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ARE STORKS HOMOSEXUALS? PERSISTENCE OF MISCONCEPTIONS AMONG UNIVERSITY STUDENTS

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Abstract. *The misconceptions about different scientific phenomena are persisting from childhood till adulthood and no method managed to transform it into the correct form. The study is focused on finding out the misconceptions about common facts of zoology and also human body. The respondents were 112 university students. Among these respondents were 22 science major students and the rest of the respondents were non-science majors. The number of females was 82. All respondents are potentially future teachers at elementary schools, so there is a great chance/ possibility they will teach pupils and present them the kinds of information which are investigated in this study. Research tool contained 7 items, most of them were from the field of zoology and one from the field of human anatomy. Obtained data were analysed by the proportional ratio of correct and incorrect answers and the chi-square test was used for the determination of differences between groups of variables gender and field of study. There was not found a significant difference between males and females and science major students often answered some items more. There were found many misconceptions about common facts of zoology and human body.*

Key words: *animals, human body, misconceptions, persistence, university students.*

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Introduction

The diagnosis of students' misconceptions and the identification of reasons for those misconceptions is a prerequisite for developing lessons that result in conceptual change. Recent years the research on students' misconceptions has been of considerable interest to science educators and cognitive psychologists. It is now generally agreed that each student has his/her own misconceptions of the world because of students' wide variety of experiences, each concept will hold a somewhat different meaning. Furthermore, many of the conceptions will be different from those generally accepted by the scientific community. A well-known misconception was that younger students had a true and open desire to learn and as such were openly receptive to, and enthusiastic about new knowledge, but as students got older there were many mediating factors, including fear of failure and entrenched misconceptions that made it difficult for them to either engage in the learning process or accept that they may be wrong (Thompson & Logue, 2006). Older students are very resistant to modifying ones that we did identify. The older students tended to give fairly definite answers, and even when they were challenged and given evidence that they were incorrect, we encountered a great deal of resistance to modifying their existing schema (Guesne & Tiberghien, 1985).

Theoretical Background

Concepts are units of mental representation roughly equivalent to a single word, such as *object, animal, alive, heat, weight,* and *matter*. Theories of how people represent knowledge require concepts of fulfill many distinct functions, and there are currently no theories that successfully provides a picture of mental representations in which concepts discharge all the burdens placed on them (Carey, 2000). Concepts can be considered as ideas, objects or events that help us understand the world around us (Eggen & Kauchak, 2004). Misconceptions, on the other hand can be described as ideas that provide an incorrect understanding of such ideas, objects or events that are constructed based on a person's experience (Martin, Sexton & Gerlovich, 2002) including such things as preconceived notions, non-scientific beliefs, naive theories, mixed conceptions or conceptual misunderstandings (Hanuscin, 2001). The

prior knowledge depends on level of ability, age, amount of education, gender, culture and also language (Dekkers & Thijs, 1998). The sources of misconceptions are different, textbooks, reference books, teachers, language, cultural beliefs and practices are some of the principal sources of students' misconceptions of many science concepts, including biology (Abimbola & Baba, 1996; Buckley, 2000; Deshmukh & Deshmukh, 2007; Dikmeli & Cardak, 2004; Sanders, 1993; Storey, 1992).

The persistence of misconceptions is connected with the remembering and memory (Wenning, 2008). Research has shown that instead of remembering a host of accurate details, people tend to remember events by incorporating a few details within a schema for the event (Silva et al., 2006; Scoboria et al., 2006). The declarative memory is the main type of memory, which has got the influence on the persistence of misconceptions. The declarative memory consists of facts and events that can be consciously recalled or "declared." Also known as explicit memory, it is based on the concept that this type of memory consists of information that can be explicitly stored and retrieved. Declarative memory comprises an episodic memory and semantic memory (Tulving 1972). The saving of memory engrams in declarative memory is connected with the cognitive processes of evaluating, comparing and reasoning. These processes caused the memory tracks are not reproduction of information perceived by sensual organs, but they are the result of their processing on the basis of previous experience (Gais & Born, 2004).

Current State of Literature

Studies related to animals show that students have many alternative interpretations of these concepts. Trowbridge and Mintzes (1988) examined students' alternative conceptions in animal classification at the elementary, secondary, and college levels. Based on a previous study that made use of clinical interviews and a classification task. Results suggest that students subscribe to a highly restricted view of animals; applying the label almost exclusively to vertebrates, especially in common mammals. When asked to distinguish between vertebrate and invertebrate animals and to classify several species into vertebrate groups, a wide range of alternative conceptions emerged. Cross-age comparisons indicate that many of these alternative views remain intact throughout the school years, while others yield more readily to formal instruction and/or non-school experiences.

