

BASIC KNOWLEDGE OF THE CARDIOVASCULAR SYSTEM: A COMPARISON BETWEEN STUDENTS OF THE FACULTIES OF EDUCATION IN LJUBLJANA (SLOVENIA) AND BRNO (CZECH REPUBLIC)

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Abstract: *A basic knowledge of the structure and function of our bodies is fundamental to our everyday life and health. Such knowledge is particularly important for teachers who both disseminate it to their pupils and have responsibility for the welfare and safety of the children in their care. A basic understanding of bodily structure and function at an early age also promotes responsible, healthy behaviour and can minimise risk of disease in later life. In this study we investigated the knowledge and understanding of first-year education students about the cardiovascular system. We compared the responses of Slovene and Czech students who are training to teach in primary and lower secondary schools. In particular, we aimed to investigate how much knowledge of the circulatory system they had retained after completing upper secondary school (gymnasium), whether they understand the main roles of blood circulation through the body, the functions of the heart and why we need to breathe.*

Key words: *children's ideas about cardiovascular system, heart, blood, veins, breathing*

Introduction

One of the most important sections of the biology syllabus in primary and secondary school is that on the structure and function of the human body. Basic education should provide pupils with knowledge about their own bodies so that they are aware of behaviours that enable them to avoid some diseases and live healthily. Everyone knows that we have to eat, drink and breathe, but do we know why our body needs us to engage in these activities? We accept some facts while not necessarily understanding the main reasons for them.

Even small children know that blood is red, but very few of them know that there are two distinct red colours - light red and dark red, and the difference between them (Bajd, 2006). Most children will draw a heart as for Valentine's day and many are aware of the link between the heart and romance, but almost all are unaware that there is a septum dividing the heart vertically into a right and left part. Why do we need two halves for the heart? Why does the heart have four chambers? Do pupils understand the function of double circulation in the human body, with blood entering the right side of the heart, being pumped into the lungs, and the oxygenated blood then being pumped from the lungs back to the left side of the heart from where it is circulated to the rest of the body? What is transported in the blood?

While the great majority of young children know that we have to breathe to stay alive, they do not know the main reason. It is difficult to understand the processes at cell level, especially for young children who are not able to think abstractly. But older pupils who have completed 12 years of schooling might be expected to know the structure of the cell and cell particles, and to be aware of the processes going on in mitochondria. All living things obtain energy for life processes by breaking down food. This energy release is respiration. While the majority of living things need oxygen to release energy, many kinds of bacteria and yeast can respire anaerobically, without oxygen.

In our research we wished to investigate the extent of students' knowledge and understanding of the human body. In particular, we wanted to explore how much future teachers have learned in school about bodily structure and function, and how much knowledge they have retained when they enter the University. Do they know the structure and understand the function of their body? Conversely, if their knowledge is incomplete, we wanted to explore the reasons for such insufficient knowledge.

Slovene and Czech education systems and students

Pupils meet with the structure and function of human body twice within Slovenian compulsory education: the first occasion is in year four, the second time in year nine. In upper secondary school they refresh their knowledge of cells and the human body again, extending and deepening the information acquired from primary school. In the Czech Republic pupils also learn about the human body twice during compulsory schooling: the first occasion is in year five, the second in years eight or nine, so that in upper secondary school they also meet with this content again, at a more demanding level.

One of the aims of our research was to find out if there is any difference in the answers of Slovene and Czech students. We suggest that differences in the responses of Slovene and Czech students may relate to differential representation of these topics in the upper secondary syllabus and in approaches to teaching the subjects in the two national education systems.

We expected that students starting university will have basic knowledge of the human body –for example, why we have a heart, that it contains four chambers, and is structured into left and right halves. We predicted that students will know:

– the colour of blood, since they will have experience of seeing it when they were injured

- that blood has two different colours, depending on oxygen content,
- why we have blood in the body
- the main roles of blood and the heart, because they learned this in school
- the necessity for and primary purpose of breathing, since they will have learned in school about cells and cell processes
- the main source(s) of their knowledge about bodily structure and function.

Methods

In our inquiry we included 132 students – 82 from the Faculty of Education, University of Ljubljana (Slovenia), and 50 students from the Faculty of Education, Masaryk University in Brno (Czech Republic). All were students of the first year of study who had not yet had any university teaching on the human body in their program. Consequently, all their knowledge and understanding of human bodily structure and function derived from their previous schooling.

