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The role of biology education in health development: a questionnaire survey study of secondary school biology teachers and university students

Doctoral (Ph.D.) thesis

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INTRODUCTION

Most people are of the opinion that students should be equipped with the basic knowledge and skills necessary for leading a healthy lifestyle during their compulsory education (Buda, 2003, p. 180). Any change in health behaviour in society is a slow and complicated process; therefore, it is important to impart basic health knowledge even to children from a very young age (Csima, Finánczy, Nyitrai, & Podráczky, 2018). According to the 2014 HBSC survey, it seems young people did not successfully adopt habits that could be the indicators of a long-term healthy lifestyle. Considering the results of the 2016 Health Report (Varsányi & Vitrai, 2017) Hungary appears to fall behind other EU countries on most health indicators. Health damage is mainly due to risky health behaviours; therefore, the health status of the population can only be improved if these behaviours are rectified. The question is, how to achieve such a change in society at large? Only through activities that broaden the population's knowledge of what constitutes a healthy lifestyle and provide an ideal circumstances to motivate and enable people to make lifestyle changes. Naturally, this requires the "co-operation of key players in several sectors" (Varsányi & Vitrai, 2017, p. 10) which can only be achieved slowly and gradually through a public health system with a novel approach towards health education. The primary target group for health development are schoolchildren, whose education in this field is mainly achieved through schools' health education and promotion programs. Therefore, the development of effective methods for enhancing students' health behaviour and their implementation in everyday school life is a crucial factor in improving the health status of the population.

AIMS

The aim of this study is to learn more about the role of biology education in health development, which was examined within the framework illustrated in Figure 1.

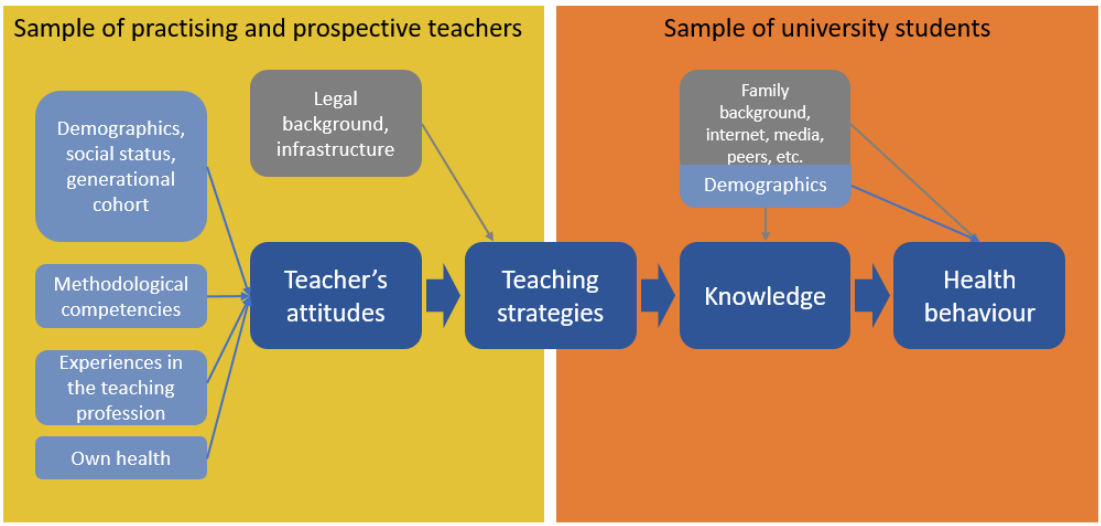

Figure 1. The theoretical framework of the dissertation (author's own work)

The main goal of health development programs and action plans is to exert a positive influence on the individual's health behaviour. One way of doing this is to increase one's knowledge about health. Therefore, in this research project we would like to study the connections between health knowledge and health behaviours. Information about health-related issues can come from many sources; for example, from parents, doctors, or the internet. However, we shouldn't forget the important role of educational institutions. Biology teachers can play a key part in two areas; namely, teaching students about the health-related aspects of their subject and in serving as role models for their students. Even though the list topics that teachers can discuss with their students are fixed in the curriculum, the teachers' individual lesson planning and choice of teaching methods can exert a considerable influence on how much emphasis is placed on these issues and how well the students absorb the material. The focus of this study is on how and in what ways biology teachers' attitudes towards health and health-related topics influence the priority of these issues in their teaching, how well the students absorb the knowledge imparted by the teachers, and how this knowledge affects their health behaviour. To investigate this process, we approached it from two angles. First, factors that have an impact on education were explored from the teachers' perspective. We chose to survey a population of high-school biology teachers since this group can be clearly defined and is homogeneous. Gaining a deeper insight into biology teachers' attitudes and beliefs and how these manifest themselves in their teaching is a promising area for researching health development and all its complexities. To explore health education, knowledge and health behaviour from the students' side, we chose a sample of university students. We consider this population ideal for this purpose because they are still part of public education, but at the same time they are already independent enough to

manage their own lifestyle and make their own decisions. Therefore, the indicators of their health behaviour and the factors that influence them are more easily discernible.