Cardak (2009) determined the misconceptions of science students attending the university on the classification and behaviour of birds, and their interaction with people. It was found out that the science students surveyed had various misconceptions with regard to the classification and behaviour of birds, and their interaction with people. Bell (1981) and Braund (1991) have disclosed that students confused animals with other living organisms, and their knowledge of the diversity of animal species is limited by domestic animals. For example, students tend to classify some vertebrates that have no visible limbs as invertebrate, and some invertebrates that have large exoskeletons as a vertebrate. Hatano and Inagaki (2002) argued that skeletal principles are combined with a mode of explanation of living things in terms of their similarity to human beings and the idea that living phenomena are produced by a vital principle, as distinct from a purely chemical or physical force (vitalism). Randler, Hollwarth & Schaal (2007) found out misconceptions about animals among different adult people by the using of questionnaire in Germany. As it is seen, it has been determined that misconceptions about animals can be seen among pupils from elementary and high schools and also among university students (Bahar, 2003; Trowbridge & Mintzes, 1985, 1988).

It is possible to find out many misconceptions also in other biological disciplines. For example Arnaudin & Mintzes (1985) conducted a study with primary and lower secondary school pupils, college freshmen, non-biology majors and biology majors to identify their alternative conceptions about the human blood circulatory system. The findings of the study indicated several alternative conceptions in different grade levels, a number of these alternative conceptions were reported to remain stable among elementary, secondary and college level students. Similar to students, biology teachers were found to hold misconceptions in the same topic (Yip, 2010). Similar topic provided Özgür (2013), according to the results of the study, the distributions of the percentages of students' misconceptions demonstrate a decreasing trend from elementary school students to university students without totally disappearing. Prokop and Fancovicova (2006) found out the knowledge of adult students about the human body in Slovakia is inconsistent. They used drawing and also written methods.

Thompson & Logue (2006) identified through interviews many misconceptions among science university students in different science topics, for example from biology "Birds, fish and insects are not animals" and also from physics "Clouds contain water that leaks out as rain." Meir et al (2007) identified misconceptions among college students about evolutionary trees and many students still showed problems with eliminating of misconceptions after attending the course relating to this topic. Odum (1995) found out secondary biology students, non-biology and biology majors

continue to have misconceptions about diffusion and osmosis. Yangin (2013) found out through interview with pre-service teachers focused on the misconception about plants, the main misconception was that students classify some of the plants they knew well in a wrong way according to the criteria which was not biological.

From the other disciplines, Libarkin et al. (2005) after analysis of questionnaire and interview responses indicated that students hold a number of non-scientific ideas about the Earth. Additionally, students apply a range of ontological categories to geologic phenomena, with significant implications for teaching Geosciences from a systems perspective or Park (2013) found out misconceptions about lunar phases among Korean students.

Purpose of Study

The aim was not to find out the huge variety of misconceptions about different biological phenomena, but to find out the misconceptions about common biological facts, which are presented to children from their birth from the different sources such as books, parents, media (TV, internet), friends, magazines, cartoons, etc. So, the choice of questions and tasks used in the research was intentional with the focus on that all of the respondents are future teachers and they can present themselves to pupils not only in science classes in their future job as a teacher. And if the misconceptions are on the side of future teachers, there is a big chance the total persistence of misconceptions about common biological facts in the society will last.

The main aim of the study was to find out the university students' misconceptions about common facts from biology mainly from the field of zoology.

The partial aims was to find out, if there is any difference between males and females, and between science major and non-science major students in the level of misconceptions.

The following research questions were defined on the basis of those aims:

1. What is the level of misconceptions among university students?
2. Is there any difference between males and females in the level of misconceptions?
3. Is there any difference between science major and non-science major students in the level of misconceptions?

Methodology of Research

Sample Selection

The data were collected from 112 students, who agreed voluntarily to participate in the research of misconceptions. The students attended courses, of which one of the researchers was a teacher. The sample included all students who agreed with the participation in the research. Among these respondents were 22 science major students and the rest of the respondents were non-science majors. The number of females was higher (n = 82) in comparison with males. All respondents were fourth-year students at the Faculty of Education in Czech Republic. All respondents are potentially future teachers at elementary schools, so there is a great chance/possibility, they will teach pupils and present them the kinds of information investigated in this study.