Students received a questionnaire with 7 open questions. They first have to draw a heart from memory, and then attempt the following questions.

- Why do we have a heart?
- Why do we have blood in our body?
- What colour is our blood?
- How does the blood flow in our body?
- Why do we breathe?
- What we are breathing?
- Where did you get the information to answer the above questions?

There was no time limit on completing the questionnaire. The questionnaire for Brno students was translated into Czech from the original Slovene version, while the answers of Czech students were again translated back into the Slovene language. The responses were analysed by Excel program and are presented as tables for comparison.

Results

Drawing the heart was difficult for most of the students. Some drew it as in cartoons or on post cards, and very few depicted it realistically, as it is in our body. We categorise the drawing in five groups based on the completeness and accuracy of the representation. In the first category were the drawings of the heart with four chambers and veins. In the second category were drawings with four chambers but without or not correctly positioned veins. In the third group were the pictures of those who drew only the interventricular septum, with or without veins. In the last group were pictures without chambers, incorrect shape with wrongly positioned veins (table 1).

Table 1

	Characteristics	Number of students' answers		% of students' answers	
		SLO	CZ	SLO	CZ
1.	Four chambers and veins	7	6	8	12
2.	Four chambers without veins or not correctly positioned	17	26	20	52
3.	Only interventricular septum	18	2	22	4
4.	Only the shape of the heart	7	2	8	4
5.	No chambers, no septum, no correct shape	33	14	40	28

The majority of the pictures represented the heart from inside although the instruction was not specific. The drawings of a substantial proportion of Slovene students (40 %) were without chambers, septum and veins, while more than half of Czech students draw the heart with for chambers.

Why do we have a heart?

On this question most of the students answered that the heart pumps the blood in the body. 83 % of Slovene students and 70 % of Czech students gave this answer. Some also mentioned that we need a heart to live (9 % of Slovene and 20 % of Czech students).

Why do we have blood in our body?

While a substantial number (43 %) of Slovene students think that blood transports food, only 4 % of Czech students gave this answer (Table 2). 24 % of Czech students stated that blood transports oxygen compared with 11 % of Slovenes, while nearly equal percentages of both students (24 % and 27 %) mentioned that blood transports oxygen, carbon dioxide and nutrients. Only few students mentioned the blood's function in protecting against harmful microorganisms and other substances. A small proportion of Czech replies (6 %) mentioned erythrocytes, leukocytes and thrombocytes, but no Slovene students did so.

Table 2

Why do we have blood in our body?	SLO	CZ
Transporting nutrients in the body	43 %	4 %
Transporting oxygen, carbon dioxide and nutrients	27 %	24 %
Transporting oxygen	11 %	28 %
Do not know	5 %	-
For functioning some processes	4 %	2 %
That we can live	2 %	4 %
For protection	1 %	6 %

What colour is our blood?

Most Slovene students (82 %) and 26 % of Czech students answered this question by stating that we have red blood (Table 3). A substantial proportion of Czech students were more precise, and stated that blood may be dark or light red (44 %), while only 11 % of Slovene students gave this answer. Only a few Slovene students (4 %) mentioned that blood is dark red, while the percentage of Czech students was appreciably higher (24 %).

Table 3

What colour is your blood?	SLO	CZ
Red	83 %	26 %
dark and light red	11 %	44 %
dark red	4 %	24 %

How does the blood flow in our body?

The answers of Slovene and Czech students to this question were very similar: 72% of Czech and 78 % of Slovene students said that blood flows in blood vessels, and 26 % of Czech and 21 % of Slovene students said that blood flows through the whole body.

Why do we breathe?

The answers were very similar (Table 4). 57 % of Slovene and 70 % of Czech students think that we breathe to get oxygen and some (23 % and 18 %) that we breathe to live. Only 15 % of Slovene students and 4 % of Czech students mentioned that we breathe to produce energy.

Table 4

Why do we breath?	SLO	CZ
to get oxygen	57 %	70 %
To live	23 %	18 %
to get energy	15 %	4 %
to exchange gases	-	8 %

What we are breathing?