METHODS

To answer our research questions, we collected data by conducting three separate questionnaire surveys and analyzing the data. The ethical licence codes of our project are: 7072- PTE 2018 and 7073- PTE 2018. The contents of the questionnaires for prospective and practising teacher overlap; therefore, we could compare them easily. The survey aimed at biology teachers covered a wide range of topics. Apart from socio-deomgraphics, we collected information about their teaching background and context. They also answered questions about their subjective health, sport activities, nutrition and some of the questions pertained to their opinions and attitudes towards biology teaching. The respondents marked the level of their agreement or disagreement with statements about biology education, their own health, teaching methods (e.g.: experiential teaching, ICT[1]) and the importance of discussing health-related topics[2] during their lessons on a 6-point Likert scale.

The questionnaires filled in by university students did not overlap at all with the ones aimed at biology teachers. After recording their socio-demographic data, they answered questions about their health behaviours. Their nutritional habits and knowledge were surveyed based on guidelines and nutritional data published by the WHO[3], and they were also asked to fill in a more detailed chart on their food consumption. Furthermore, they also answered questions on risky health behaviours[4] and their sport activities[5]. Finally, the survey also tested the participants' health-related knowledge[6].

The sampling process

The university student questionnaires were distributed with the help of university educators. 181 students filled in the survey on a voluntary basis. We reached out to prospective biology teachers through their educators, as well. 66 students took part in the survey and, again, participation was entirely voluntary. We contacted school principals in order to reach biology teachers for our teacher survey. 153 biology teachers filled in our anonymous questionnaire.

[1] Studies served as inspiration for this part of the questionnaire: Prokop, Tuncer & Chudá, 2007, Kubiatko & Haláková, 2009; Kubiatko, Harun & Zuzana, 2012; Ana-Belén, Juan-José, Mar'a & HeGuan; 2012, Bas, Kubiatko & Sunbul, 2016

[2] http://folyoirat.nefi.hu/index.php?journal=Egeszsegfejlesztes&page=article&op=downloadSuppFile&path%5B%5D=24&path%5B%5D=20 (2020. 02.16.)

[3] https://www.who.int/news-room/fact-sheets/detail/healthy-diet (2020.01.30.)

[4] http://www.tarsadalomkutatas.hu/kkk.php?TDATA-E72/kerdoiv/kerdoiv/e72_kerd.pdf (2019.07.02.)

[5] http://www.sporteseletmod.hu/letoltes/KerdoivMSEpiac.pdf (2020.01.30.)

[6] We used the chart of on page 95 on Kriska and Karkus's 2015 book, The theory and practice of biology teaching as a guideline for developing the questions for this section.

Statistical analysis

We analyzed our data with the help of IBM SPSS Statistics Version 20.0 and Microsoft Excel 2010. During the analysis we used a margin of error of 5% ($\alpha = 0.05$) and for multiple testing correction we used the Bonferroni or Tukey adjustments to increase the significance threshold. Furthermore, we employed principal component analysis in cases where separate items were used to create one component. Apart from descriptive statistical methods, we also employed various one-, two- and multiple-way difference and correlation tests including correlation and regression analyses, various ANOVA procedures, t-tests, Chi-square tests, and other non-parametric tests. The results were then mapped using charts and diagrams.

RESULTS

Comparing prospective and practising biology teachers

When comparing prospective and practising biology teachers, it is important to keep in mind that whether they are already working in the teaching profession or not is not the only difference between these two groups. In fact, there are also several other, important distinctions in terms of their demographics, social status, environment, and life situations. Prospective teachers are obviously younger (Mann-Whitney $U = 155.5$, $Z = 11.441$, $p < 0.001$) and have much less teaching experience. However, since they are from a different generation, their response to and use of ICT will probably be different from that of practising teachers. Another discrepancy between the two groups is that they were taught using different methods and in different contexts during their university education and the contents of their methodological training also vastly differs. Even though we cannot control for variables such as the effects that age and teaching experience have on the results of our research, comparing these two groups is still extremely informative. By exploring the differences in their training and background we can gain a deeper insight into methodological attitudes and preferences of the present and future generations of teachers.

The health value of biology teachers

H1: We hypothesize that there is a significant difference in how important practicing and prospective biology teachers believe their own health to be.

With our first hypothesis, we wanted to test whether present and future biology teachers had differing views on how highly they valued their own health (i.e. health value). We also included the respondents' gender as a second variable in the analysis. According to our results, the

interaction between the teacher group (practising or future teacher) the participant belonged to and their gender is not significant ($F(1, 198) = 0.247$, $p = 0.620$, $\eta^2 = 0.001$). The main effect of the group variable is significant ($F(1, 198) = 4.086$, $p = 0.045$, $\eta^2 = 0.02$); prospective teachers view their health as less important than present teachers. The main effect of gender is not significant ($F(1,198) < 0.001$, $p = 0.995$, $\eta^2 < 0.001$). To further explore the effect the group variable had on the results, we performed a series of ANOVA procedures on the men and the women in the sample separately (Simple effects testing). To correct for a Type 1 error due to the multiple comparisons performed, we employed the Bonferroni correction. Therefore, the significance level was raised to $\alpha = 0.025$. As for the men, there are no significant differences between practising and prospective teachers in terms of their health value ($F(1, 198) = 0.818$, $p = 0.367$, $\eta^2 = 0.004$); however, we found significant discrepancies among the women ($F(1, 198) = 5.482$, $p = 0.020$, $\eta^2 = 0.027$). In their case, practising teachers value their health more than prospective ones. The interactions we found through Simple effects testing are shown in Figure 2.