Instrument and Administration

As the research tool was used a questionnaire with 5 open-ended questions and 2 graphic tasks. Open-ended questions are suitable for the research of misconceptions due to identification of concepts and patterns in written responses (Patton, 2002). Nearly all of questions/tasks were related to zoology and the last one was related to anatomy of human. All questions used in the research are related to common facts of previous mentioned fields of biology. The respondents had a possibility to meet with all of them in the primary schools. All open-ended questions from zoology were used in our previous studies (Kubiatko & Prokop, 2007; Prokop, Kubiatko & Fancovicova, 2007; Prokop, Kubiatko & Fancovicova, 2008), but they were distributed among lower secondary and high school pupils. The drawing task relating to human body was used in the study of Prokop & Fancovicova (2006) and the last (drawing) task relating to giraffe neck vertebras is only part of the research, which was not published yet (Kubiatko & Dozbabova unpublished manuscript). The aim was not to find out a big scale of misconceptions, but only the misconceptions about common facts, because if this kind of misconceptions will be eliminated, we can move on to research the more complex misconceptions in the science subjects.

Open-ended questions were:

1. Why does the rooster crow?
2. What is a female pheasant called?
3. Where does the stork migrate?
4. What do hedgehogs eat?
5. What is in a camel's hump?

The graphic tasks were:

1. Draw a neck of giraffe and in the next step draw the neck vertebras and try to draw a real number of vertebras.
2. Sketch the outline of a human body and draw a heart in it.

The relatively small number of items was caused by the fact, the research was limited by time donation and all items were open-ended respectively graphic, so the respondents needed time for the evolvement of the questionnaire. The pilot study among 5 students showed the solving of this set of 7 items was about 25 – 30 minutes; this time is suitable due to the concentration span (Bunce, Flens & Neiles, 2010; Wilson & Korn, 2007; Young, Robinson & Alberts, 2009).

The research tool was managed among university students by one of the authors. The students were informed how to answer and they were assured about the anonymity of the questionnaire. The students filled in the questionnaire approximately in 30 minutes.

Data Analysis

The obtained data were analysed by two ways. The first one is only a determination of correct and incorrect answers. Incorrect answer was marked as "0" and correct answer was marked as "1". The reliability of research tool was determined on the basis of this coding. Reliability was $\alpha = 0.53$, what is sufficient value for not standardized research tools (Christmann & Van Aelst, 2006; George & Mallery, 2003). The validity of the questionnaire was determined by the previous using of all questions/tasks in the research among pupils and students. The next coding was to precise determination of misconceptions of each student in each question. The determination of differences between groups of observed variables (gender, field of study) was calculated by the using of chi-square coefficient (χ^2). The significant differences were determined at the levels of significance: $p < 0.05$; $p < 0.01$ and $p < 0.001$.

Results of Research

The obtained data were evaluated by two means, first one is a description of the proportion of correct and incorrect answers and the second one is an evaluation of misconceptions among respondents from their answers. At first the written questions were analysed and then graphic tasks were analysed.

The greatest number of correct answers was found out in the question 4 "What do hedgehog eats?", where only 15.85 % of respondents answered this question incorrectly. Most answers were correct; the food of hedgehog (*Erinaceus europaeus*) is insects. There was not found out a statistical significant difference between males and females ($\chi^2 = 0.85$; $p = 0.36$), but between science major and non-science majors was identified a statistical difference ($\chi^2 = 4.90$; $p < 0.05$). The non-science major students more often answered incorrectly as was expected. Among incorrect answers predominated answer "fruits", some of the students wrote concretely "pears" or "apples". Next wrong answers were leaves and grass. As it was mentioned above, the majority of incorrect answers were among non-science major students.

Approximately similar number of incorrect and correct answers (53.57 % vs. 46.43 %) was identified in the next question "What is in a camel's hump?" There was not found out a statistical significant difference between males and females ($\chi^2 = 0.68$; $p = 0.40$), the significant difference was between science major and non-science major students ($\chi^2 = 4.04$; $p < 0.05$), the non-science majors answered more incorrectly in comparison with science major students. The correct answer of this question – the fat is in the camel's (*Camelus dromedarius*) hump, nearly all incorrect answers were "water", only in one case it was "bone".

In other written questions the number of incorrect answers was higher in comparison with correct answers.

The question "Why does a rooster crow?" 26.79 % of respondents answered correctly. In the variable gender was not found out a significant difference ($\chi^2 = 2.14$; $p = 0.14$) and in the variable field of study was not also found out a statistical significant difference ($\chi^2 = 1.28$; $p = 0.26$). The correct question was taken in consideration "allure the female" or "protection of territory". Most frequent incorrect answers were "because it is morning". This answer was registered at nearly 20 % of students. Nearly 15 % of students answered, that rooster wakes the people and it is the cause, why it crows. The next incorrect answer was "rooster has adapted internal organs for the crowing", the next two incorrect answers were similar, first of them was "it calls females in one place" and the second one is "it wakes the females".