The greatest proportions of students think that we breath air, 46 % of Slovene and 50 % of Czech students (Table 5). It is interesting that Slovene students answered air without further comment or qualification, but all Czech students who answered air also mentioned that air is a mixture of oxygen, carbon dioxide and other gasses. Sizeable proportions of students (44 % Slovene and 22 % Czech) only mentioned that we breath oxygen. However, the proportions of responses stating that we inspire oxygen and

expire carbon dioxide, while low, were nearly the same between Czech and Slovene students.. Some Czech students are also aware of polluted air, and mentioned that during inspiration we may take in different gasses and various dirty particles.

Table 5

What are we breathing?	SLO	CZ
Air	47 %	50 %
Oxygen	44 %	22 %
We inspire oxygen and expire carbon dioxide	10 %	12 %
Mixture of gasses and polluted air	-	8 %

Where did you get all this information?

Most students (68 % in Slovenia and 58 % in the Czech Republic) stated that they acquired their information at school (Table 6). Family, books and television influenced fewer students from both countries, while a small number of Czech students (5 %) also cited their own interest.

Table 6

Where did you get all this information?	SLO	CZ
In school	68 %	58 %
Family	11 %	18 %
Books	11 %	14 %
TV	8 %	6 %
My own interest	-	5 %

Discussion

While the numbers of Czech and Slovene students differed, both comprise sizeable samples and we therefore consider their different responses to be reliable indicators of the national groups from which they are drawn. The drawings provided by Czech students contain more information than those by Slovene students: more Czech students know that the heart has four chambers and a smaller proportion of them drew the heart without any details. For whatever reasons, the pictures indicate that Czech students are better informed about the structure of the heart.

Whilst a high percentage of the students were clearly aware of the heart’s primary function it is nonetheless surprising – and disappointing – that some university students, even after completing upper secondary-school, still were not aware of the heart’s primary function. The answer that ‘we have a heart to live’ does not describe its function. We anticipated better results for this question, especially since the pulse and heart beat are evident when running or being otherwise physically active.

In relation to blood function, most Slovene students (70 %) stated that blood transports nutrients around the body, whereas 28 % Czech students gave this response. Nearly one quarter of each group of students stated that blood transports oxygen, carbon dioxide and nutrients, pointing to similarity of knowledge in this aspect. However, only one Slovene student mentioned that blood also has a protective function compared with 6 % of Czech students. Students of both groups are evidently unaware of the blood's important role of blood in transporting not only gases and nutrients, but also hormones, enzymes and waste products. Blood also has an important role in regulating clotting to stop bleeding, and in regulating the body's acid-base balance (pH) through the distribution of buffers. A further crucial role is that the blood contains white blood cells, proteins and antibodies contributing to the inflammatory and immune responses. Very few replies (only 6 % of Czech students and none of the Slovene ones) differentiated between the various types of blood cells- erythrocytes, leukocytes and thrombocytes. While students undoubtedly learned about these in school, it is very likely that they never examined them microscopically, and that accordingly they do not associate blood cells and other inclusions with the blood's functions.

Czech students were more precise in mentioning two different reds, dark and light, for the colour of blood, and we think that they are probably aware that oxygenated blood is different from deoxygenated blood carrying more carbon dioxide. About two thirds of both groups stated that blood flows in blood vessels, and one third that blood circulates around the body. We think that these latter students also know about blood vessels but gave less precise answers that didn't enable us to confirm the extent of their knowledge.

We do not usually differentiate between inhalation and breathing or respiration - in everyday life we say that we breathe with lungs and that fish breathe with gills. But lungs and gills are only the organs which bring the air from the surroundings to the body. In fact respiration occurs at a cellular level, when the oxygen transported by blood is accepted by mitochondria which convert the energy stored in carbon-containing molecules, especially glucose, into high-energy bonds of ATP. The percentage of students who stated that we breathe to obtain energy is low, especially among the Czech sample. During their school years students evidently do not receive sufficient information about the importance of breathing, the respiratory process and its role in energy release. It is somewhat surprising that after learning about cell structure and function students do not remember the main reason why living organisms respire, and that bacteria and yeast use another process to obtain the energy they need for life.

Everybody knows that we breathe air containing oxygen. In response to the question 'What do we breathe?' a sizeable number of students answered 'air' and did not name the primary gas, but the question was an open one and the students were not required to be specific. It is interesting that some Czech students mentioned polluted air, clearly aware of pollution and its influence on their health and perhaps acquainted with pollution and environmental issues more generally.

