secondary school textbooks.

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