The concept female in this part has the meaning "hen". Approximately 30 % of respondents knew the name of the female pheasant (*Phasianus colchicus*) (hen). The statistically significant difference was not observed between males and females ($\chi^2 = 1.77$; $p = 0.18$), but the significant difference was detected between science majors and non-science majors ($\chi^2 = 8.29$; $p < 0.01$), the non-science majors answered more incorrectly in comparison with science major students. Half of the respondents wrote that the name of female pheasant is the partridge.

The last written question had a similar number of correct and incorrect answers like the previous one. Approximately 30 % of respondents answered correctly the stork (*Ciconia ciconia*) migrates to Africa. As in previous questions between males and females was not found out a statistically significant difference ($\chi^2 = 0.96$; $p = 0.33$). The non-science majors more often answered, statistically significantly, incorrectly in comparison with science majors ($\chi^2 = 5.00$; $p < 0.05$). Approximately 44 % of respondents wrote, the storks are migrating into warm countries, what was the most frequent incorrect answer. More than 10 % of respondents wrote that the storks are migrating into the south. Other answers were "they (storks) do not migrate" and some respondents mentioned continents like Europe, Asia and Australia.

Next the graphical tasks were analysed. The first one related to neck vertebras of giraffe. Two third of students drew correctly 7 vertebras in the neck of giraffe. Between males and females was not detected a statistically significant difference ($\chi^2 = 0.002$; $p = 0.97$). The non-science majors more often answered, statistically significantly, incorrectly in comparison with science majors ($\chi^2 = 4.66$; $p < 0.05$). The incorrect drawings provided the variety of neck vertebras number. Some students wrote answers "many", and some drew concrete numbers, most of them were higher than a real number (8, 9), some students drew a neck with a higher number of vertebras (Figure 1). Majority of incorrect answers contained a higher number of vertebras than a real number, but some students drew a lower number, concretely 3 (Figure 2).

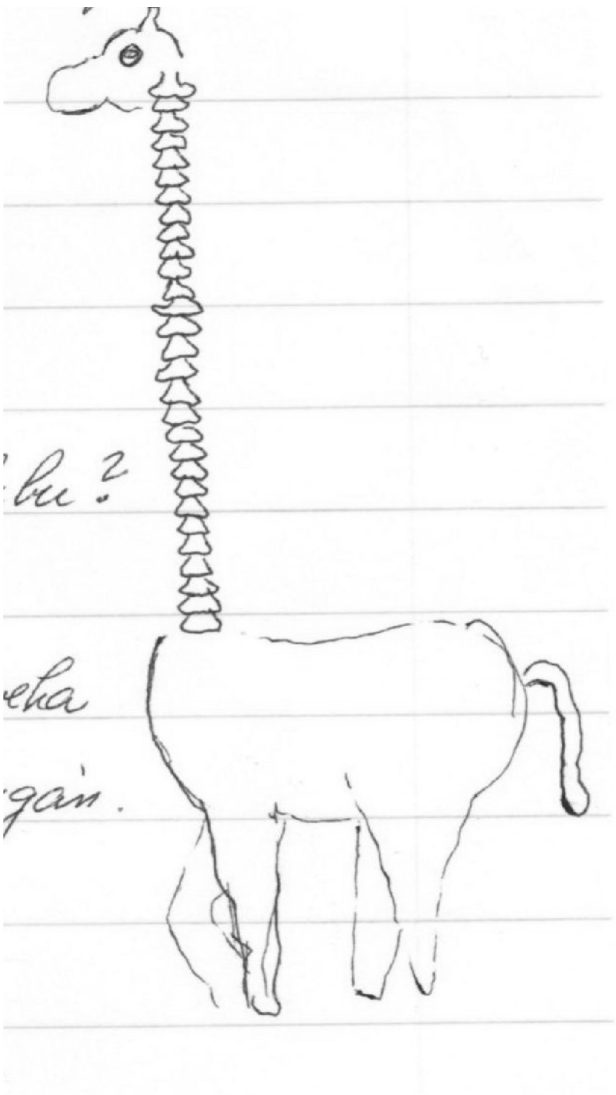

Figure 1: The incorrect drawing of giraffe vertebras in which a number of vertebras is higher than a real number.