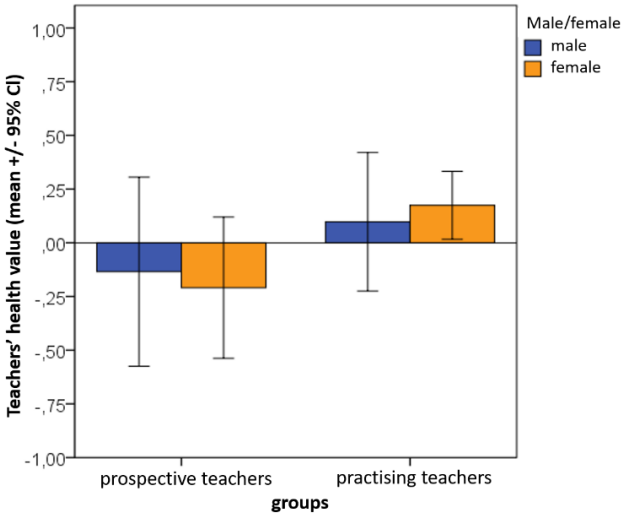

Figure 2. Graphical representation of the differences between males and females, as well as prospective and practising teachers in terms of their health value (author's own work)

This difference is probably due to several reasons. As for women, it is known that their health value increases with age (Lau, Hartman, & Ware, 1986), and as they reach the age when they plan to start a family, they focus more on health-protective behaviours, making their own health a priority. This is in in accordance with Baranyai et al.'s (2006) results, who also found that women value health and a healthy lifestyle more than men (Baranyai, Bakos, Steptoe, Wardle, & Kopp, 2006). As we will see later, the effect health value has on how much emphasis health-related topics receive in biology lessons is not completely straightforward; however, this

variable has an important role when we consider teachers as role models to their students. This idea is also supported by Bodóczky's (1994) study saying that teachers serve as role models for their students; therefore, it is their duty to exhibit values which have a positive influence on future generations and their health development. Reflecting on the difference between male and female teachers further, we can also theorize that health education through conscious modeling of health behaviour could be more pronounced in women.

The hypothesis proved to be right; practising biology teachers do value their health more than prospective teachers.

The role of biology lessons in recognizing illnesses

H2: We suppose that there is a significant difference between practising and future biology teachers in their opinions on how important a role they think biology lessons play in teaching students to recognize illnesses.

Similarly to the previously investigated 'health value' variable, we were curious whether there are any differences between present and future biology teachers in how important a role they think biology lessons play in learning about diseases and how to recognize them. We used a two-way ANOVA analysis to see whether the group or gender variable had any effect on the participants' opinions on this issue. The interaction is not significant ($F(1, 201) = 0.087$, $p = 0.768$, $\eta^2 < 0.001$). The group variable's main effect is significant ($F(1, 201) = 24.822$, $p < 0.001$, $\eta^2 = 0.110$) and is higher in case of practising teachers. However, the main effect of the gender variable is not significant ($F(1, 201) = 0.020$, $p = 0.888$, $\eta^2 < 0.001$).

This result can probably be explained by the fact that as biology teachers-in-training leave the university, start working and become old enough to start a family, their health becomes increasingly important to them. They pay more attention to recognizing and understanding illnesses and this personal interest is reflected in what topics they place more emphasis on in their teaching. Furthermore, in the course of our lives we become responsible for ourselves and others gradually: in childhood, others are responsible for us, while as adults we become responsible for others. It is true that compared to high school students, university students are more independent, but a sense of responsibility for others only fully develops once they enter adulthood. Similarly, teachers only begin to feel a true sense of accountability for their students when they begin working as teachers. Therefore, it is logical that practising teachers would place a higher priority on teaching their students to recognize illnesses and their warning signs and symptoms.

The second hypothesis was also confirmed inasmuch as practising biology teachers do seem to believe that the role of biology lessons in recognizing and learning about diseases is bigger than future biology teachers.

The importance of experiential learning during biology lessons

H3: We speculate that there is a significant difference between practising and future biology teachers in how central they think experiential learning is to biology teaching.

Next, we focus on a specific methodological approach in biology teaching. We were curious whether present and future teachers' attitudes vary when it comes to experiential learning. Although there are many opportunities for using this approach in biochemistry, plant biology, or zoology, human biology also offers plenty of possibilities to implement practical learning opportunities (e.g. measuring lung capacity, monitoring heart rate, tracking physiological changes after physical exertion, studying reflexes, first aid...etc.). Such learning opportunities help students deepen their knowledge of the subject matter and make the whole learning experience more personal, thereby contributing to the students' health development.