The main problem hindering school pupils' understanding appears to be that they cannot visualise the processes involved, and so connect up the various components of the system. It is difficult to present them with meaningful information on the internal body organs since they do not have direct experience of the circulatory, digestive or

respiratory systems. Students may learn about these from books and pictures and yet have no concrete experience of what they are learning about. The typical outcome is that they will simply memorise things (or not) but without gaining an overview and understanding of the entire system. So in many cases their ideas are inexact or even plain wrong. If they, as young teachers, do not have a firm grasp of the fundamentals of the structure and functions of the human body it will be very difficult, if not impossible, for them to teach even younger children and provide them with simple but correct knowledge of their body. Our findings suggest that in many cases students have learned and memorised the content of these important topics and concepts but without understanding them.

According to our survey school is the primary source of students' knowledge of these topics in both Slovenia and the Czech Republic. Some students obtained information from family members and from books, but it is surprising that very few students mentioned TV, and not one the internet. Television and the internet are increasingly very popular as information sources and can also be highly effective learning devices and means of providing better visual explanations. New media techniques especially can provide excellent images and appropriate animation to help visualise, and so understand, bodily processes that we cannot observe directly. We should therefore make greater use of new IT visualisation techniques more often in schools. Reliance on broadcasting as a substitute for this is certainly ineffective since there are not enough programs with educative content, and students may well not be interested to watch them in their own 'free' time.

We expected better results from our survey. We conclude that both Slovene and Czech students have similar problems in understanding the structure and function of the human body. What might we do to improve their knowledge? Should we be spending more time teaching the human body in school? Should we change and improve our didactic approach to the subject, or can we better motivate the pupils as learners of this topic?

In our view the problem is not about representation of the human body in the curriculum or the number of hours spent teaching the topic. The main problem is that students are still learning by rote memorisation without visualisation of the organs and understanding the function of the system. Models of organ systems (such as the cardiovascular system) can help students in visualisation (Bajd, Praprotnik 2004), while highlighting the relationship between basic understanding of bodily structure and function and the improved health and disease avoidance for the individual should improve students' motivation in learning about these topics.

Our inquiry shows that both Slovene and Czech students have some basic knowledge of their own bodies but often without sufficient understanding of the functions of different body systems at the stage when they enter university and start studying to become schoolteachers. Our results point to some differences of detail in Slovene and Czech student responses (eg in oxygenated/deoxygenated blood; in obtaining energy and in gas exchange; in inspired pollutants) that *may* reflect differential representation of these topics in the upper secondary syllabus and in approaches to teaching the subjects in the two countries. Investigation of this possibility will require larger student samples and more comprehensive questionnaires, as well

as a detailed comparison of biological science teaching and its place in the curriculum of the two countries.

Literature:

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SROVNÁNÍ ZÁKLADNÍCH ZNALOSTÍ STUDENTŮ PEDF UNIVERZITY LUBLAŇ (SLOVINSKO) A PEDF MU BRNO (ČR) O KARDIOVASKULÁRNÍM SYSTÉMU

Souhrn: Poznání základních struktur a funkcí našeho těla je nutností pro každodenní život, zvláště pro budoucí učitele, kteří budou předávat své znalosti žákům ve školách a poneseou odpovědnost za blaho a bezpečí dětí, které budou mít ve své péči. Základní znalost struktury a funkcí našeho těla v raném věku podporuje prevenci nemocí a pomáhá nám chovat se odpovědně vůči našemu zdraví v pozdějším věku. V naší studii jsme pokládali studentům 1. ročníku obou pedagogických fakult otázku, jaké jsou jejich představy o kardiovaskulárním systému. Porovnávali jsme odpovědi českých a slovinských studentů, kteří budou učiteli základních a nižších středních škol. Chtěli jsme si ověřit, kolik vědomostí o oběhovém systému si udrželi po absolvování všeobecné střední školy (gymnázia), zda rozumějí hlavním funkcím systému krevního oběhu, funkce srdce a zda pochopili, proč potřebujeme dýchat.

Klíčová slova: představa dětí o kardiovaskulárním systému, srdce, krev, cévy, dýchání