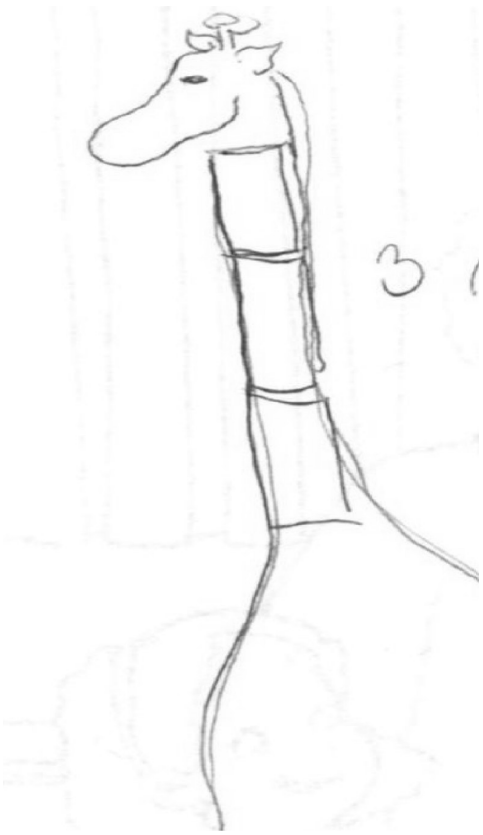

Figure 2: The incorrect drawing of giraffe vertebras in which a number of vertebras is smaller than a real number.

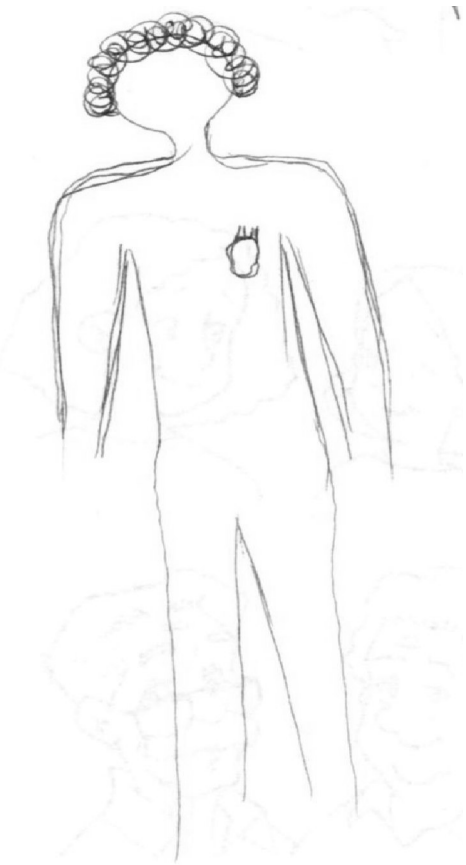

Figure 3: The incorrect drawing of a heart in the human body.

The last task was concerning a localization of the human heart. This task was problematic for respondents. Only 15 % of respondents drew a heart approximately in the centre of the chest. The other respondents drew a heart on the left side of the chest as it is in the figure 3. The variable gender did not show the statistically significant difference between groups ($\chi^2 = 1.94$; $p = 0.16$), also the variable field of study did not show the statistically significant difference between groups ($\chi^2 = 0.01$; $p = 0.92$).

Discussion

The study is focused on the level of misconceptions among university students. The misconceptions were found out through the questionnaire with 7 items (5 open-ended form and 2 in graphic form). The items were from the field of zoology and one from field of anatomy of human body. The items were chosen according to previous researches (Kubiatko & Dozbabova, unpublished manuscript; Kubiatko & Prokop, 2007; Prokop & Fancovicova, 2006; Prokop, Kubiatko & Fancovicova, 2007; Prokop, Kubiatko & Fancovicova, 2008), in which these kinds of items were evaluated as the most interesting from the point of view of pupils, teachers and also from the point of view of researchers.

The misconceptions were found out in each question, for example, some students have still persisting misconception about the food of hedgehog, what is according to them fruits (apples, pears) (Kubiatko & Prokop 2007). It is relatively surprising, that this kind of misconception is still present among students. This misconception is common among pupils from elementary schools, its manifestation is decreasing, but it still persists. Maybe the influence of the media or teachers from kindergarten or primary schools was so strong, that the any

attempt to eliminate it was useless. It is possible to find about the strong influence of media on the creation and persistence of misconceptions in many scientific literary sources (e.g. Thompson & Logue 2006). The influence of media on pre-service teacher is also strong and caused the new misconceptions or it makes the misconception more resistant against the influence of other factors (Khalid, 2001). And maybe, but only in a hypothetical manner, the internet had the influence on this persistence of misconception. After writing a concept "hedgehog" in the web browser a sequence of hedgehog pictures appeared as the hedgehogs had fruits on its spines (e. g. www.shutterstock.com). However, this question was answered correctly by the majority of students, in another question the number of correct answers was decreasing.