We used a multi-way ANOVA to examine the main effects of and the interaction between the biology teacher group and gender variables. Their interaction is not significant ($F(1, 201) = 1.947$, $p = 0.164$, $\eta^2 = 0.010$) and neither is the main effect of gender ($F(1, 201) = 0.210$, $p = 0.647$, $\eta^2 < 0.001$). In contrast, the group variable's main effect was found to be significant ($F(1,201)=25.014$, $p < 0.001$, $\eta^2= 0.111$), more specifically, prospective teachers thought experiential learning was of higher importance. Nowadays, experiential learning is increasingly integrated in programs and curricula to encourage teachers to use such approaches, for example research-based teaching[7]. However, implementing this approach in everyday teaching is not as straightforward as it seems. According to practising teachers, one of the main obstacles is the low number of biology lessons a week and the large amount of material that has to be covered in these lessons. Furthermore, the number of students in class is usually too high for such approaches to be effective and there is often a shortage of materials or equipment necessary for such assignments. Finally, the students' disinterest also curbs the teachers enthusiasm for using these methods (Kontai & Nagy, 2011c in Nagy & Nagy, 2016). However, if these problems are addressed, then research-based teaching and learning can become more widespread in classroom teaching (Nagy & Nagy, 2016). Despite all these issues, there is an increasing number of studies published on using these teaching methods, which seem to support that such

[7] The main steps of research-based teaching and learning: 1. defining the problem, 2. collecting data, 3. analysis, 4. drawing conclusions (Nagy, 2010). (2019.08.14.)

approaches are truly effective. The fact that prospective biology teachers have a more positive attitude towards such approaches may be due to the fact that in the present double major teacher training system (as opposed to the previous Bachelor and Master level programs), a large emphasis is placed on experiential teaching and related teaching methods (Kiss, Almássy, Kovács-Nagy, & Kovács, 2015). Students do not only learn about these approaches in theory, but are also taught using such methods in the course of their own training; therefore, they are more likely to implement them in their own teaching. It is also worth noting that there are many ICT technologies available for teaching and learning nowadays, which have considerably widened the arsenal of experiential teaching and learning tools and materials.

The third hypothesis seems to be validated since future biology teachers place a greater importance on using experiential teaching and learning than practising teachers.

Attitude towards ICT

H4: According to our hypothesis, there is a significant difference between practising and prospective biology teachers in how they view ICT.

Apart from experiential learning, theoretical education is also considerably impacted by the use of ICT technologies. Therefore, it seems logical to now turn to biology teachers' attitudes and beliefs about ICT in general. We examined whether the participants' attitudes towards ICT are influenced by their gender or the teacher group (prospective or practising teachers) they belong to. When analyzing the answers, we explored the following areas: ICT anxiety, open-mindedness towards ICT (ICT open-mindedness), the motivating force of ICT (ICT motivation), and how much the respondent believes that ICT contributes to and makes lessons more interesting (ICT contribution). The main effect was found to be significant in one instance; namely, the biology teacher group variable had a significant effect on ICT anxiety ($F(3, 201) = 18.855$, $p < 0.001$, $\eta^2 = 0.086$). It may come across as surprising at first that it is the future biology teachers who seem more concerned about the use of ICT. Yet, considering that this variable concerns anxiety towards ICT technologies and devices used in biology teaching specifically, and not those used in everyday life, this result may seem less unexpected. Practising teachers are already familiar with the ICT technologies they employ in their teaching and, therefore, can feel competent when using them. On the other hand, teachers-in training could be intimidated by the multitude of ICT techniques they are introduced to in the course of their training, but have no opportunity to familiarize themselves with as part of their day to day teaching routine. As for the other variables (ICT open-mindedness, ICT motivation, ICT contribution), no significant effects and interactions were found. Considering health

development programs specifically, ICT technologies have great potential in making them more effective, especially for the younger generations. Most health development programs only use traditional teaching methods, which are not that suitable for students who belong to generations Y, Z, or alpha. For them, the more modern, interactive, experiential learning opportunities offered by ICT could be the most effective form of education (Feith et al., 2016).

The fourth hypothesis was only partly confirmed, since only one of the four separate ICT components revealed significant differences between present and future biology teachers. Prospective teachers seem to experience significantly higher levels of anxiety regarding ICT technologies used in biology teaching. As for the other three variables (open-mindedness towards ICT, the motivating force of ICT and the extent to which respondents believe that ICT contributes to teaching), no significant differences were found.

Dealing with health development topics in biology lessons

H5: We hypothesize that there is a significant difference between present and prospective biology teachers in how much emphasis they think health development-related topics should receive during biology lessons.

So far, we have learned more about biology teachers and some of their methodological preferences, as well as their attitudes and beliefs about their own health. Undoubtedly, biology teachers have a crucial role in transferring not only knowledge about their subject matter, but about health-related topics, as well. Therefore, we also examined how much biology teachers' health value and subjective health influence their beliefs about dealing with health related topics during biology lessons. We used a Friedman ANOVA analysis to see how highly each group values health education in biology teaching. Significant differences were found in both groups as to how much importance they attach to these issues (prospective: X^2 (10, N=63) = 76.910, $p < 0.001$; practising: X^2 (10, N=148) = 472.690, $p < 0.001$).