It is obvious, that the influence of other sources like media, parents, other relatives, friends, books is very strong. For example, many students are holding information about the water in the hump of a camel; this information is presented from all media mainly through cartoons in early childhood. So children hold this information in memory and it is very hard to eliminate it. This misconception is pervasive in many countries, among all age cohorts of the population and mentions about it is possible to find also in older researches (Young, 1982).

The situation with other misconceptions related to birds is not so optimistic. The majority of students answered these questions incorrectly. We can suppose, there was the influence of parents in the early childhood. The majority of parents told to children the storks migrate to hot countries, the female of pheasant is partridge and the reason of rooster crawling is waking up the people. In the last misconception is obvious anthropomorphic answer (Prokop, Kubiatko & Fancovicova, 2007). So, there are obviously two facts, the cyclic character of the misconceptions passing down, where the parents have got misconceptions about basic and common scientific facts, and the second reason is the strong influence of parents on the ideas of children. The children consider the parents' words as an unquestionable truth, which is resistant to any other truth, which could be presented at the school environment. These ideas are occurring in the context of a study by Goodnow (1988).

The influence of media and parents is also possible to find in the answers to the two drawing questions, in which the majority of students localized the heart of human on the left side of the body and for many students giraffes have a higher number of neck vertebras as it is. We can see in many documentary films, movies, etc. the localization of the heart is on the left side of the human body. Also, parents say in many situations, that the heart is on the left side. So our finding is in concordance with other authors (e.g. Prokop & Fancovicova, 2006; White & Gunstone, 1994).

But the problem of the giraffe's neck is very interesting. Why many students think, that the number of vertebras is higher than it is? Maybe their imagination suppresses the presentation of facts in the school, maybe the students think the longer neck the higher number of vertebras. This question is very interesting as it was mentioned above and further research is needed, for example to compare drawings of giraffe and human vertebras neck. From the previous kinds of information is obvious the misconceptions are very stable, resistant to influence of other sources (like teachers) if they had very strong base in the early childhood. The similar expression is possible to find in many studies (e.g. Hammer, 1996; Smith, diSessa & Roschelle, 1993/1994), if the teacher does not create such a situation, which deconstruct pupils or students previous wrong idea (misconceptions), this misconception still be remaining in the memory of student and it will be transmitted cyclically from teacher to his/her pupils.

In the study the differences between genders and study areas were also investigated. As it is possible to observe, males and females answered in similar levels of incorrectness of answers for each question. But it is possible to see the science major students answered some questions better in comparison with non-science major students. This fact is possible to explain, the interest about science, in this case biology, has got a positive impact on the level of misconceptions (Kara & Yesilyurt, 2008), but we cannot be optimistic, because the level of misconception was also high among science major students.

Conclusions

In the study the effort was to prove the persistence of the common misconceptions among Czech university students. From the results is obvious the students have misconceptions about the common biological facts. As the research method was used a questionnaire. Authors are realizing it is not the only one method for the detecting misconceptions among students. In the further research is possible after the evaluation of questionnaire or test answers realized interview with respondents, how they thought their answers. Another limit of the study is the selection of sample. In the further research could be sampled represent students from all grades

of the university or realize longitudinal research, if misconceptions are changing over time from elementary school to university.

The authors could draw some conclusions from these findings. The first one lies in the importance of the research related to common facts, not only from the biology. If the misconceptions about common biological facts, which were presented in this study, will persist, there is a chance to create the "misconception circle", in which teachers will not teach pupils correct kinds of information. From this conclusion arises another one, how to eliminate the misconceptions of university students. It is possible to find many suggestions, for example, Christianson & Fisher (1999) reported that college students in a "constructivist" course learned significantly more diffusion and osmosis concepts than students in a more traditional biology course. It was suggested that motivation and learning in biology could be enhanced by:

1. Allowing teacher-student and student-student discussion.
2. Allowing time for prediction. Once students have been presented with a body of information, they need opportunities to apply that information in order to weed out misconceptions, reinforce understanding, and make predictions.
3. Using concept mapping to anchor concepts and construct meaning.
4. Using the best teaching method- a variety of methods. Lecture, discussion, laboratory demonstration, prediction, consensus building, and computer organization of knowledge all contribute to learning. Different students will respond to different techniques. Some important implications how to eliminate misconceptions, is possible to find in the works by Carey (2000) or Smith et al. (1997).

The next conclusion is which we do not have to forget, above are presented common misconceptions among future teachers. These teachers will teach at elementary school**s**, so they will provide the incorrect facts and from this follows the persistence of misconceptions in population.

References

Abimbola, I. O., & Baba, S. (1996). Misconceptions & alternative conceptions in science textbooks: The role of teachers as filters. *The American Biology Teacher*, *58* (1), 14-19.

Arnaudin, M. W., & Mintzes, J. S. (1985). Students' alternative conceptions of the human circulatory system: A cross-age study. *Science Education*, *69* (5), 721-733.

Bahar, M. (2003). Misconceptions in biology education and conceptual change strategies. *Educational Sciences: Theory & Practice*, *3* (1), 55-64.

Bell, B. F. (1981). When is an animal, not an animal? *Journal of Biological Education*, *15* (3), 213-218.

Braund, M. (1991). Children's ideas in classifying animals *Journal of Biological Education*, *25* (2), 103-110.

Buckley, B. (2000). Interactive multimedia and model-based learning in biology. *International Journal of Science Education*, *22* (3), 895-935.

Bunce, D. M., Flens, E. A., & Neiles, K. Y. (2010). How long can students pay attention in class? A study of student attention declines using clickers. *Journal of Chemical Education*, *87* (12), 1438-1443.

Cardak, O. (2009). Science students' misconceptions about birds. *Scientific Research and Essay*, *4* (12), 1518-1522.

Carey, S. (2000). Science education as conceptual change. *Journal of Applied Developmental Psychology*, *21* (1), 13-19.

Christianson, R. G., & Fisher, K. M. (1999). Comparison of student learning about diffusion and osmosis in constructivist and traditional classrooms. *International Journal of Science Education*, *21* (6), 687-698.

Christmann, A., & Van Aelst, S. (2006). Robust estimation of Cronbach's alpha, *Journal of Multivariate Analysis*, *97* (7), 1660-1674.

Dekkers, P. J. J. M., & Thijs, D. G. (1998). Making productive use of students' initial conceptions in developing the concept of force. *Science Education*, *82* (1), 31-51.

Deshmukh, N. D., & Deshmukh, V. M. (2007). A study of students' misconceptions in biology at the secondary school level. *Proceedings of epiSTEME-2: An International Conference to Review Research on Science, Technology and Mathematics Education* (137-141). Delhi, India: Macmillan India Ltd.

Dikmenli, M., & Cardak, O. (2004). A study on misconceptions in the 9th grade high school Biology textbooks. *Eurasian Journal of Educational Research*, *17* (1), 130-141.

Eggen, P., & Kauchak, D. (2004) *Educational psychology: Windows, classrooms*. Upper Saddle River: Pearson Prentice Hall.

Gais, S., & Born, J. (2004). Declarative memory consolidation: Mechanisms acting during human sleep. *Learning & Memory*, *11* (6), 679-685.

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 updates* (4th Ed.). Boston: Allyn & Bacon.

Goodnow, J. J. (1988). Parents' ideas, actions, and feelings: Models and methods from developmental and social psychology. *Child Development*, *59* (2), 286-320.

Guesne, E., & Tiberghien, A. (1985). *Children's ideas in science*. Philadelphia: Open University