When examining the mean scores each health-related topic received, we can clearly see that the two groups ranked them differently. In case of practising teachers, the 'Factors affecting health' topic received noticeably higher scores than the other topics. In fact, this topic was even ranked significantly higher than the topic they considered to be the second most important ('Healthy nutrition') ($Z = 4.244$, $p < 0.001$). While prospective teachers also consider this topic to be of high importance, it is only the second most important and does not have a significantly higher score than the other topics. As for teachers-in-training, the most highly ranked issue was "Developing communication skills", which is only in 7th place for practising teachers. Another interesting observation is that in case of prospective teachers, the "Accident prevention,

personal safety" topic received the lowest score, but it was in the mid-rankings in case of practising teachers. In contrast, present biology teachers placed "Conflict resolution strategies" in last place, while future teachers thought it was mildly important. In both groups the difference is significant, but their direction is the opposite (prospective: $Z = 3.181$, $p = 0.001$; practising: $Z = -5.784$, $p < 0.001$). In both groups, the „Harassment" topic was ranked quite low; in fact, it was in last place for practising teachers. All in all, we can conclude that topics related to mental health and personal development were higher on the list for future teachers, while for practising teachers, issues related more closely to the subject matter seemed to be more central.

One of the reasons behind this pattern of responses is that in most teacher training programs there is a considerable emphasis placed on pedagogy and psychology related courses, but as the program progresses and students are about to enter their teacher training phase, the focus shifts to methodology courses (Chrappán, 2011). In a 2006 study, when examining the struggles teachers experienced with the loss of their teacher identities and motivation, their opinions and attitudes towards teacher roles were surveyed. Their results correspond to ours to the extent that practising teachers would emphasize their role as instructors of their subject matter and would separate their roles as instructors and as mentors to their students sharply. This does not mean that they do not see themselves as mentors at all, but their role as instructors overshadows it (Paksi & Schmidt, 2006). Other reasons may include the differences between teacher education in the past and now, and that practising teachers may have run into several situations in the course of their work where their help was not enough and the assistance of a school psychologist or other professional was necessary to solve an issue. Paski and Schmidt also theorize that the reason why teachers see themselves primarily as instructors is because they feel less competent in other areas (Paksi & Schmidt, 2006). Teachers may feel confident in answering their students' questions that are related to the body and bodily functions since it is within their professional capacity as biology teachers; however, they might feel insecure and incompetent when asked about complex psychological matters. Such experiences strengthen their beliefs that they are more capable when answering subject-related questions, which can influence how they rank health development topics in their teaching.

Thus, the 5th hypothesis is also supported since based on the data future teachers do attach greater importance to the psychological and social aspects of health, while for practising teachers, topics related to the body and its functions received a higher ranking.

Factors influencing the priority of health-related topics in biology lessons

H6: We surmise that biology teachers' own lifestyle has a great influence on how salient they believe health-related topics should be during biology lessons.

We wanted to explore how far the teachers' own health factors determine the priority health-related topics receive in their teaching. The following factors were analyzed: importance of own health, subjective health, regular exercise, regular meals, and the respondents' opinion on whether their lifestyle is healthy or not. In the final model, two variables (importance of own health and subjective health) served as predictors and explain about 8% of the variance in the importance attached to health related topics. The model as a whole is significant ($F(2, 194) = 8.060$, $p < 0.001$). The 'importance of own health' predictor is significant with a positive value, while 'subjective health' is also significant, but its direction is negative. While it may be obvious that the higher teachers value their own health, the more importance they attach to teaching health-related content in their lessons, the negative connection between subjective health and health-related topics may need some explanation. This means that those teachers who believe that they are in good health deal with health-related topics in their lessons less frequently. One possible explanation is that if one's health is satisfactory, they personally do not have a reason to delve into topics like treating illnesses and protecting their own health; thus, they do not feel the need to devote too much time to these issues in their lessons either. Yet, it is important to note that one's subjective opinion on how good their own health is does not always corresponds to reality.

Based on the analysis of the data, the sixth hypothesis was also validated. Looking at the regression model we created, we can see that the importance teachers attach to their own health and their subjective health affect how much emphasis is placed on health-related topics in their lessons. The predictive value of the two variables is about the same.

The survey of university students

To explore students' health behaviour, we chose the university student population, mainly because their health behaviour-related indicators reflect their own beliefs and attitudes more than that of high school students. In case of secondary school students, their family's preferences play an important role in their health behaviour, while university students have more personal responsibility in their lifestyle choices. Our main aim was to examine the relationship between university students' health behaviour-related indicators and their health knowledge. All in all, we analyzed the responses of 181 university students (75 men, 106

women). Their average age was 21.883 years (SD = 2, 315, Min = 18, Max = 29). When assessing their own health, 1.1% thought they were in bad health, 6.1% thought their health status was satisfactory, 65.7% said they were in good health, and 27.1% thought their health was excellent. As for how much they exercise outside school, 14.4% reported that they never do any sport, 27.1% exercise less than once a week, 13.3% partake in sports activities once a week, 37.6% exercise several times a week, while 7.7% do sports every day. The students were grouped according to the faculties they attended: 1. Faculty of Health Science (FHS) with 46 students, 2. Faculty of Science (FS) with 27 students, 3. Other Faculties (OF) - students who attended faculties that were not health or science related were grouped into this category, including students studying arts, liberal arts, technical studies and economics. There were 73 students in this group.

University students' exposure to biology education and biology knowledge

H7: We speculate that there is a connection between university students' exposure to biology education and the extent of their health science knowledge.

The questionnaires the university students filled in had questions aimed at measuring their knowledge of health sciences and health-related topics. We grouped the questions into four topic areas: Nutrition, Epidemiology, Respiration and circulation, Molecular biology and genetics. We wished to measure how well-versed the students were in health sciences and whether the faculty they attended and whether they took extra biology lessons during their high school years had any effect on the depth of their knowledge. Therefore, to examine the relationships between the students' faculty and their knowledge of the above-mentioned topics, we ran a two-way ANOVA analysis, then a Simple effects test was used to check for the effects of the extra biology lessons in the next step. Finally, the effect of the respondents' gender was explored in a separate analysis. The interaction between the students' faculty and health science knowledge is significant ($F(6, 429) = 2.855$, $p = 0.010$, $\eta^2 = 0.038$). The results are mapped in Figure 3 below, where all the interactions are ordinal, meaning that in each of the four subject areas there is a difference in how wide the gaps are between the scores of each faculty.

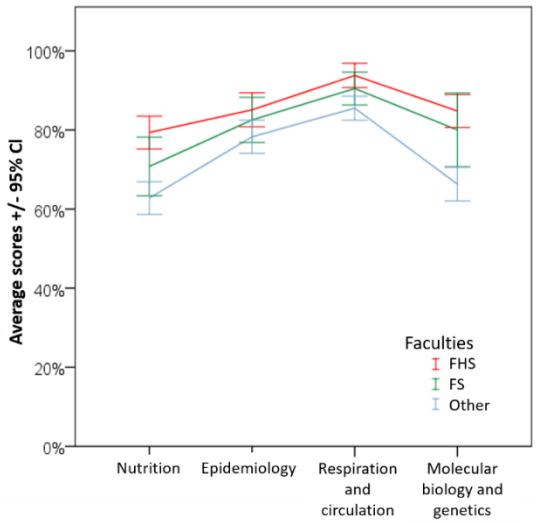

Figure 3. University students' health science knowledge in each faculty (author's own work)

The main effect of the faculty variable is significant ($F(1, 143) = 20.910$, $p < 0.001$, $\eta^2 = 0.226$). According to the results of a post-hoc Tukey Test, the difference is due to the fact that students in the Other faculties group got lower scores than the FHS ($p < 0.001$) and FS ($p = 0.004$) students. There were no significant differences between the FHS and FS groups ($p = 0.146$). Although the main effect of the students' health science knowledge is significant ($F(3, 429) = 41.583$, $p < 0.001$, $\eta^2 = 0.225$), examining the absolute differences between each topic would not be informative since the questions in the survey are not of equal difficulty. Therefore, the differences could be due to the varying complexity of the questions. However, comparing the topics may be meaningful if there is a pattern in how knowledgeable students of each faculty are in the four subject areas. To examine these patterns, we ran a Simple effects test and since we analyzed the differences between the faculties in all four subject areas, we used the Bonferroni correction to raise the significance level to $\alpha = 0.0125$. Excluding the Epidemiology questions, there is a significant difference between the faculties in all other subject areas (Nutrition: $F(2, 143) = 13.789$, $p < 0.001$, $\eta^2 = 0.162$; Epidemiology: ($F(2, 143) = 2.568$, $p = 0.080$, $\eta^2 = 0.035$; Respiration and circulation: $F(2, 143) = 7.271$, $p < 0.001$, $\eta^2 = 0.092$; Molecular biology and genetics: $F(2, 143) = 16.016$, $p < 0.001$, $\eta^2 = 0.183$). As for the Nutrition questions, according to the post-hoc test, there is a significant difference between all faculties in their knowledge about this issue. FHS students scored the highest within this subject area, followed by the FS (difference between the two groups: $p = 0.037$) and finally, the Other faculties reached the lowest score (difference from FHS score: $p < 0.001$; difference from FS score: $p = 0.036$). The FHS earned the most points on Respiration and circulation, and the Other faculties scored the lowest (difference between the two groups: $p < 0.001$) with the FS in-

between the two, not significantly differing from either of them (difference from FHS: $p = 0.246$; OF: $p = 0.062$). When it comes to Molecular biology and genetics, there are no significant differences between the FHS and FS students' knowledge on this topic ($p = 0.280$), but both of them performed significantly better than the students of the Other faculties group (FHS: $p < 0.001$; FS: $p = 0.001$). All in all, the FS students seem to have a better understanding of all subject areas. When compared to OF students, they excel especially in Molecular biology and genetics. This can probably be explained by the heavily scientific and interdisciplinary nature of this topic. As for FHS students, their knowledge seems to be the most comprehensive across all subject areas, especially on Nutrition where they performed noticeably better than the other two faculties. One explanation could be that courses related to Nutrition Studies are of central importance in several programs run by the FHS.