Hammer, D. (1996). Misconception or p-prims: How may alternative perspectives of cognitive structure influence instructional perceptions and intentions? *Journal of the Learning Sciences*, *5* (2), 97-127.
Hanuscin, D. (2001). *Misconceptions in science E328: Elementary Methods*. [Online] http://www.indiana.edu/~w505a/studwork/deborah/. [05/02/2014].
Hatano, G., & Inagaki, K. (2002). *Young children's thinking about the biological world*. New York: Psychological Press.
Hedgehog – Apple (2014). http://www.shutterstock.com/s/hedgehog-apple/search.html <2014-04_16>
Kara, Y., & Yesilyurt, S. (2008). Comparing the impacts of tutorial and edutainment software programs on students' achievements, misconceptions, and attitudes towards biology. *Journal of Science Education and Technology*, *17* (1), 32-41.
Khalid, T. (2001). Pre-service teachers' misconceptions regarding three environmental issues. *Canadian Journal of Environmental Education, 6* (1), 109-120.
Kubiatko, M., & Dozbabova, E. (Unpublished manuscript). Lower secondary school pupils' misconceptions about and attitudes toward mammals.
Kubiatko, M., & Prokop, P. (2007). Pupils' misconceptions about mammals. *Journal of Baltic Science Education*, *6* (1), 5-14.
Libarkin, J. C., Anderson, S. W., Dahl, J., Beilfuss, M., & Boone, W. (2005). Qualitative analysis of college students' ideas about the earth: Interviews and open-ended questionnaires. *Journal of Geoscience Education*, *53* (1), 17-26.
Martin, R., Sexton, C., & Gerlovich, J. (2002). *Teaching science for all children: Methods for constructing understanding*. Boston: Allyn and Bacon.
Meir, E., Perry, J., Herron, J. C., & Kingsolver, J. (2007). College students' misconceptions about evolutionary trees. *The American Biology Teacher*, *69* (7), 71-76.
Odum, L. A. (1995). Secondary & college biology students' misconceptions about diffusion & osmosis. *The American Biology Teacher*, *57* (7), 409-415.
Özgür, S. (2013). The persistence of misconceptions about the human blood circulatory system among students in different grade levels. *International Journal of Environmental & Science Education*, *8* (2), 255-268.
Park, S. K. (2013). The relationship between students' perception of the scientific models and their alternative conceptions of the lunar phases. *Eurasia Journal of Mathematics, Science and Technology Education*, *9* (3), 285-299.
Patton, M. Q. (2002). *Qualitative research and evaluation*. Thousand Oaks, CA: Sage.
Prokop, P., & Fancovicova, J. (2006). Students' ideas about the human body: Do they really draw what they know? *Journal of Baltic Science Education*, *2* (10), 86-95.
Prokop, P., Kubiatko, M., & Fancovicova, J. (2007). Why do cocks crow? Children's concepts about birds. *Research in Science Education*, *37* (4), 393-405.
Prokop, P., Kubiatko, M., & Fancovicova, J. (2008). Slovakian pupils' knowledge of and attitudes toward birds. *Anthrozoös*, *21* (3), 221-235.
Randler, C., Hollwarth, A., & Schall, A. (2007). Urban park visitors and their knowledge of animal species, *Anthrozoös*, *20* (1), 66-74.
Sanders, M. (1993). Erroneous ideas about respiration: The teacher factor. *Journal of Research in Science Teaching*, *30* (8), 919-934.
Scoboria, A., Mazzoni, G., Kirsch, I., & Jimenez S. (2006). The effects of prevalence and script information on plausibility belief and memory of autobiographical events. *Applied Cognitive Psychology, 20* (8), 1049-1064.
Silva, M., Groeger, J., & Bradshaw, M. (2006). Attention-memory interactions in scene perception. *Spatial Vision*, *19* (1), 9-19.
Smith, J., diSessa, A., & Roschelle, J. (1993 / 1994). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *The Journal of the Learning Sciences*, *3* (2), 115-163.
Smith, C., Maclin, D., Grosslight, L., & Davis, H. (1997). Teaching for understanding: A study of students' pre-instruction theories of matter and a comparison of the effectiveness of two approaches to teaching about matter and density. *Cognition and Instruction*, *15* (3), 317–393
Storey, R. D. (1992). Textbook errors and misconceptions in biology: Cell energetics. *The American Biology Teacher*, *54* (3), 161-166.
Thompson, F., & Logue, S. (2006). An exploration of common student misconceptions in science. *International Education Journal*, *7* (4), 553-559.
Trowbridge, J. E., & Mintzes, J. J. (1985). Students' alternative conceptions of animals and animal classification. *School Science and Mathematics*, *85* (4), 304-316.
Trowbridge, J. E., & Mintzes, J. J. (1988). Alternative conceptions in animal classification: A cross-age study. *Journal of Research in Science Teaching*, *25* (7), 547-571.
Tulving, E. (1972). Episodic and semantic memory. In *Organization of Memory*, Ed. E Tulving, W Donaldson, (381–403). New York: Academic
Wenning, C. J. (2008). Dealing more effectively with alternative conceptions in science. *Journal of Physics Teacher Education Online, 5* (1), 11-19.
White, R. T., & Gunstone R. F. (1994). *Probing understanding*. London, UK: Falmer Press.
Wilson, K., & Korn, J. H. (2007). Attention during lectures: Beyond ten minutes. *Teaching of Psychology*, *34* (2), 85-89.
Yangin, S. (2013). Pre-service classroom teachers mislearning of classification of the plant kingdom and the effect of porphyries tree on removing them. *Journal of Baltic Science Education*, *12* (2), 178-190.
Yip, D. Y. (1998). Teachers' misconceptions of the circulatory system. *Journal of Biological Education*, *32* (3), 207-215.
Young, J. A. (1982). Camels on the Western range. *Rangelands*, *4* (6), 248-251.

Young, M. S., Robinson, S., & Alberts, P. (2009). Students pay attention!: Combating the vigilance decrement to improve learning during lectures. *Active Learning in Higher Education*, *10* (1), 41-55.

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