After examining how how students' health-related knowledge varies among faculties, we turn to study the effect of taking extra biology classes in high school had on how well they did on the health science questions. Investigating this connection may pose some problems since the subjects students choose to specialize in during their high school education is usually chosen with the type of studies they wish to pursue at university in mind. Thus, it is logical that among FHS and FS students there will be more people who had taken extra biology classes in secondary school and since they continued to study the subject at university, it is impossible to measure what they learned in high school from what they learned in university separately. However, it is possible to circumvent this problem if we examine the faculties one by one. As for students attending Other faculties, they most probably were not exposed to further biology education after high school; therefore, studying the effect of secondary school education is meaningful in their case. Examining FHS students can also be informative since all of them received the same courses on biology as part of their university education irrespective of whether they had extra biology classes in high school or not. FS students, however, can be left out of the analysis because in their case the amount and type of biology education they received at university is not uniform; it depends on the specific program they attend. We analyzed the FHS and OF student data in two separate ANOVA tests. As for FHS students, the effect of the extra high school biology lessons is not significant ($F(1, 44) = 0.957$, $p = 0.333$, $\eta^2 = 0.021$), while in case of OF students the effect was found to be significant ($F(1, 71) = 5.061$, $p = 0.028$, $\eta^2 = 0.067$). According to the results of the post-hoc test, it seems that the difference high school biology education makes is significant in case of the Molecular biology and genetics ($F(1, 71) = 9.873$, $p = 0.002$, $\eta^2 = 0.122$); those who attended extra classes had a better knowledge of this subject matter. In case of the other topics, no significant differences were found between those

who took extra classes in secondary school and those who did not (Nutrition: $F(1, 71) = 0.538$, $p = 0.466$, $\eta^2 = 0.008$; Epidemiology: $F(1, 71) = 0.693$, $p = 0.408$, $\eta^2 = 0.010$; Respiration and circulation: $F(1, 71) = 0.845$, $p = 0.361$, $\eta^2 = 0.012$). The dissertation includes a more detailed analysis of the health science knowledge of FHS, FS and OF students, the results of which are consistent with those described above. Namely, that unless students continued to study biology at university, they fail to recollect most of the more specific and technical aspects of their biology knowledge, but they seem to retain terms and functions used in everyday life.

The hypothesis is confirmed; both the faculty students attend and the extra biology classes in high school affect the students' biology knowledge.

University students' biology knowledge and health behaviour

H8: We hypothesize that there is a significant connection between the students' biology knowledge and health behaviour.

When testing the eighth hypothesis, we were curious to see if the depth of the students' biology knowledge predicts their health behaviour in any way. To measure how well-versed they are in biology, we used the four topics previously analyzed (see H7) and variables related to students' nutrition and sport habits as indicators of health behaviour. Regarding nutrition, we examined four factors: the Unhealthy foods variable describes the consumption of chips, energy drinks, fizzy soft drinks and fast food. The Healthy diet variable includes eating vegetables, fruits, fish and nuts or seeds. The Sweet treats variable includes any sweet treats, desserts and snacks. Finally, coffee and alcohol consumption, as well as smoking is included under the Addiction variable. We added dairy intake, regular meals, eating sitting down and regular exercise as individual variables. The results are show below in Table 1. Based on the results of the regression analysis, we can conclude that being aware of what a healthy lifestyle involves does not necessarily have a significant influence on health behaviour-related indicators.

Table 1. Summary of the regression analyses performed to investigate the effect of biology knowledge on health behaviour (authors own work)

Regression	**Output variable**	**F**	**df_1,df_2**	**p**	**R^2**
Linear	Unhealthy foods	1.792	4,176	0.133	0.039
	Healthy diet	0.536	4,176	0.710	0.012
	Sweet treats	0.337	4,176	0.853	0.008
	Addiction	2.212	4,176	0.070	0.048
		Chi-square	**df**	**p**	**Nagelkerke R^2**
Ordinal	Dairy	692.756	8	0.183	0.175
	Eating sitting down	476.442	8	0.928	0.249
	Regular meals	569.548	8	0.078	0.114
	Regular exercise	561.719	8	0.117	0.161
The predictive variables for all regressions are the scores obtained in the following subject areas: 1) Nutrition, 2) Epidemiology, 3) Respiration and circulation, and 4) Molecular biology and genetics					

To better understand the connection between students' knowledge of healthy living and their behaviour, we looked for and analyzed question pairs that addressed the same health-related topic, with one aiming at the respondents' familiarity with the topic and the other at their behaviour. In case of fruit and vegetable consumption, there is a mild but significant, positive correlation between knowledge and actual behaviour ($r = 0.472$, $p < 0.001$). However, looking at the results in more detail, it seem that they are not that straightforward. We employed an individual sample t-test to check whether the recommended amount of fruit and vegetable intake given by the respondents corresponded to the 400 grams specified by the WHO. According to our analysis, the amount estimated by the students is significantly lower than that recommended by the WHO ($M = 357.459$g, $SD = 128.288$, $t(180) = 37.172$, $p < 0.001$, $r = 0.941$). Furthermore, we analyzed the difference between the recommended amount specified by the respondents and their actual fruit and vegetable consumption using a Wilcoxon test. The test results were significant, meaning that the participants consume significantly less than what they believe the recommended quantities to be ($Z = -8.037$, $p < 0.001$, $r = 0.667$). As for the number of meals a day, we found a significant, positive correlation ($r = 0.286$, $p < 0.001$). Based on the results of a single sample t-test, we see that the recommended number of meals a day specified by the respondents is different from the five daily meals recommended by specialists. The number given by the participants is significantly lower than the one specified by professionals ($M = 4.691$, $SD = 0.777$, $t(180) = -5.357$, $p < 0.001$). A paired sample t-test also reveals that the actual number of meals students have a day is significantly lower than the one they believe to be the recommended amount ($M = 3.635$, $SD = 0.918$, $t(180) = -13.987$, $p < 0.001$). Those students who specified a suggested amount of fluid intake per day gave the right estimate, around 2 liters per day. We paired this question up with the one aimed at the actual quantity participants consume each day. Looking at the respondents' answer to these questions, we can say that their fluid intake seems to be satisfactory. As for salt intake, 58% of students are aware of the suggested daily amount and only a fraction of those respondents (46.7%) monitor their salt intake. Overall, this means 35.4% of the whole sample.

The hypothesis was not supported; there is no significant relationship between biology knowledge and health behaviour.

MAIN CONTRIBUTIONS

- One innovative aspect of the study is that it describes the health-related aspects of biology teaching by comparing practising and future biology teachers. To our knowledge, such a design has not been previously used in any study.
- Another unique element is that the dissertation examines the effect of biology education on health knowledge and health behaviour both from the teachers' and the students' side.
- In this study, we attempted to point out systematic differences between present and prospective biology teachers. Practising teachers view their own health as more important than teachers-in-training, and believe that biology lessons can play a more central role in helping students recognize illnesses. In contrast, prospective teachers believe experiential teaching should receive more emphasis compared to practising teachers. Concerning the relevance of health development issues during biology lessons, present teachers seemed to prioritize topics connected to the body and its functions, which were more closely related to their subject, while prospective teachers thought social and mental aspects of health should also be dealt with.
- Furthermore, our results also confirmed that the teachers' subjective health and how highly they value their own health affects their attitude towards teaching health-related content in their lessons.
- Finally, in the university student sample we found no significant connection between how familiar the respondents were with health-related topics and their health behaviour-related indicators. Based on our results we suggest the implementation of long-term health development programs for young people that can integrate their knowledge about health and healthy lifestyle choices into an action plan aimed at developing long-term healthy habits.

SUMMARY

First of all, based on the results of this study, it seems that teachers need to pay close attention to their own health since, although indirectly, it affects how health-related content is taught and learned in their lessons. The literature also supports the idea that teachers who lead a healthy lifestyle, attend regular screening tests, avoid risky health behaviours can serve as authentic role models for the younger generation (Barabás & Ócsai, 2006). Furthermore, based on our research outcomes, such teachers place more emphasis on health-related issues and health protection in their lessons as well, thereby encouraging their students to lead a healthy lifestyle. Thus, they contribute to improving the health status of the population both at the individual and the social level. Secondly, if our aim is to make health education more effective, it appears that

the development and implementation of teaching methods suited for 21st century expectations is indispensable. To achieve this, ICT is the most important means at our disposal, which includes a wide range of technologies and tools that can be integrated into education. These have the potential to enhance the effectiveness of health education (Buda, 2003, p.166), especially for generations Z and aplha. Future teachers can already familiarize themselves with ICT supported biology teaching during their university teacher training and can become confident users of these technologies by the time they enter the teaching profession. However, if they wish to become truly skilled users of ICT, some dedication and persistence on their part is also necessary. Thirdly, we believe that educational institutions and biology teachers, for whom this topic is especially relevant, should make a conscious effort to augment theoretical education with a complex, multi-layered health development program that reaches students both within and outside the school walls. When choosing a health development plan, it is always better to opt for long-term, complex programs which not only reinforce students' existing health-related knowledge, but also help them implement this knowledge into practice. One example of such a program is the promising TANTUdSZ, which targets medical students, high school and elementary school pupils, as well as kindergartners (Feith, Melicher, & Falus, 2015). It does not only focus on the transfer of knowledge, but also uses methods and techniques like role modeling, games, experiential learning, and ICT. As Vitrai (2018) emphasizes, rather than trying to improve the health status of the current adult population, it would be more considerably more effective to focus on creating a health culture that promotes a healthy lifestyle and behaviour. This could be achieved most efficiently through improving and supporting health development in schools.

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